# FCC SAR TEST REPORT

**Report No: STS1412001H01**

Issued for

**RM ACQUISITIONS LLC**

**9855 Woods Drive Skokie. IL 60077 U.S.A**

| | |
|---|---|
| **Product Name:** | TND Tablet |
| **Brand Name:** | RAND MCNALLY |
| **Model No.:** | TNDT80 |
| **Series Model:** | Road Explorer 80 |
| **FCC ID:** | A4C-10007A |
| **Test Standard:** | ANSI/IEEE Std. C95.1 |
| | FCC 47 CFR Part 2 ( 2.1093) |
| | IEEE 1528: 2013 |
| **Max. SAR (1g):** | Body:0.588 W/kg |



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# Test Report Certification

| | | |
|---|---|---|
| **Applicant's name** | : | RM ACQUISITIONS LLC |
| Address | : | 9855 Woods Drive Skokie. IL 60077 U.S.A |
| **Manufacture's Name** | : | Apical Technology Research（shenzhen）Co., Ltd |
| Address | : | 9/F,B, Building, singhua Unis Infoport, Langshan Road, North District, Hi-tech Industrial park, Nanshan, Shenzhen, China |

**Product description**

| | | |
|---|---|---|
| Product name | : | TND Tablet |
| Trademark | : | RAND MCNALLY |
| Model and/or type reference | : | TNDT80 |
| Serial Model： | | Road Explorer 80 |
| **Standards** | : | ANSI/IEEE Std. C95.1-1992<br>FCC 47 CFR Part 2 ( 2.1093)<br>IEEE 1528: 2013 |

The device was tested by Shenzhen STS Test Services Co., Ltd. in accordance with the measurement methods and procedures specified in KDB 865664. The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

| | | |
|---|---|---|
| **Date of Test** | : | |
| Date (s) of performance of tests | : | 12 Dec. 2014 |
| Date of Issue | : | 13 Dec. 2014 |
| Test Result | : | **Pass** |

Testing Engineer **:** (Tony Liu)

Technical Manager **:** (Vita Li)

Authorized Signatory **:** (Bovey Yang)

# TABLE OF CONTENS

# 1. General Information

## 1.1 EUT Description

| | |
|---|---|
| Equipment | TND Tablet |
| Brand Name | RAND MCNALLY |
| Model No. | TNDT80 |
| Serial Model | Road Explorer 80 |
| FCC ID | A4C-10007A |
| Model Difference | Only different in model |
| Adapter | Input: AC100-240V, 0.5 A, 50/60 Hz<br>Output: DC 5V, 2000mA |
| Battery | Rated Voltage: 3.7V<br>Charge Limit: 4.2V<br>Capacity: 4000mAh |
| Hardware Version | N/A |
| Software Version | N/A |
| Frequency Range | IEEE 802.11b/g/20n: 2412MHz to 2472 MHz<br>IEEE 802.1140n: 2422MHz to 2462 MHz<br>Bluetooth: 2402 MHz to 2480 MHz |
| Transmit Power(Average): | IEEE 802.11b: 15.13 dBm<br>Bluetooth: 1.52 dBm |
| Max. Reported SAR(1g): | Body: 802.11b: 0.588W/kg |
| Operating Mode: | Maximum continuous output |
| Antenna Specification: | WIFI/BT: PIFA Antenna |
| Test Mode: | Maximum continuous output |
| Hotspot Mode: | Support |
| DTM Mode: | Not Support |

## 1.2 Test Environment

Ambient conditions in the SAR laboratory:

| Items | Required | Actual |
|---|---|---|
| Temperature (℃) | 18-25 | 22~23 |
| Humidity (%RH) | 30-70 | 55~65 |

## 1.3 Test Facility

Shenzhen STS Test Services Co., Ltd.
Add. : 1/F, Building 2, Zhuoke Science Park, Chongqing Road, Fuyong, Baoan District, Shenzhen, China
FCC Registration No.: 842334; IC Registration No.: 12108A-1

## 2. Test Standards And Limits

| No. | Identity | Document Title |
|---|---|---|
| 1 | 47 CFR Part 2 | Frequency Allocations and Radio Treaty Matters; General Rules and Regulations |
| 2 | ANSI/IEEE Std. C95.1-1992 | 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 v05r02 | Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies |
| 5 | FCC KDB 865664 D01 v01r03 | SAR Measurement 100 MHz to 6 GHz |
| 6 | FCC KDB 865664 D01 v01r03 | SAR Measurement 100 MHz to 6 GHz |
| 7 | FCC KDB 941225 D01 | SAR Measurement Procedures for 3G Devices |
| 8 | FCC KDB 248227 D01 | SAR Measurement Procedures for 802.11 a/b/g Transmitters |

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. According to EN 50360 and 1999/519/EC the limit for General Population/Uncontrolled exposure should be applied for this device, it is 2.0 W/kg as averaged over any 10 gram of tissue.

(A). Limits for Occupational/Controlled Exposure (W/kg)

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|---|---|---|
| 0.4 | 8.0 | 20.0 |

(B). Limits for General Population/Uncontrolled Exposure (W/kg)

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|---|---|---|
| 0.08 | 1.6 | 4.0 |

NOTE: Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 10 gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

**Population/Uncontrolled Environments:**
are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

**Occupational/Controlled Environments:**
are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

**NOTE**

**GENERAL POPULATION/UNCONTROLLED EXPOSURE**

**PARTIAL BODY LIMIT**

**1.6 W/kg**

# 3. SAR Measurement System

## 3.1 Definition Of Specific Absorption Rate (SAR)

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

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

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

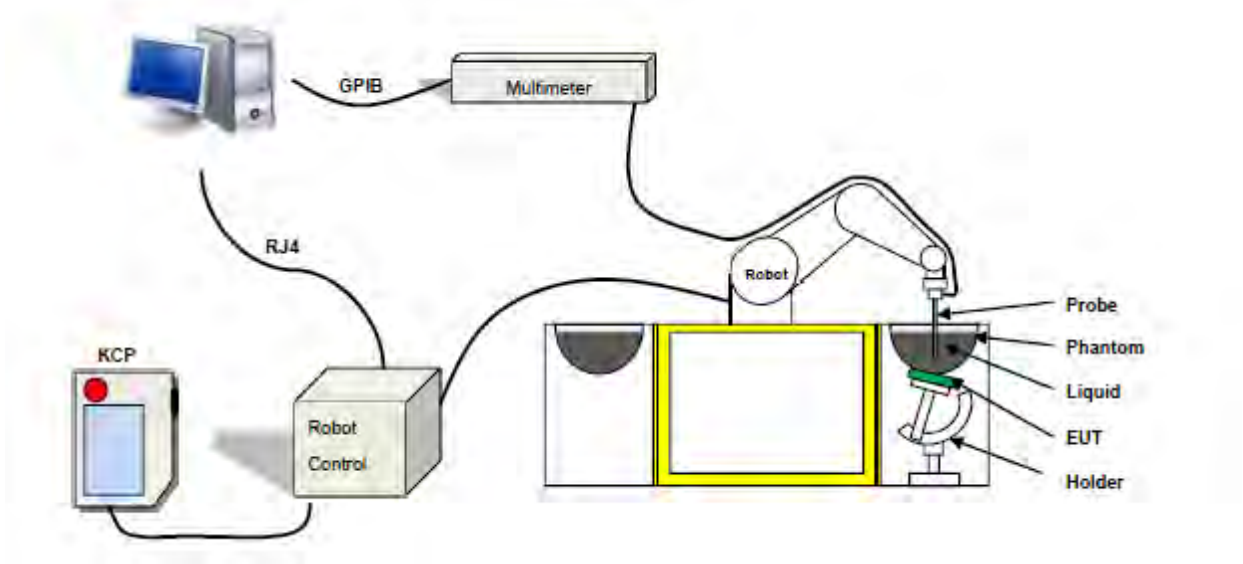
SAR is expressed in units of Watts per kilogram (W/kg) SAR measurement can be related to the electrical field in the tissue by

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

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

## 3.2 SAR System

SATIMO SAR System Diagram:




Comosar is a system that is able to determine the SAR distribution inside a phantom of human being according to different standards. The Comosar system consists of the following items:

- Main computer to control all the system
- 6 axis robot
- Data acquisition system
- Miniature E-field probe
- Phone holder
- Head simulating tissue

The following figure shows the system.


The EUT under test operating at the maximum power level is placed in the phone holder, under the phantom, which is filled with head simulating liquid. The E-Field probe measures the electric field inside the phantom. The OpenSAR software computes the results to give a SAR value in a 1g or 10g mass.

### 3.2.1 Probe

For the measurements the Specific Dosimetric E-Field Probe SN 17/14 EP221 with following specifications is used

- Dynamic range: 0.01-100 W/kg
- Tip Diameter :5 mm
- Distance between probe tip and sensor center: 2.7mm
- Distance between sensor center and the inner phantom surface: 4 mm (repeatability better than +/- 1mm)
- Probe linearity: ＜0.25 dB
- Axial Isotropy: ＜0.25 dB
- Spherical Isotropy: ＜0.25 dB
- Calibration range: 450MHz to 2600MHz for head & body simulating liquid.

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

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

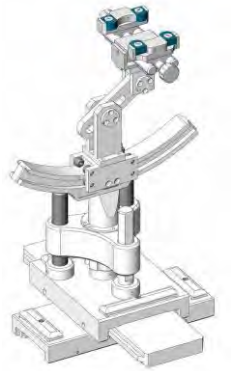
### 3.2.2 Phantom

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.

SN 32/14 SAM115

SN 32/14 SAM116

### 3.2.3 Device Holder



The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of ± 0.5 mm would produce a SAR uncertainty of ± 20 %. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.4. Tissue Simulating Liquids

# 4. Tissue Simulating Liquids

## 4.1 Simulating Liquids Parameter Check

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 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 P1528 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 P1528.

**LIQUID MEASUREMENT RESULTS**

**Date:** Dec. 12, 2014 **Ambient condition:** Temperature 22.7°C **Relative humidity:** 49%

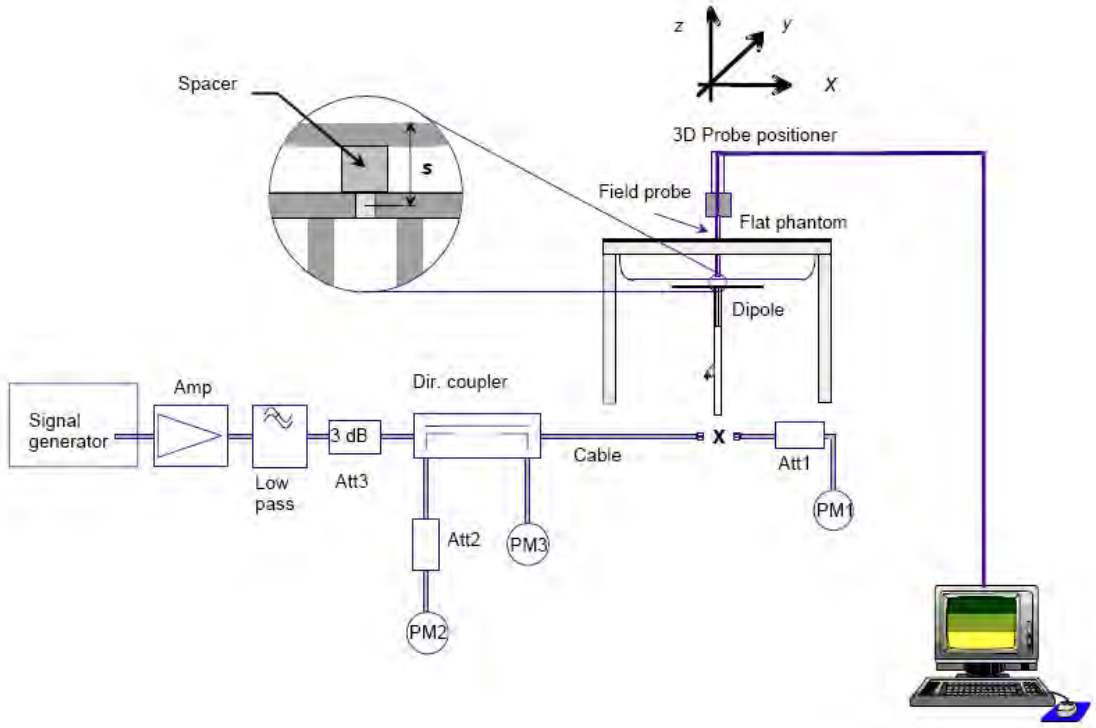
| Body Simulating Liquid | | Parameters | Target | Measured | Deviation[%] | Limited[%] |
|---|---|---|---|---|---|---|
| Frequency | Temp. [°C] | | | | | |
| 2450 MHz | 22.30 | Permitivity : | 52.7 | 52.42 | -0.53 | ± 5 |
| | | Conductivity: | 1.95 | 1.94 | -0.51 | ± 5 |

# 5. SAR System Validation

## 5.1 Validation System

Each SATIMO 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 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 validation setup is shown as below.




