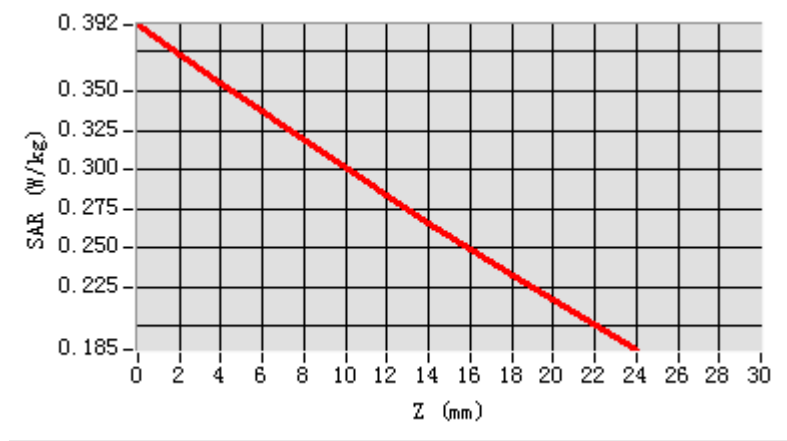
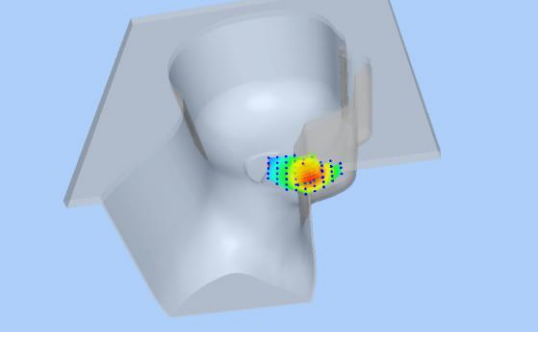
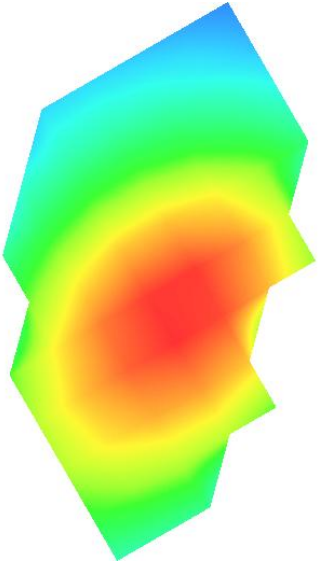


| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 0.3920 | 0.3552 | 0.3101 | 0.2662 | 0.2243 |