## 5.2 Validation Result

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

**Ambient condition:** Temperature 22.7°C **Relative humidity:** 49%

| Freq.(MHz) | Power(mW) | Tested Value (W/Kg) | Normalized SAR (W/kg) | Target(W/Kg) | Tolerance(%) | Date |
|---|---|---|---|---|---|---|
| 2450 Body | 100 | 5.233 | 52.33 | 52.7 | -0.70 | 2014-12-12 |

Note:

The tolerance limit of System validation ±10%.

# 6. SAR Evaluation Procedures

The procedure for assessing the average SAR value consists of the following steps:
The following steps are used for each test position

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

➢ Area Scan& Zoom Scan

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 D01v01r01 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.

# 7. EUT Antenna Location Sketch

It is a TND Tablet; Road Explorer 80, only support WIFI mode.

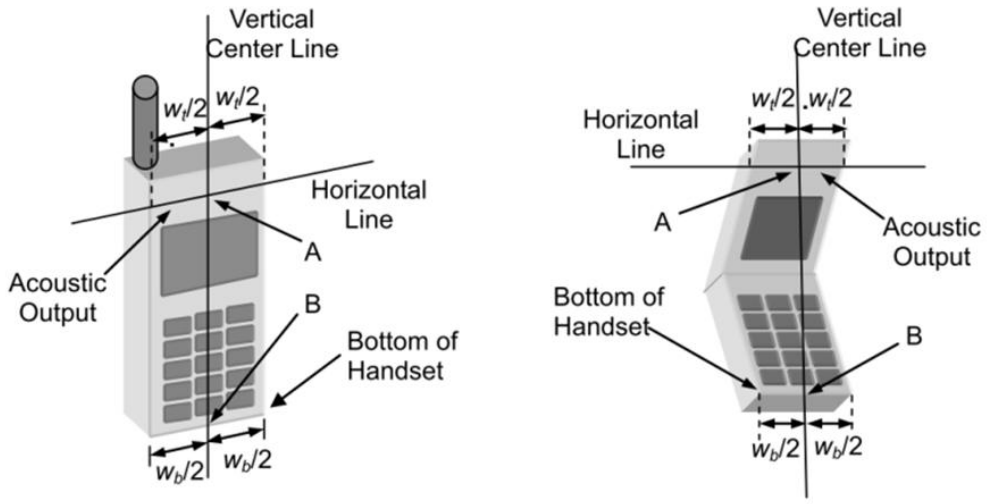

The diagonal dimension is about 244mm, So test distance is 0mm.

# 8. EUT Test Position

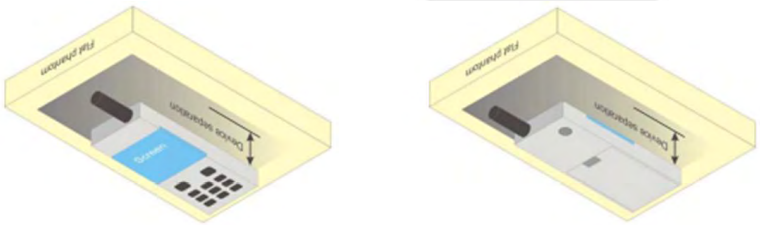
This EUT was tested in Right Cheek, Right Titled, Left Cheek, Left Titled, Front Face and Rear Face.

## 8.1 Define Two Imaginary Lines On The Handset

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

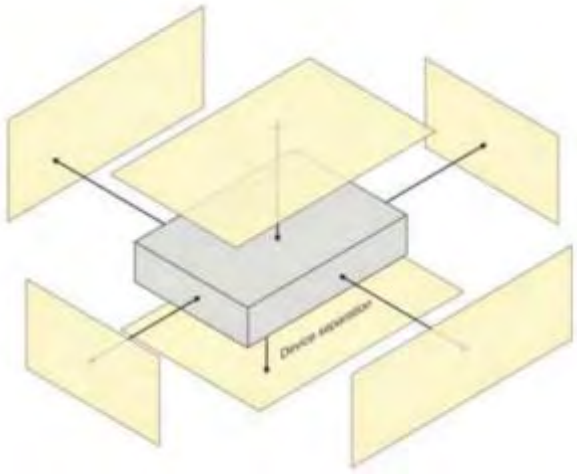



Body-worn Position Conditions
(1) To position the EUT parallel to the phantom surface.
(2) To adjust the EUT parallel to the flat phantom.
(3) To adjust the distance between the EUT surface and the flat phantom to 5mm.



## 8.2 Hotspot mode exposure position condition

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


Device separation

# 9. Measurement Uncertainty

The following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in IEEE 1528: 2013.This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

| NO | Source | Tol(%) | Prob. Dist. | Div. k | ci (1g) | ci (10g) | 1gUi | 10gUi | Veff |
|---|---|---|---|---|---|---|---|---|---|
| Measurement System□ | | | | | | | | | |
| 1 | Probe calibration | 5.8 | N | 1 | 1 | 1 | 5.8 | 5.8 | ∞ |
| 2 | Axial isotropy | 3.5 | R | √3 | $(1\text{-cp})^{1/2}$ | $(1\text{-cp})^{1/2}$ | 1.43 | 1.43 | ∞ |
| 3 | Hemispherical isotropy | 5.9 | R | √3 | $\sqrt{C_p}$ | $\sqrt{C_p}$ | 2.41 | 2.41 | ∞ |
| 4 | Boundary effect | 1.0 | R | √3 | 1 | 1 | 0.58 | 0.58 | ∞ |
| 5 | Linearity | 4.7 | R | √3 | 1 | 1 | 2.71 | 2.71 | ∞ |
| 6 | System Detection limits | 1.0 | R | √3 | 1 | 1 | 0.58 | 0.58 | ∞ |
| 7 | Modulation response | 0 | N | 1 | 1 | 1 | 0 | 0 | ∞ |
| 8 | Readout electronics | 0.5 | N | 1 | 1 | 1 | 0.50 | 0.50 | ∞ |
| 9 | Response time | 0 | R | √3 | 1 | 1 | 0 | 0 | ∞ |
| 10 | Integration time | 1.4 | R | √3 | 1 | 1 | 0.81 | 0.81 | ∞ |
| 11 | Ambient noise | 3.0 | R | √3 | 1 | 1 | 1.73 | 1.73 | ∞ |
| 12 | Ambient reflections | 3.0 | R | √3 | 1 | 1 | 1.73 | 1.73 | ∞ |
| 13 | Probe positioner mech. restrictions | 1.4 | R | √3 | 1 | 1 | 0.81 | 0.81 | ∞ |
| 14 | Probe positioning with respect to phantom shell | 1.4 | R | √3 | 1 | 1 | 0.81 | 0.81 | ∞ |
| 15 | Max.SAR evaluation | 1.0 | R | √3 | 1 | 1 | 0.6 | 0.6 | ∞ |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Test sample related | | | | | | | | | |
| 16 | Device positioning | 2.6 | N | 1 | 1 | 1 | 2.6 | 2.6 | 11 |
| 17 | Device holder | 3 | N | 1 | 1 | 1 | 3.0 | 3.0 | 7 |
| 18 | Drift of output power | 5.0 | R | √3 | 1 | 1 | 2.89 | 2.89 | ∞ |
| Phantom and set-up | | | | | | | | | |
| 19 | Phantom uncertainty | 4.0 | R | √3 | 1 | 1 | 2.31 | 2.31 | ∞ |
| 20 | Uncertainty in SAR correction for deviation(in permittivity and conductivity) | 2.0 | N | 1 | 1 | 0.84 | 2 | 1.68 | ∞ |
| 21 | Liquid conductivity (target) | 2 | N | 1 | 1 | 0.84 | 2.00 | 1.68 | ∞ |
| 22 | Liquid conductivity (temperature uncertainty) | 2.5 | N | 1 | 0.78 | 0.71 | 1.95 | 1.78 | 5 |
| 23 | Liquid conductivity (meas) | 4 | N | 1 | 0.23 | 0.26 | 0.92 | 1.04 | 5 |
| 24 | Liquid Permittivity (target) | 2.5 | N | 1 | 0.78 | 0.71 | 1.95 | 1.78 | ∞ |
| 25 | Liquid Permittivity (temperature uncertainty) | 2.5 | N | 1 | 0.78 | 0.71 | 1.95 | 1.78 | 5 |
| 26 | Liquid Permittivity (meas) | 5.0 | N | 1 | 0.23 | 0.26 | 1.15 | 1.30 | ∞ |
| Combined standard | | | RSS | $U_C = \sqrt{\sum_{i=1}^{n} C_i^2 U_i^2}$ | | | 10.63% | 10.54% | |
| Expanded uncertainty (P=95%) | | $U = k\, U_C$ ,k=2 | | | | | 21.26% | 21.08% | |

# 10. Conducted Power Measurement

**WIFI (2.4Gband)**

a. The client supplied a special driver to program the EUT, allowing it to continually transmit the specified maximum power and change the channel frequency.

b. Maximum conducted power was measured by replacing the antenna with an adapter for conductive measurement.

c. The conducted power was measured at the high, middle and low channel frequency before and after the SAR measurement.

d. During SAR test, the highest output channel per band measured first, and then if necessary, the other channels were measured according to the normal procedures.