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

WCDMA850, Edge D, Middle

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 19/11/2014

Measurement duration: 7 minutes 26 seconds

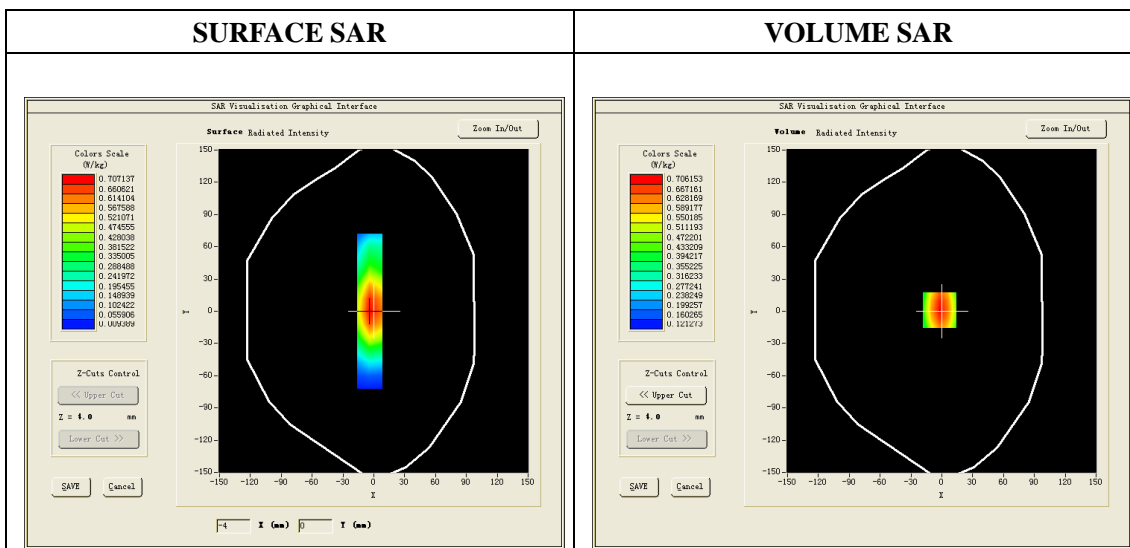
Mobile Phone IMEI number: --

A. Experimental conditions.

| | |
|-----------------|--------------------------------------|
| Area Scan | surf_sam_plan.txt |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Validation plane |
| Device Position | Edge D |
| Band | Band5_WCDMA850 |
| Channels | 4183 |
| Signal | WCDMA (Crest factor: 1:1) |

B. SAR Measurement Results

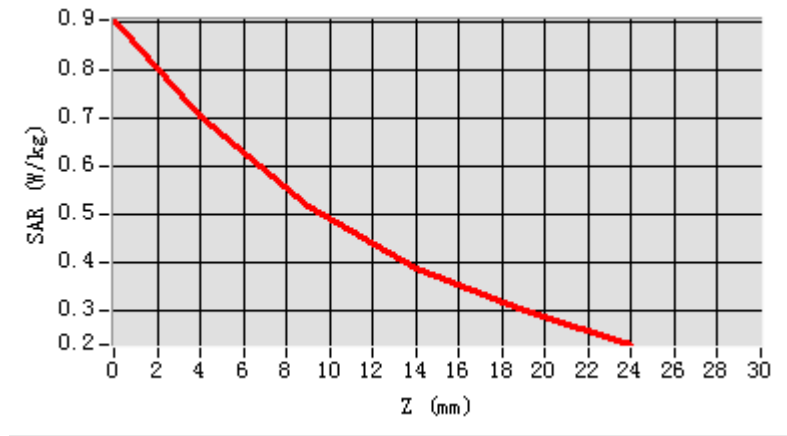
| | |
|--|-----------|
| Frequency (MHz) | 836.6 |
| Relative permittivity (real part) | 55.26 |
| Relative permittivity (imaginary part) | 21.71 |
| Conductivity (S/m) | 0.98 |
| Variation (%) | -1.680000 |
| ConvF: | 5.68 |

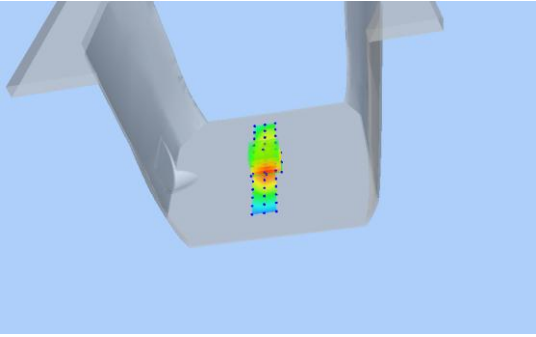



Maximum location: X=-2.00, Y=1.00

| | |
|----------------|----------|
| SAR 10g (W/Kg) | 0.515136 |
| SAR 1g (W/Kg) | 0.742315 |

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 0.9056 | 0.7062 | 0.5201 | 0.3902 | 0.2998 |



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

WCDMA1900, Left Cheek, Middle

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 21/11/2014

Measurement duration: 6 minutes 6 seconds

Mobile Phone IMEI number: --

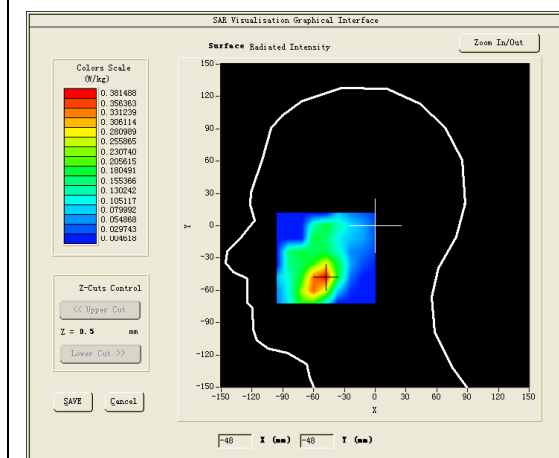
A. Experimental conditions.

| | |
|------------------------|--------------------------------------|
| Area Scan | sam_direct_droit2_surf8mm.txt |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Left head |
| Device Position | Cheek |
| Band | Band2_WCDMA1900 |
| Channels | 9400 |
| Signal | WCDMA (Duty cycle: 1:1) |