**Conducted output power (Average)(dBm):**

| Mode | Channel Number | Frequency (MHz) | Average EIRP Power (dBm) |
|---|---|---|---|
| 802.11b | 1 | 2412 | 14.79 |
| | 6 | 2437 | 15.13 |
| | 11 | 2462 | 15.12 |
| 802.11g | 1 | 2412 | 10.70 |
| | 6 | 2437 | 11.77 |
| | 11 | 2462 | 11.14 |
| 802.11n(HT-20) | 1 | 2412 | 9.92 |
| | 6 | 2437 | 10.02 |
| | 11 | 2462 | 10.20 |
| 802.11n(HT-40) | 3 | 2422 | 11.34 |
| | 6 | 2437 | 11.16 |
| | 9 | 2452 | 11.22 |

**Bluetooth Conducted output power**

V3.0

| Mode | Channel Number | Frequency (MHz) | Average EIRP Power (dBm) |
|---|---|---|---|
| 1M | 0 | 2402 | 1.21 |
| | 39 | 2441 | 1.52 |
| | 78 | 2480 | 1.23 |
| 2M | 0 | 2402 | 0.64 |
| | 39 | 2441 | 0.74 |
| | 78 | 2480 | 0.88 |
| 3M | 0 | 2402 | 0.37 |
| | 39 | 2441 | 0.43 |
| | 78 | 2480 | 0.35 |

V4.0

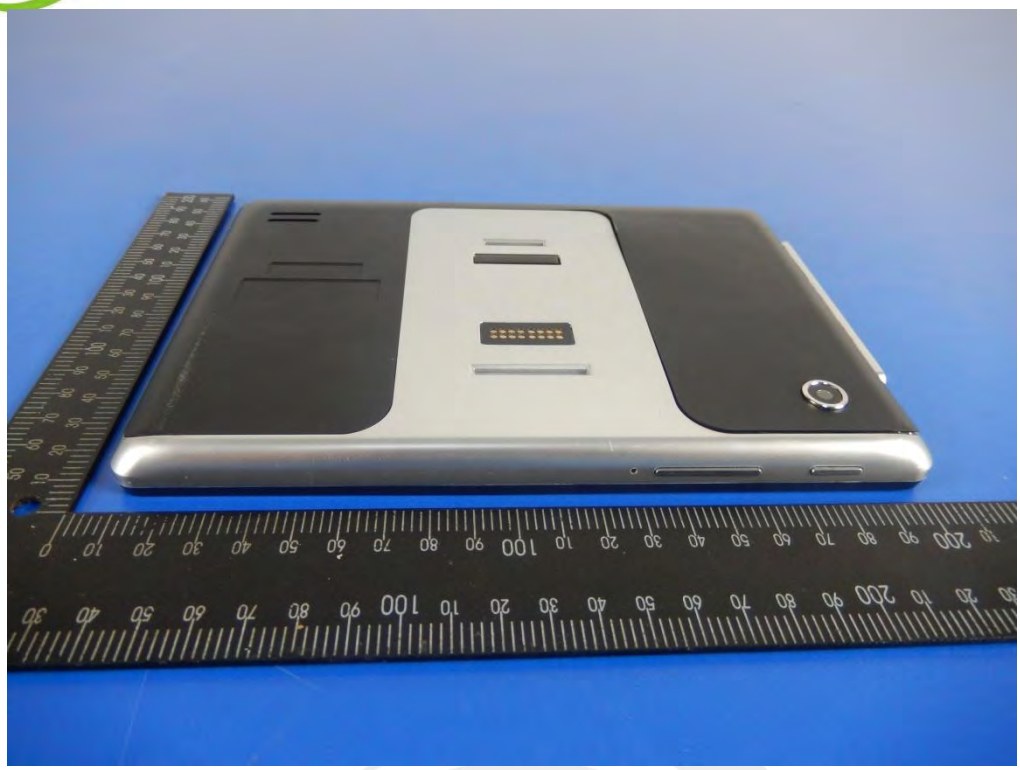
| Mode | Channel Number | Frequency (MHz) | Average EIRP Power (dBm) |
|---|---|---|---|
| GFSK | 0 | 2402 | -1.45 |
| | 19 | 2441 | -1.64 |
| | 39 | 2480 | -1.62 |

# 11. EUT And Test Setup Photo

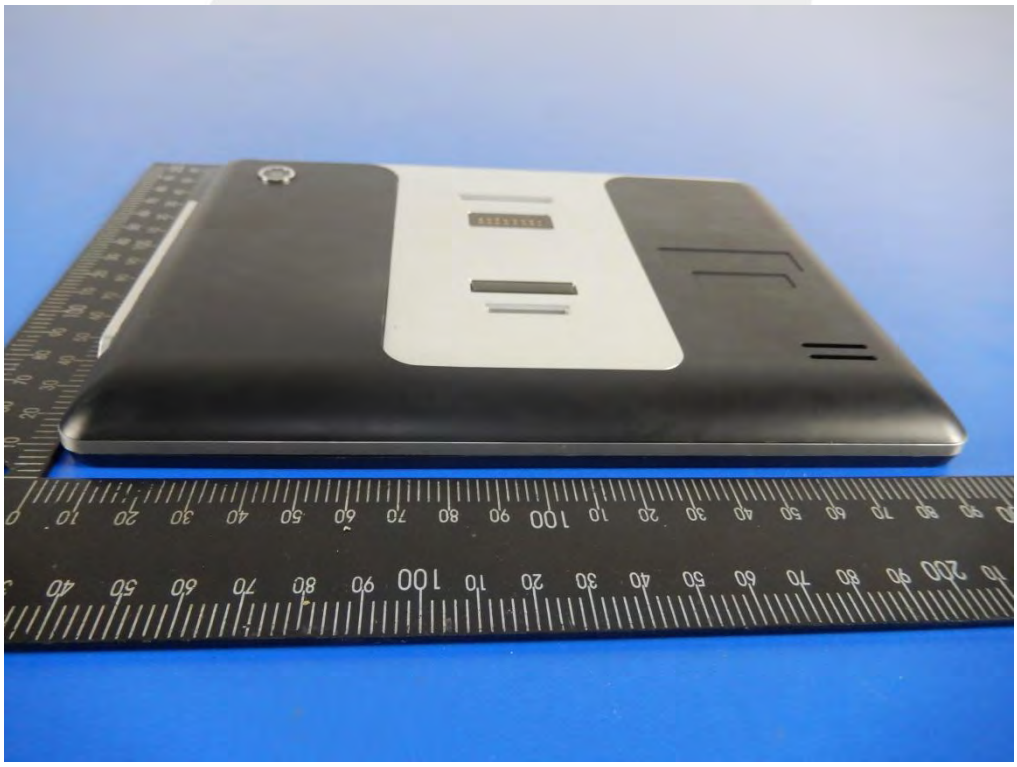
## 11.1 EUT Photo


Front side

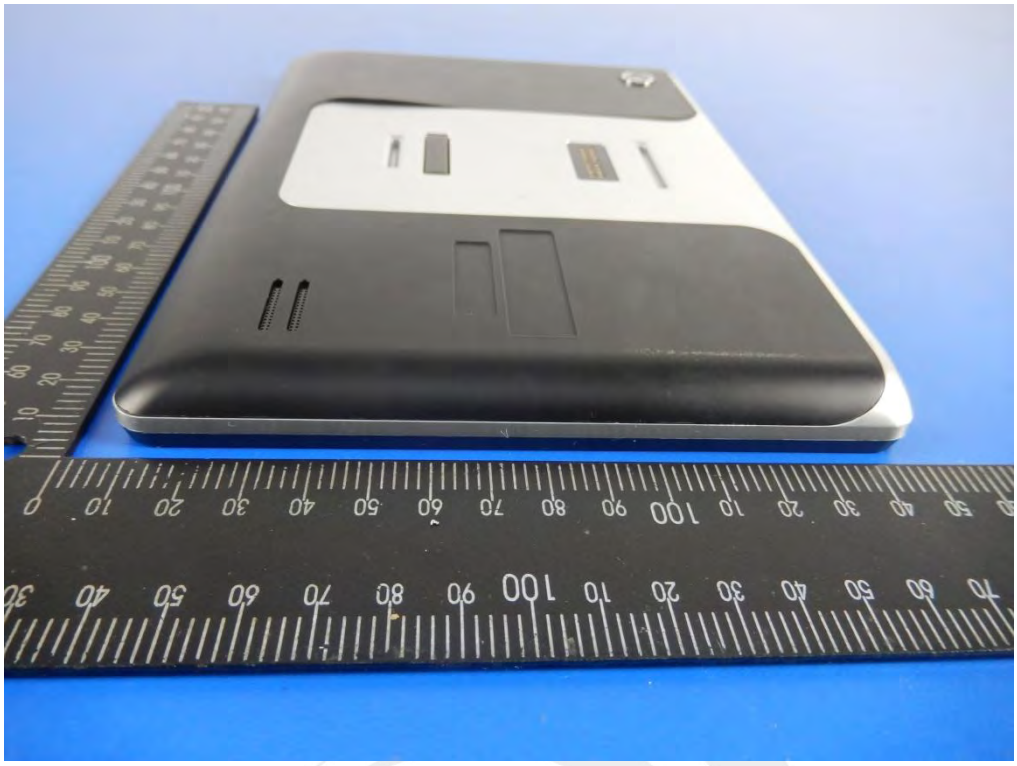
Back side



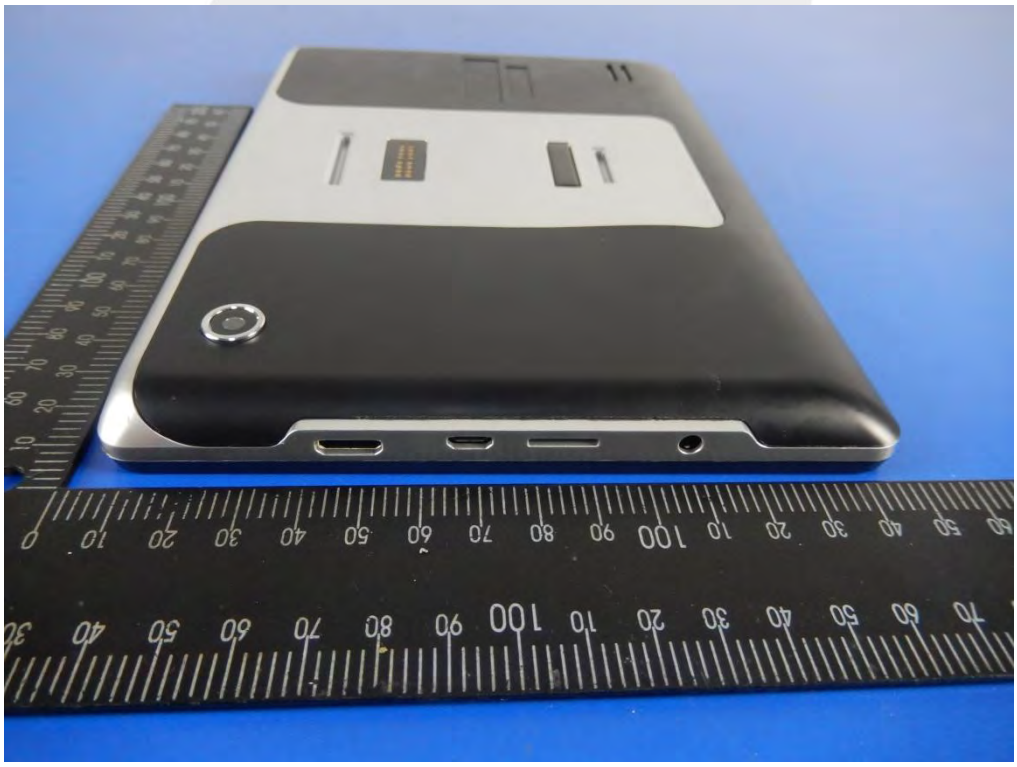
Top side



Bottom side

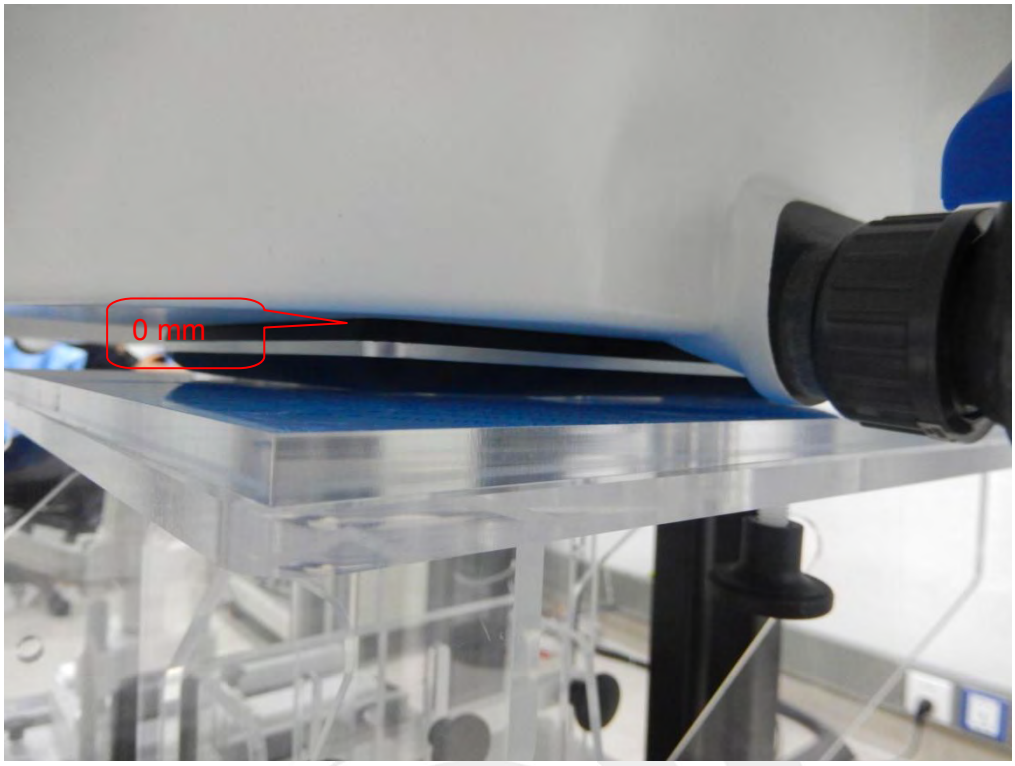


Left side

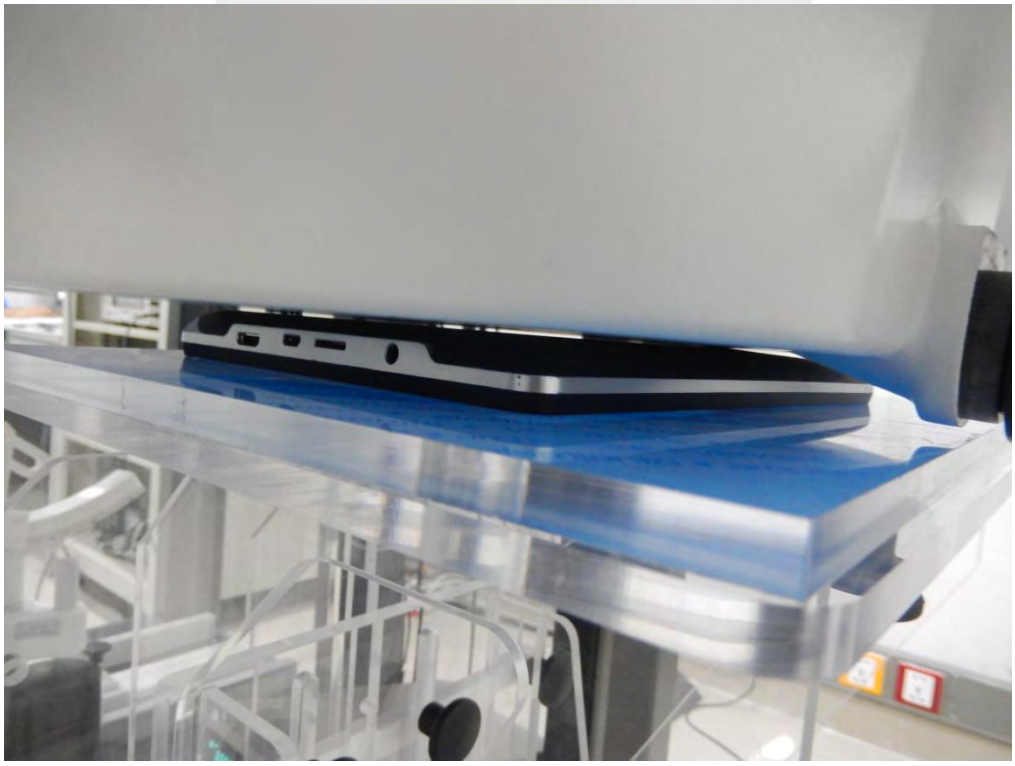


Right side

## 11.2 Setup Photo

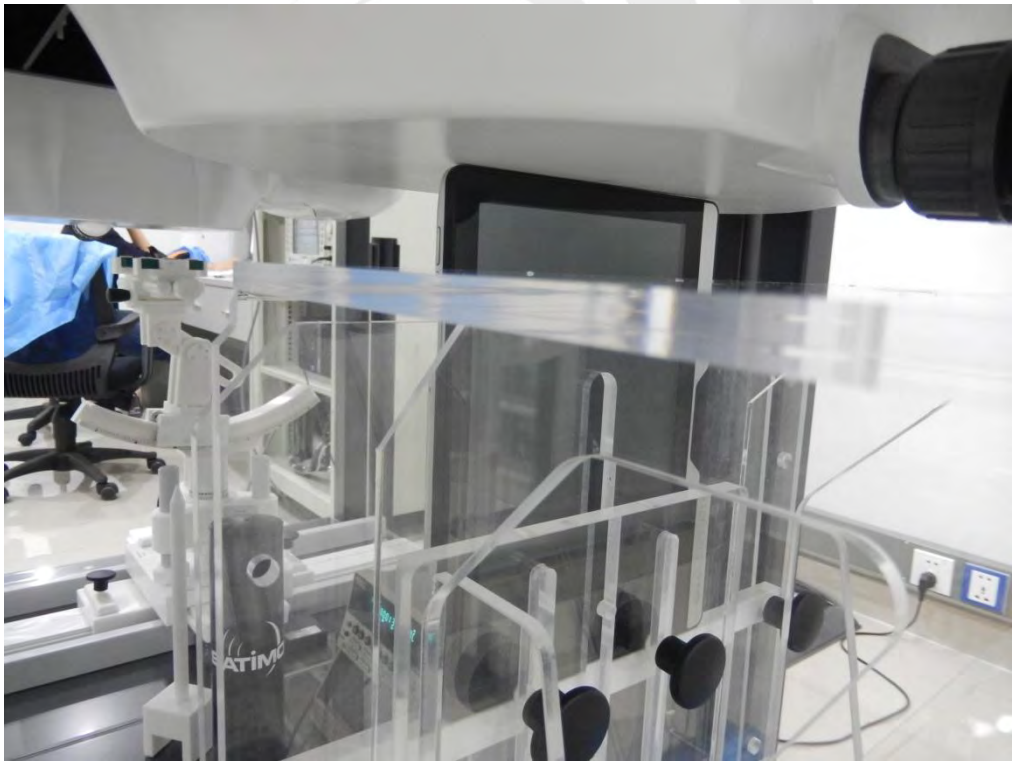



Front side

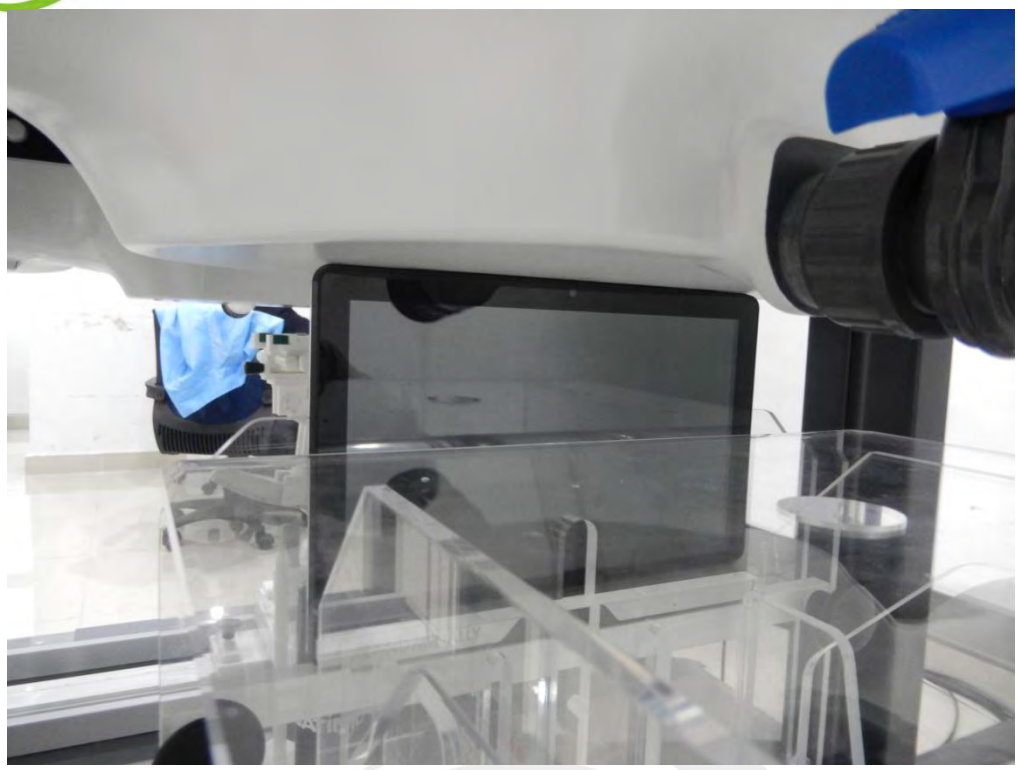


Back side

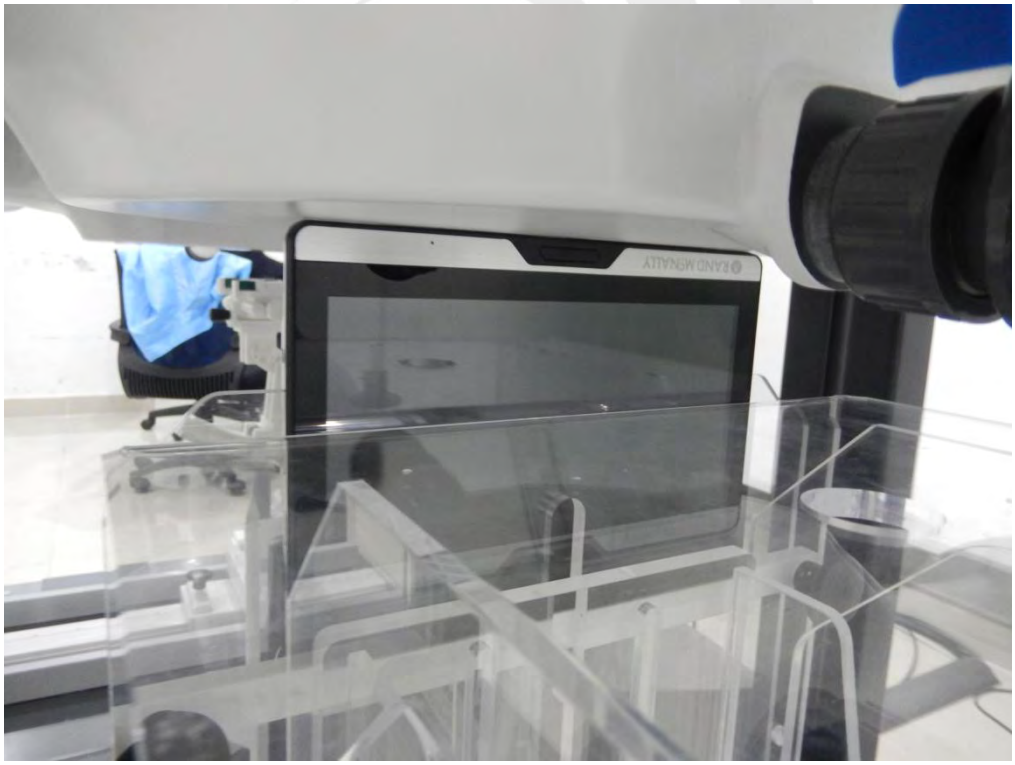
Left side



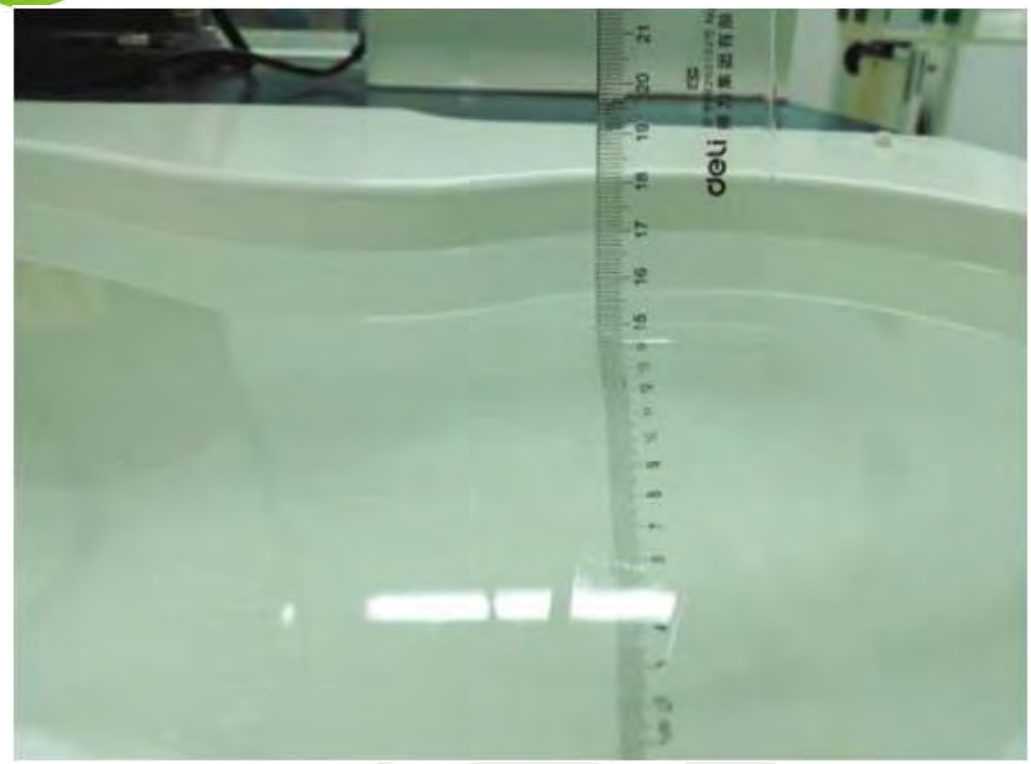
Right side



Top side



Bottom side




Liquid depth (15 cm)

# 12. SAR Result Summary

| Test Case of Body | | | | Freq. (MHz) | Power Drift | SAR (1g) (W/kg) | Max.Turn-up Power(dBm) | Meas.Output Power(dBm) | Scaled SAR (W/Kg) | Meas. No. |
|---|---|---|---|---|---|---|---|---|---|---|
| Band | Model | Test Position | Channel | | | | | | | |
| WIFI | 802.11b | Front | CH6 | 2437 | -0.91 | 0.540 | 15.50 | 15.13 | 0.588 | 1 |
| | | Back | CH6 | 2437 | 1.77 | 0.201 | 15.50 | 15.13 | 0.219 | 2 |
| | | Left | CH6 | 2437 | -2.26 | 0.057 | 15.50 | 15.13 | 0.062 | 3 |
| | | Right | CH6 | 2437 | -1.28 | 0.182 | 15.50 | 15.13 | 0.198 | 4 |
| | | Top | CH6 | 2437 | 0.2 | 0.068 | 15.50 | 15.13 | 0.074 | 5 |
| | | Bottom | CH6 | 2437 | -2.43 | 0.220 | 15.50 | 15.13 | 0.240 | 6 |

Note:

The test separation of all above table is 0mm.

BT and WIFI can't transmit simultaneously.

# 13. Equipment List

| NO. | Instrument | Manufacturer | Model | S/N | Cal. Date | Cal. Due Date |
|---|---|---|---|---|---|---|
| 1 | 2450 MHz Dipole | SATIMO | SID2450 | SN 30/14 DIP2G450-335 | Sep.1, 2014 | Sep.1, 2015 |
| 2 | E-Field Probe | SATIMO | SSE5 | SN 17/14 EP221 | 2014.09.01 | 2015.08.31 |
| 3 | Antenna | SATIMO | ANTA3 | SN 07/13 ZNTA52 | 2014.09.01 | 2015.08.31 |
| 4 | Waveguide | SATIMO | SWG5500 | SN 13/14 WGA32 | 2014.09.01 | 2015.08.31 |
| 5 | Phantom1 | SATIMO | SAM | SN 32/14 SAM115 | 2014.09.01 | 2015.08.31 |
| 6 | Phantom2 | SATIMO | SAM | SN 32/14 SAM116 | 2014.09.01 | 2015.08.31 |