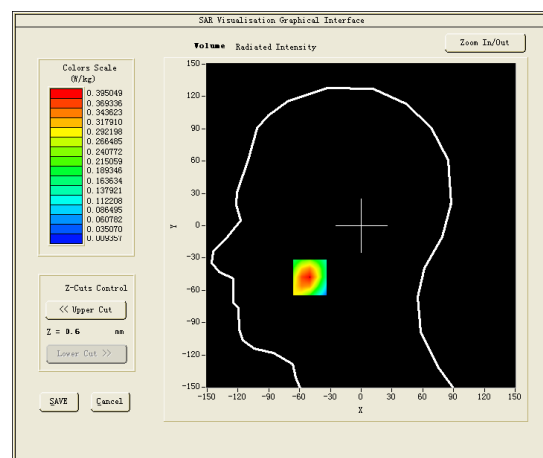
B. SAR Measurement Results

| | |
|--|----------|
| Frequency (MHz) | 1880.0 |
| Relative permittivity (real part) | 39.98 |
| Relative permittivity (imaginary) | 15.07 |
| Conductivity (S/m) | 1.41 |
| Variation (%) | 0.190000 |
| ConvF: | 5.49 |

SURFACE SAR



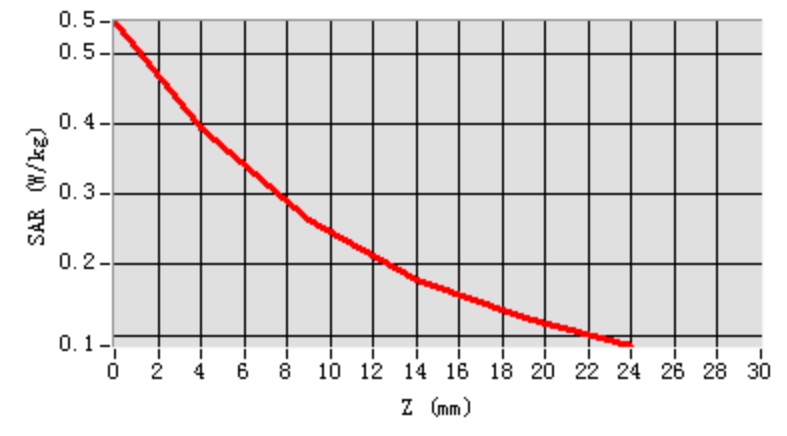
VOLUME SAR

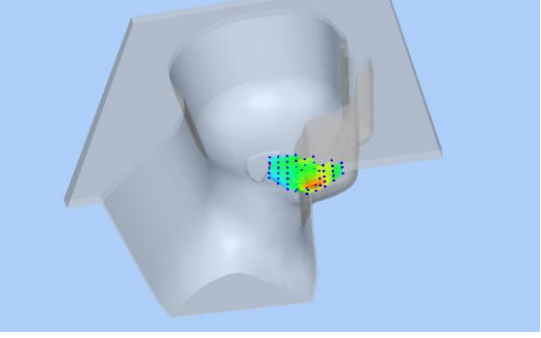
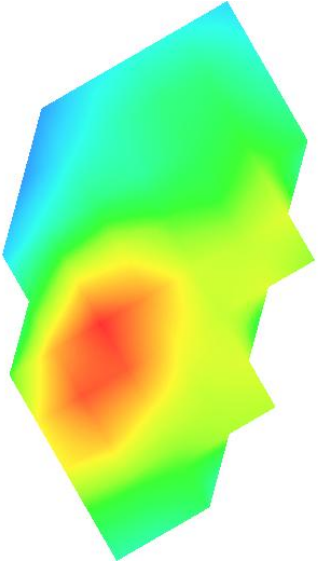


Maximum location: X=-50.00, Y=-48.00

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.223731 |
| SAR 1g (W/Kg) | 0.372996 |

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 0.5458 | 0.3950 | 0.2628 | 0.1774 | 0.1229 |