| 7 | SAR TEST BENCH | SATIMO | TND TABLET; ROAD EXPLORER 80 POSITIONNIN | SN 32/14 MSH97 | 2014.09.01 | 2015.08.31 |
| 8 | SAR TEST BENCH | SATIMO | LAPTOP POSITIONNIN G SYSTEM | SN 32/14 LSH29 | 2014.09.01 | 2015.08.31 |
| 9 | Dielectric Probe Kit | SATIMO | SCLMP | SN 32/14 OCPG52 | 2014.09.01 | 2015.08.31 |
| 10 | MultiMeter | Keithley | MultiMeter 2000 | 4050073 | 2014.11.20 | 2015.11.19 |
| 11 | Signal Generator | R&S | SMF100A | 104260 | 2014.10.27 | 2015.10.26 |
| 12 | Power Meter | R&S | NRP | 100510 | 2014.10.25 | 2015.10.24 |
| 13 | Power Sensor | R&S | NRP-Z11 | 101919 | 2014.10.25 | 2015.10.24 |
| 14 | Network Analyzer | R&S | 5071C | EMY46103472 | 2013.12.12 | 2014.12.11 |

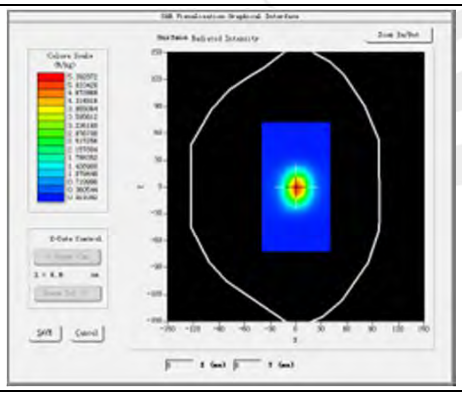
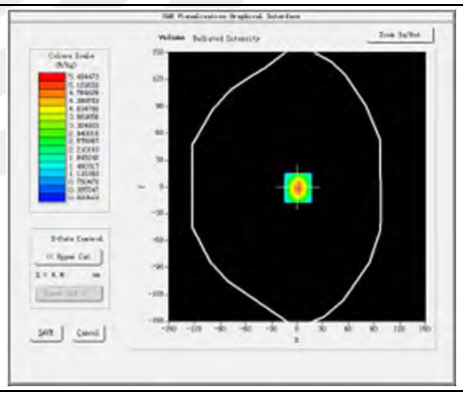
# Appendix A. System Validation Plots

## System Performance Check Data(2450MHz Body)

Type: Phone measurement (Complete)
Area scan resolution: dx=8mm,dy=8mm
Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm
Date of measurement: 2014.12.12

**Experimental conditions.**

| Device Position | Validation plane |
|---|---|
| Band | 2450 MHz |
| Channels | - |
| Signal | CW |
| Frequency (MHz) | 2450 |
| Relative permittivity (real part) | 54.189000 |
| Relative permittivity | 11.9733281 |
| Conductivity (S/m) | 1.920000 |
| Power drift (%) | 0.170000 |
| Ambient Temperature | 22.7°C |
| Liquid Temperature | 22.3°C |
| Probe | SN 17/14 EP221 |
| ConvF | 4.25 |
| Crest factor: | 1:1 |

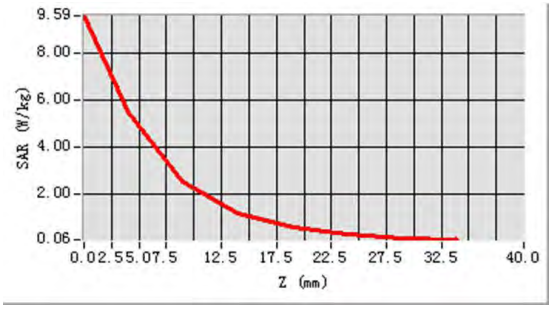
| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |

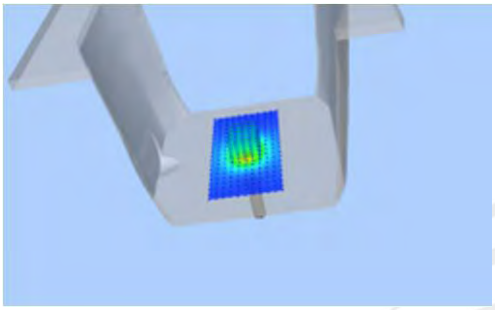
**Maximum location: X=1.00, Y=1.00**

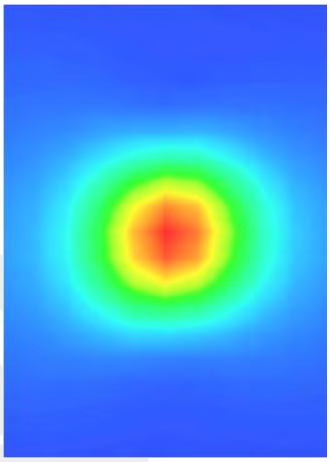
**SAR Peak: 9.46 W/kg**

| | |
|---|---|
| SAR 10g (W/Kg) | 2.294256 |
| SAR 1g (W/Kg) | 5.233532 |

# Z Axis Scan


9.59
8.00
6.00
4.00
2.00
0.06
SAR (W/kg)
0.0 2.5 5.0 7.5 12.5 17.5 22.5 27.5 32.5 40.0
Z (mm)





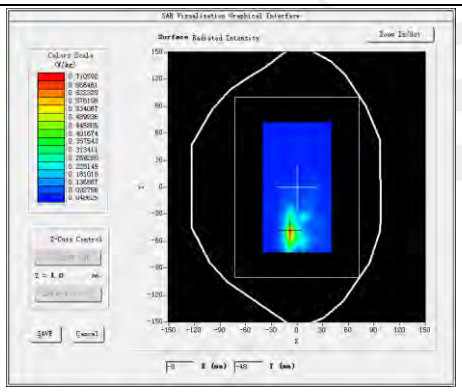
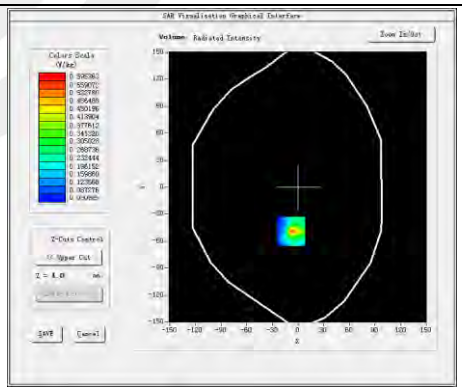
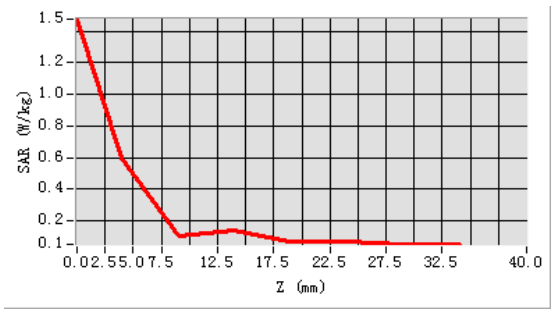
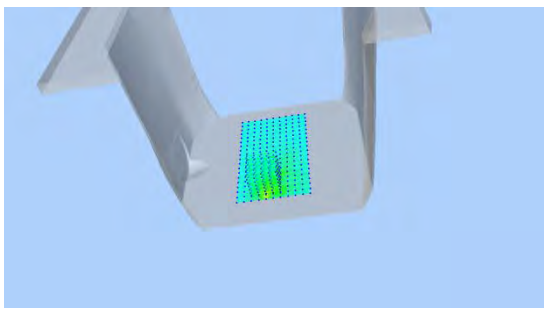
# Appendix B. SAR Test Plots

## Plot 1: DUT: TND Tablet; EUT Model: TNDT80

| | |
|---|---|
| Test Data | 2014-12-12 |
| Probe | SN 17/14 EP221 |
| ConvF | 4.25 |
| Area Scan | dx=8mm dy=8mm, h= 5.00 mm |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm |
| Phantom | Validation plane |
| Device Position | Body Front |
| Band | IEEE 802.11b ISM |
| Channels | Middle |
| Signal | IEEE802.b (Crest factor: 1.0) |
| Frequency (MHz) | 2437 |
| Relative permittivity (real part) | 39.22 |
| Conductivity (S/m) | 1.78 |
| Variation (%) | -0.91 |

**Maximum location: X=-8.00, Y=-49.00**
**SAR Peak: 1.41 W/kg**

| | |
|---|---|
| SAR 10g (W/Kg) | 0.211207 |
| SAR 1g (W/Kg) | 0.540221 |

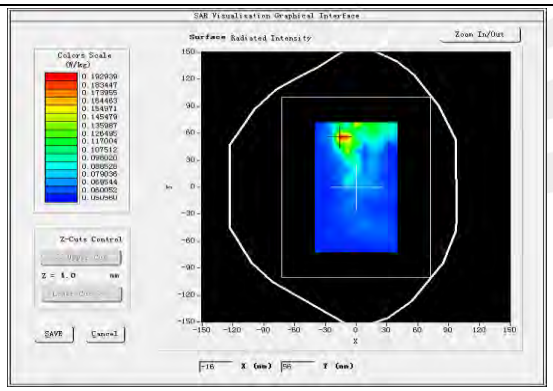
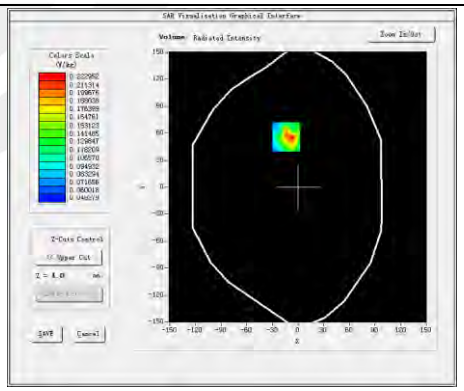
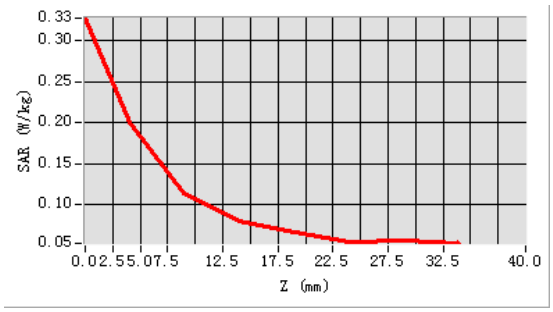
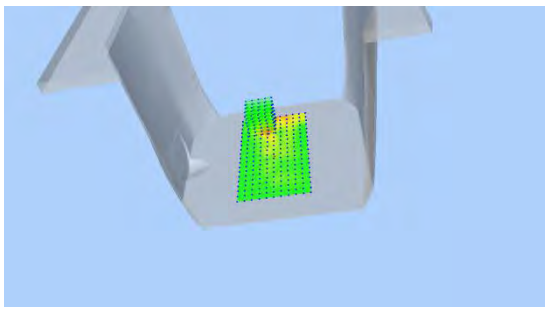
| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |
| **Z Axis Scan** | **3D** |
|   |  |

**Plot 2: DUT: TND Tablet; EUT Model: TNDT80**

| | |
|---|---|
| Test Data | 2014-12-12 |
| Probe | SN 17/14 EP221 |
| ConvF | 4.25 |
| Area Scan | dx=8mm dy=8mm, h= 5.00 mm |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm |
| Phantom | Validation plane |
| Device Position | Body back |
| Band | IEEE 802.11b ISM |
| Channels | Middle |
| Signal | IEEE802.b (Crest factor: 1.0) |
| Frequency (MHz) | 2437 |
| Relative permittivity (real part) | 39.22 |
| Conductivity (S/m) | 1.78 |
| Variation (%) | 1.77 |

## Maximum location: X=-14.00, Y=56.00
## SAR Peak: 0.42W/kg

| | |
|---|---|
| SAR 10g (W/Kg) | 0.113265 |
| SAR 1g (W/Kg) | 0.201262 |

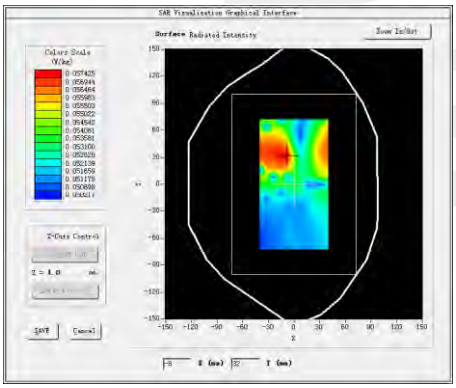
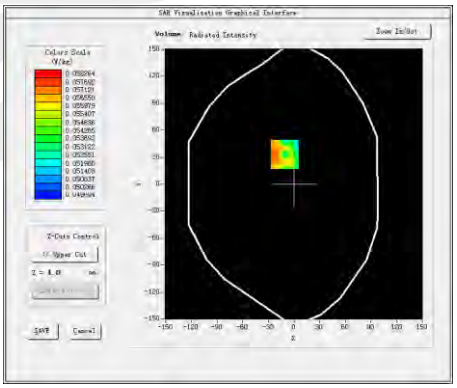
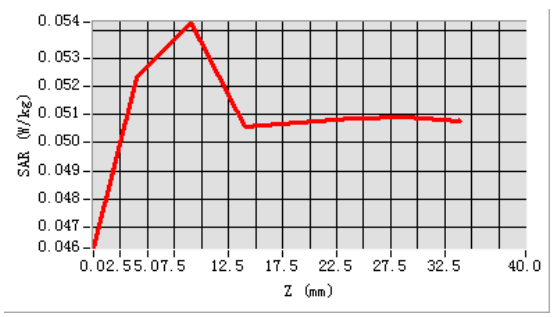
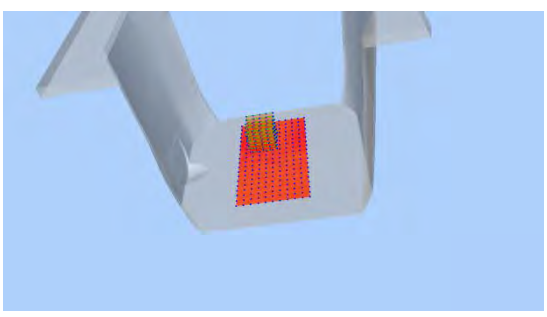
| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |
| **Z Axis Scan** | **3D** |
|   |  |

**Plot 3: DUT: TND Tablet; EUT Model: TNDT80**

| Test Data | 2014-12-12 |
|---|---|
| Probe | SN 17/14 EP221 |
| ConvF | 4.25 |
| Area Scan | dx=8mm dy=8mm, h= 5.00 mm |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm |
| Phantom | Validation plane |
| Device Position | Body left |
| Band | IEEE 802.11b ISM |
| Channels | Middle |
| Signal | IEEE802.b (Crest factor: 1.0) |
| Frequency (MHz) | 2437 |
| Relative permittivity (real part) | 39.22 |
| Conductivity (S/m) | 1.78 |
| Variation (%) | -2.26 |

## Maximum location: -11.00, Y=33.00
## SAR Peak: 0.07 W/kg

| SAR 10g (W/Kg) | 0.053212 |
|---|---|
| SAR 1g (W/Kg) | 0.057023 |

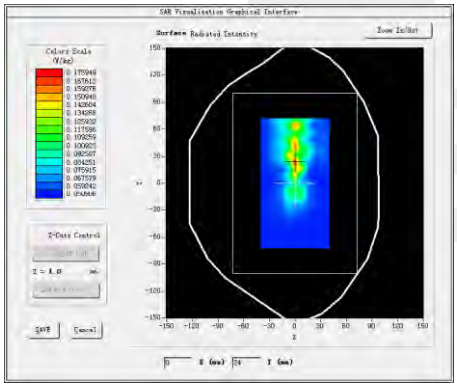
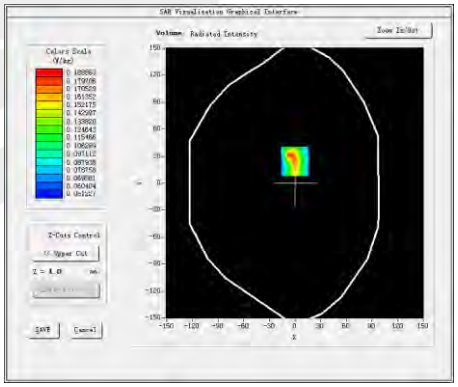
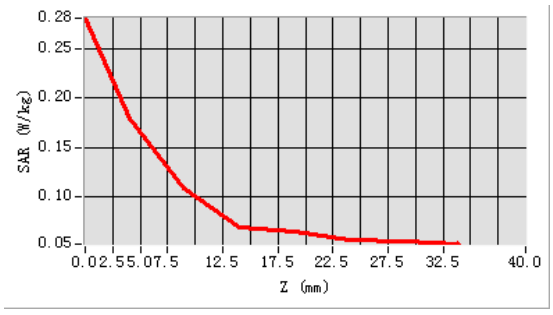
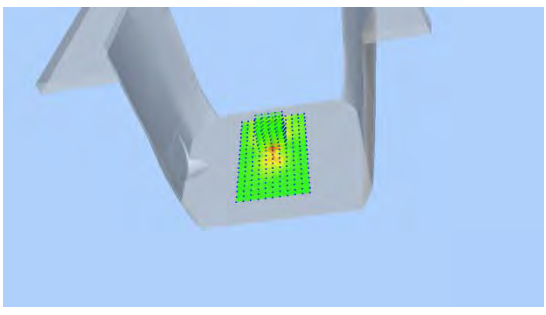
| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |
| **Z Axis Scan** | **3D** |
|  |  |

**Plot 4: DUT: TND Tablet; EUT Model: TNDT80**

| | |
|---|---|
| Test Data | 2014-12-12 |
| Probe | SN 17/14 EP221 |
| ConvF | 4.25 |
| Area Scan | dx=8mm dy=8mm, h= 5.00 mm |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm |
| Phantom | Validation plane |
| Device Position | Body right |
| Band | IEEE 802.11b ISM |
| Channels | Middle |
| Signal | IEEE802.b (Crest factor: 1.0) |
| Frequency (MHz) | 2437 |
| Relative permittivity (real part) | 39.22 |
| Conductivity (S/m) | 1.78 |
| Variation (%) | -1.28 |

## Maximum location: X=0.00, Y=24.00
## SAR Peak: 0.38 W/kg

| | |
|---|---|
| SAR 10g (W/Kg) | 0.098196 |
| SAR 1g (W/Kg) | 0.182447 |

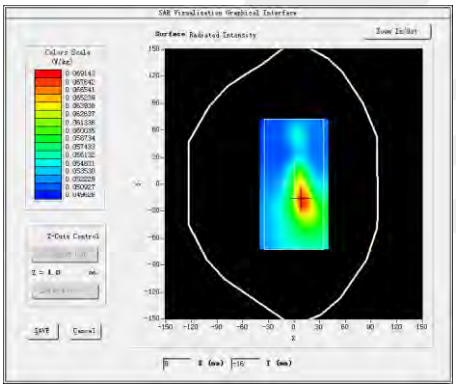
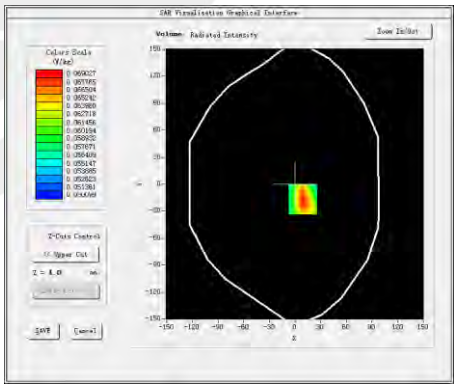
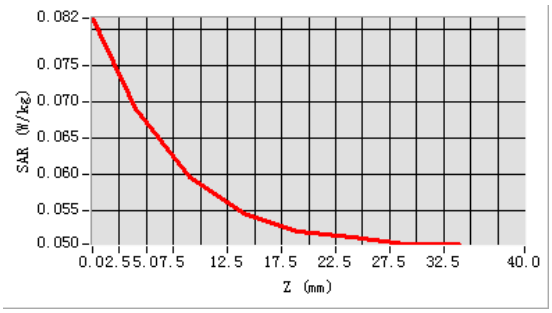
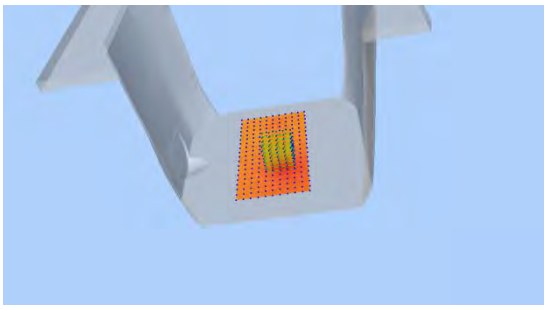
| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |
| **Z Axis Scan** | **3D** |
|   |  |

**Plot 5: DUT: TND Tablet; EUT Model: TNDT80**

| | |
|---|---|
| Test Data | 2014-12-12 |
| Probe | SN 17/14 EP221 |
| ConvF | 4.25 |
| Area Scan | dx=8mm dy=8mm, h= 5.00 mm |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm |
| Phantom | Validation plane |
| Device Position | Body top |
| Band | IEEE 802.11b ISM |
| Channels | Middle |
| Signal | IEEE802.b (Crest factor: 1.0) |
| Frequency (MHz) | 2437 |
| Relative permittivity (real part) | 39.22 |
| Conductivity (S/m) | 1.78 |
| Variation (%) | 0.20 |

## Maximum location: X=9.00, Y=-17.00
## SAR Peak: 0.08 W/kg

| | |
|---|---|
| SAR 10g (W/Kg) | 0.058909 |
| SAR 1g (W/Kg) | 0.067878 |

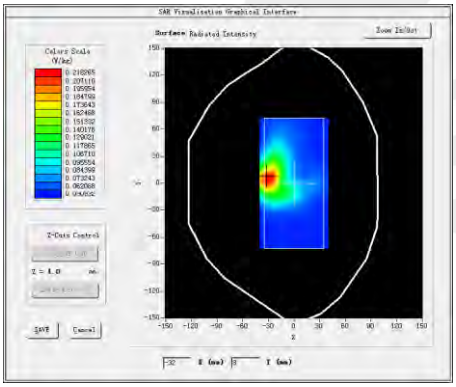
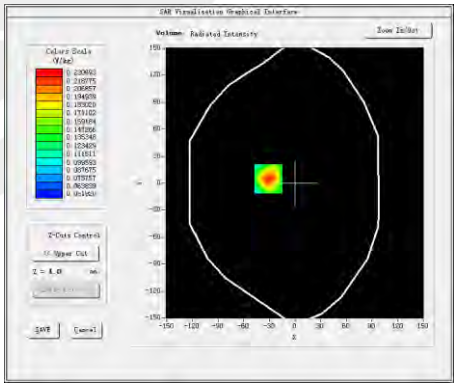
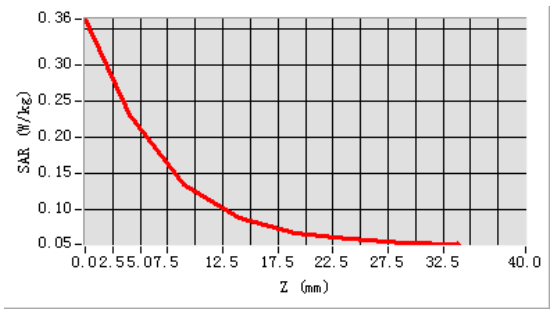
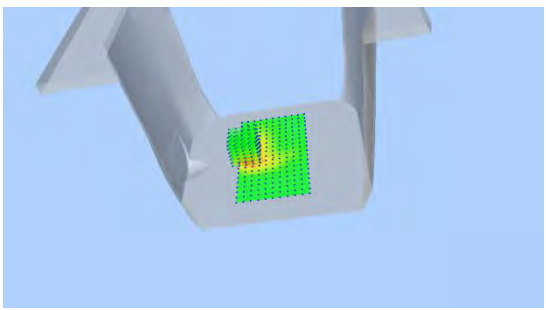
| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |
| **Z Axis Scan** | **3D** |
|   |  |

**Plot 6 :DUT:TND Tablet; EUT Model: TNDT80**

| | |
|---|---|
| Test Data | 2014-12-12 |
| Probe | SN 17/14 EP221 |
| ConvF | 4.25 |
| Area Scan | dx=8mm dy=8mm, h= 5.00 mm |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm |
| Phantom | Validation plane |
| Device Position | Body bottom |
| Band | IEEE 802.11b ISM |
| Channels | Middle |
| Signal | IEEE802.b (Crest factor: 1.0) |
| Frequency (MHz) | 2437 |
| Relative permittivity (real part) | 39.22 |
| Conductivity (S/m) | 1.78 |
| Variation (%) | -2.43 |

## Maximum location: X=-31.00, Y=5.00
## SAR Peak: 0.36 W/kg

| | |
|---|---|
| SAR 10g (W/Kg) | 0.130662 |
| SAR 1g (W/Kg) | 0.220003 |

| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |
| **Z Axis Scan** | **3D** |
|   |  |

# Appendix C. Probe C alibration And Dipole Calibration Report

SATIMO
The microwave vision company

## COMOSAR E-Field Probe Calibration Report

Ref : ACR.262.1.14.SATU.A

**SHENZHEN STS TEST SERVICES CO., LTD.**
**1/F, BUILDING 2, ZHUOKE SCIENCE PARK, CHONGQING ROAD**
**FUYONG, BAO' AN DISTRICT, SHENZHEN,CHINA**
**SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE**
**SERIAL NO.: SN 17/14 EP221**

**Calibrated at SATIMO US**
**2105 Barrett Park Dr. - Kennesaw, GA 30144**

ilac-MRA
A2LA ACCREDITED

**09/01/2014**

*Summary:*

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

| | Name | Function | Date | Signature |
|---|---|---|---|---|
| Prepared by : | Jérôme LUC | Product Manager | 9/19/2014 | |
| Checked by : | Jérôme LUC | Product Manager | 9/19/2014 | |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 9/19/2014 | |

| | Customer Name |
|---|---|
| Distribution : | Shenzhen STS Test Services Co., Ltd. |

| Issue | Date | Modifications |
|---|---|---|
| A | 9/19/2014 | Initial release |
| | | |
| | | |
| | | |

## TABLE OF CONTENTS

# 1 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | Satimo |
| Model | SSE5 |
| Serial Number | SN 17/14 EP221 |
| Product Condition (new / used) | New |
| Frequency Range of Probe | 0.4 GHz- 6 GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.179 MΩ<br>Dipole 2: R2=0.167 MΩ<br>Dipole 3: R3=0.178 MΩ |

A yearly calibration interval is recommended.

# 2 PRODUCT DESCRIPTION

## 2.1 GENERAL INFORMATION

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

**Figure 1** – *Satimo 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.

### 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% |
| 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 % |

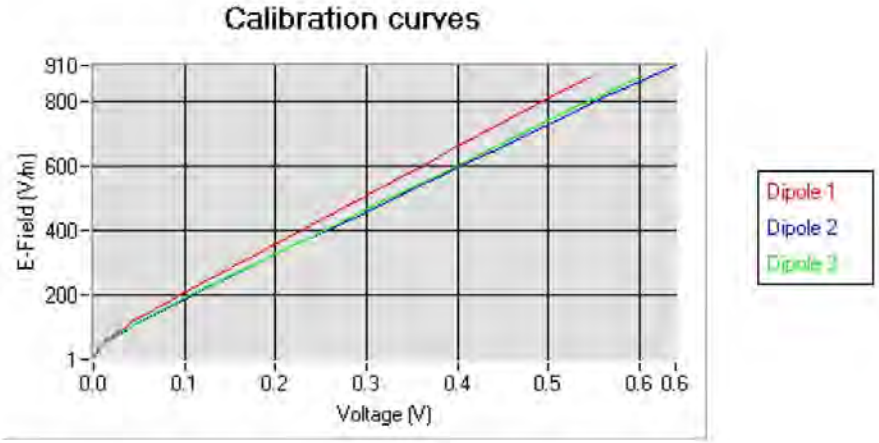
### 5.1 SENSITIVITY IN AIR

| Normx dipole 1 (μV/(V/m)$^2$) | Normy dipole 2 (μV/(V/m)$^2$) | Normz dipole 3 (μV/(V/m)$^2$) |
|---|---|---|
| 4.81 | 6.15 | 6.02 |

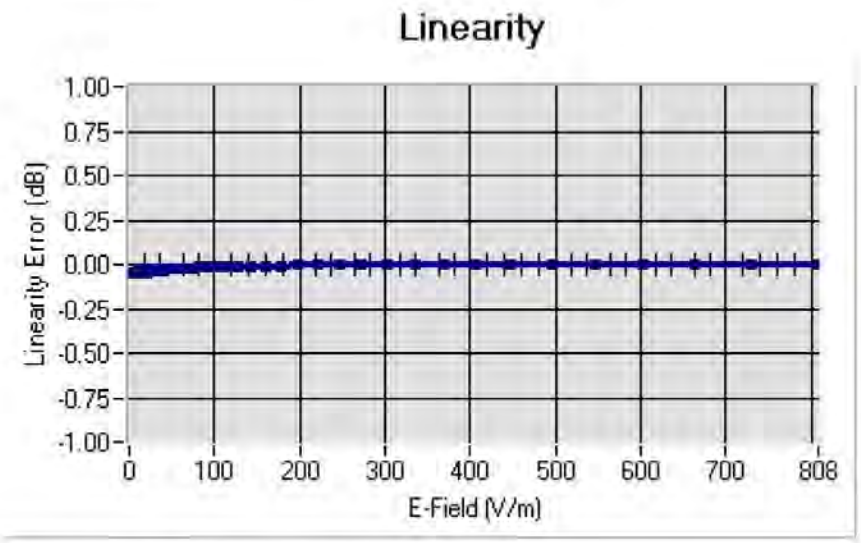
| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|---|---|---|
| 95 | 100 | 90 |

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

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



## 5.2 LINEARITY




Linearity:±1.16% (+/-0.05dB)

## 5.3 SENSITIVITY IN LIQUID

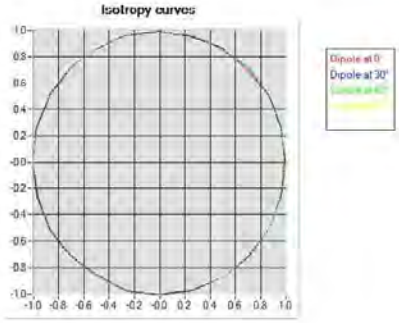
| Liquid | Frequency (MHz +/- 100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|---|---|---|---|---|
| HL450 | 450 | 43.90 | 0.87 | 4.84 |
| BL450 | 450 | 58.63 | 0.98 | 4.98 |
| HL750 | 750 | 42.06 | 0.89 | 4.53 |
| BL750 | 750 | 56.57 | 0.99 | 4.70 |
| HL850 | 835 | 42.81 | 0.89 | 4.83 |
| BL850 | 835 | 53.46 | 0.96 | 5.02 |
| HL900 | 900 | 42.47 | 0.96 | 4.74 |
| BL900 | 900 | 56.69 | 1.08 | 4.89 |
| HL1800 | 1800 | 41.31 | 1.38 | 4.25 |
| BL1800 | 1800 | 53.27 | 1.51 | 4.34 |
| HL1900 | 1900 | 41.09 | 1.42 | 4.71 |
| BL1900 | 1900 | 54.20 | 1.54 | 4.85 |
| HL2000 | 2000 | 39.72 | 1.43 | 4.27 |
| BL2000 | 2000 | 53.91 | 1.53 | 4.44 |
| HL2450 | 2450 | 39.05 | 1.77 | 4.11 |
| BL2450 | 2450 | 52.97 | 1.93 | 4.25 |
| HL2600 | 2600 | 38.35 | 1.92 | 4.20 |
| BL2600 | 2600 | 51.81 | 2.19 | 4.32 |

LOWER DETECTION LIMIT: 7mW/kg

## 5.4 ISOTROPY

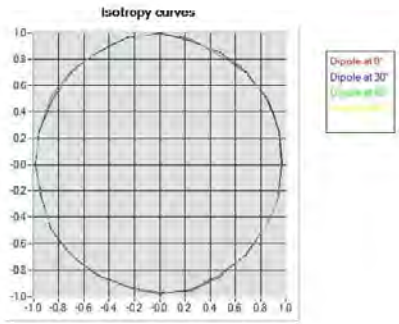
**HL900 MHz**

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.07 dB




**HL1800 MHz**

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



## 6 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| Flat 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 |
| Reference Probe | Satimo | EP 94 SN 37/08 | 10/2013 | 10/2014 |
| 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. |
| Temperature / Humidity Sensor | Control Company | 11-661-9 | 8/2012 | 8/2015 |

# SAR Reference Dipole Calibration Report

Ref : ACR.262.10.14.SATU.A

**SHENZHEN STS TEST SERVICES CO., LTD.**
**1/F, BUILDING 2, ZHUOKE SCIENCE PARK, CHONGQING ROAD**
**FUYONG, BAO' AN DISTRICT, SHENZHEN,CHINA**
**SATIMO COMOSAR REFERENCE DIPOLE**
**FREQUENCY: 2450 MHZ**
**SERIAL NO.: SN 30/14 DIP2G450-335**

**Calibrated at SATIMO US**
**2105 Barrett Park Dr. - Kennesaw, GA 30144**

**09/01/2014**

*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.

| | Name | Function | Date | Signature |
|---|---|---|---|---|
| *Prepared by :* | Jérôme LUC | Product Manager | 9/19/2014 | |
| *Checked by :* | Jérôme LUC | Product Manager | 9/19/2014 | |
| *Approved by :* | Kim RUTKOWSKI | Quality Manager | 9/19/2014 | |

| | Customer Name |
|---|---|
| *Distribution :* | Shenzhen STS Test Services Co., Ltd. |

| Issue | Date | Modifications |
|---|---|---|
| A | 9/19/2014 | Initial release |
| | | |
| | | |
| | | |

## TABLE OF CONTENTS

## 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 30/14 DIP2G450-335 |
| Product Condition (new / used) | New |

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*

## 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 |

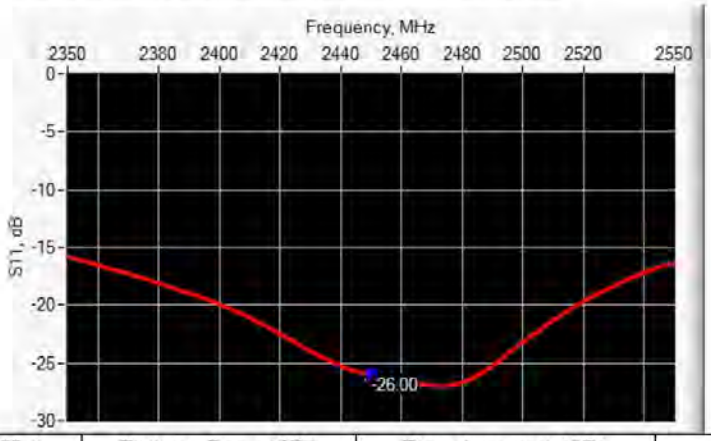
### 5.3 VALIDATION MEASUREMENT

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 % |

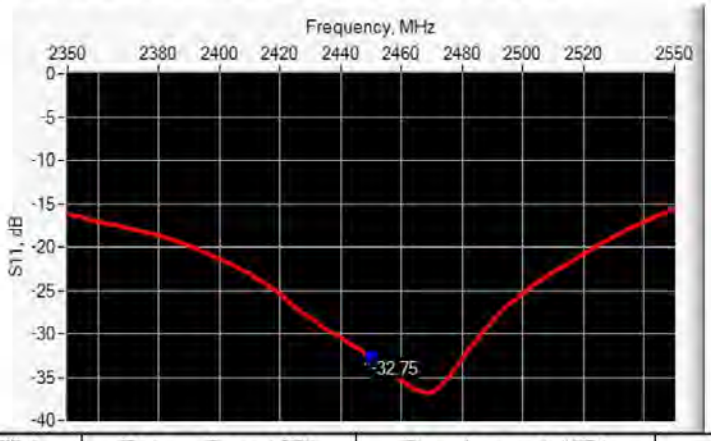
# 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 2450 | -26.00 | -20 | 46.1 Ω + 3.2 jΩ |

## 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 2450 | -32.75 | -20 | 48.8 Ω + 1.9 jΩ |

## 6.3 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 %. | |

## 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 HEAD LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity (ε,') | | 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 % | |

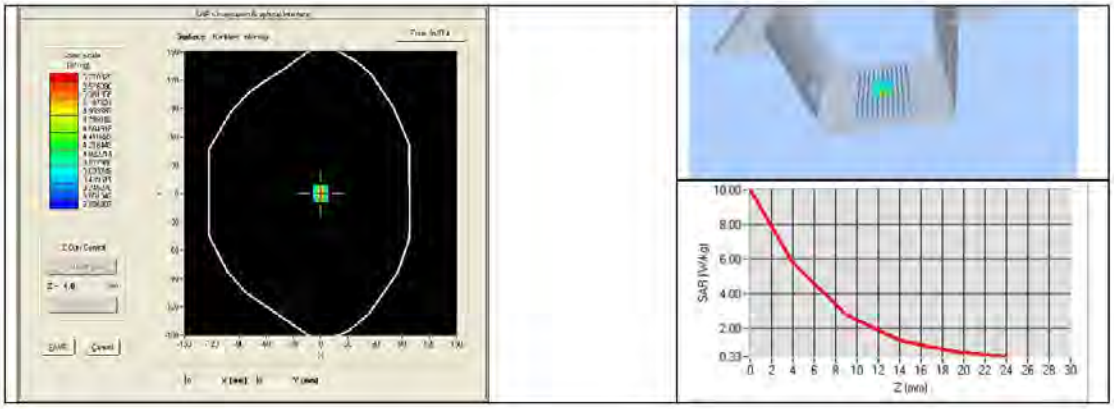
## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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.

| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Head Liquid Values: eps' : 39.0 sigma : 1.77 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8m/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) | |
|---|---|---|---|---|
| | 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 | 54.70 (5.47) | 24 | 24.11 (2.41) |
| 2600 | 55.3 | | 24.6 | |
| 3000 | 63.8 | | 25.7 | |
| 3500 | 67.1 | | 25 | |



## 7.3 BODY LIQUID MEASUREMENT

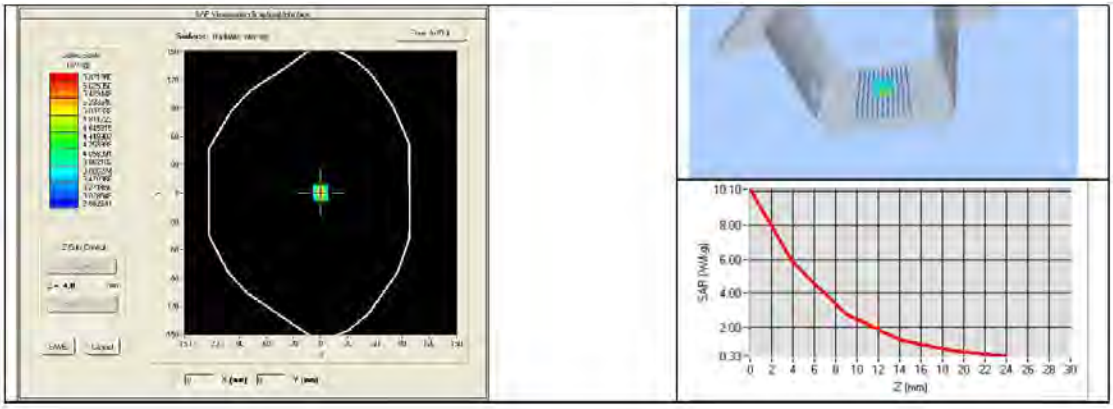
| Frequency MHz | Relative permittivity (ε,') | | Conductivity (σ) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 150 | 61.9 ±5 % | | 0.80 ±5 % | |
| 300 | 58.2 ±5 % | | 0.92 ±5 % | |
| 450 | 56.7 ±5 % | | 0.94 ±5 % | |
| 750 | 55.5 ±5 % | | 0.96 ±5 % | |
| 835 | 55.2 ±5 % | | 0.97 ±5 % | |
| 900 | 55.0 ±5 % | | 1.05 ±5 % | |
| 915 | 55.0 ±5 % | | 1.06 ±5 % | |
| 1450 | 54.0 ±5 % | | 1.30 ±5 % | |
| 1610 | 53.8 ±5 % | | 1.40 ±5 % | |
| 1800 | 53.3 ±5 % | | 1.52 ±5 % | |
| 1900 | 53.3 ±5 % | | 1.52 ±5 % | |
| 2000 | 53.3 ±5 % | | 1.52 ±5 % | |
| 2100 | 53.2 ±5 % | | 1.62 ±5 % | |
| 2450 | 52.7 ±5 % | PASS | 1.95 ±5 % | PASS |
| 2600 | 52.5 ±5 % | | 2.16 ±5 % | |
| 3000 | 52.0 ±5 % | | 2.73 ±5 % | |
| 3500 | 51.3 ±5 % | | 3.31 ±5 % | |
| 5200 | 49.0 ±10 % | | 5.30 ±10 % | |
| 5300 | 48.9 ±10 % | | 5.42 ±10 % | |
| 5400 | 48.7 ±10 % | | 5.53 ±10 % | |

| | | | | |
|---|---|---|---|---|
| 5500 | 48.6 ±10 % | | 5.65 ±10 % | |
| 5600 | 48.5 ±10 % | | 5.77 ±10 % | |
| 5800 | 48.2 ±10 % | | 6.00 ±10 % | |

## 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

| | |
|---|---|
| Software | OPENSAR V4 |
| Phantom | SN 20/09 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Body Liquid Values: eps' : 53.0 sigma : 1.93 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8m/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 | 55.65 (5.57) | 24.56 (2.46) |



## 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 | 12/2013 | 12/2016 |
| Reference Probe | Satimo | EPG122 SN 18/11 | 10/2013 | 10/2014 |
| 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. |
| Temperature and Humidity Sensor | Control Company | 11-661-9 | 8/2012 | 8/2015 |