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

WCDMA1900, FACE, Middle

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 21/11/2014

Measurement duration: 7 minutes 37 seconds

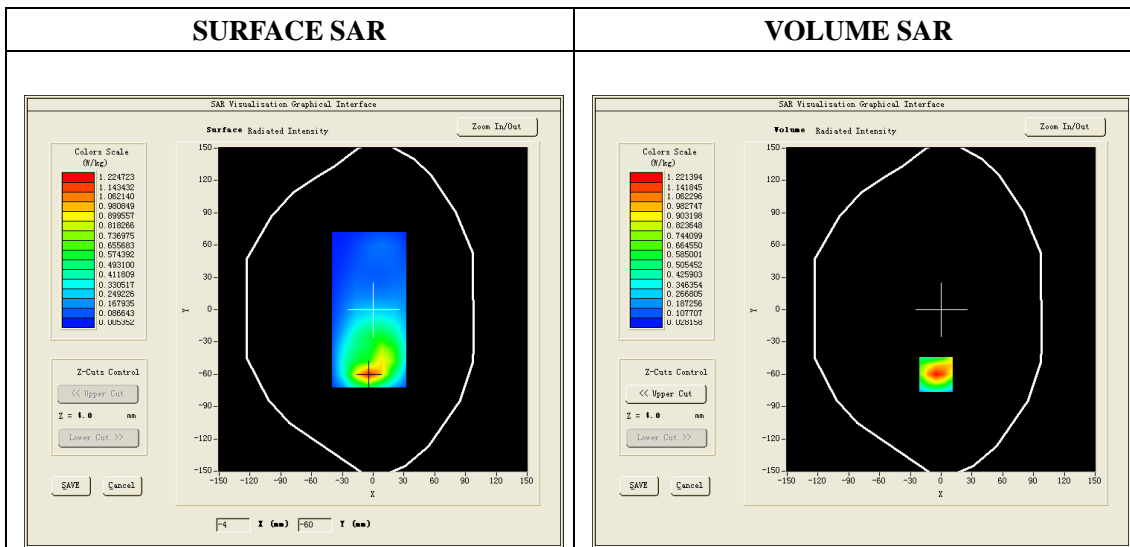
Mobile Phone IMEI number: --

A. Experimental conditions.

| | |
|------------------------|--------------------------------------|
| Area Scan | surf_sam_plan.txt |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Validation plane |
| Device Position | Back |
| Band | Band2_WCDMA1900 |
| Channels | 9400 |
| Signal | WCDMA (Duty cycle: 1:1) |

B. SAR Measurement Results

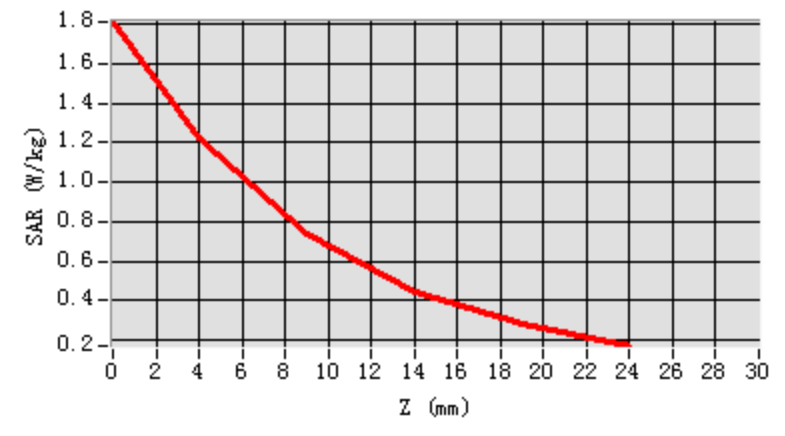
| | |
|--|-----------|
| Frequency (MHz) | 1880.0 |
| Relative permittivity (real part) | 53.28 |
| Relative permittivity (imaginary) | 12.99 |
| Conductivity (S/m) | 1.53 |
| Variation (%) | -0.710000 |
| ConvF: | 5.65 |

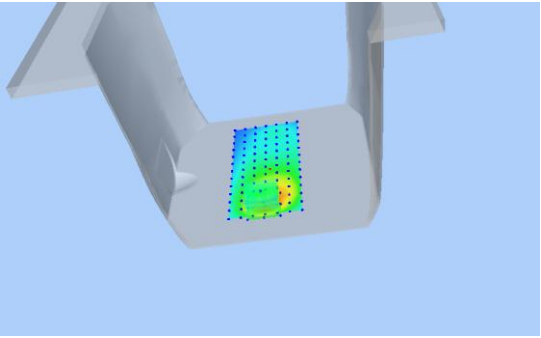
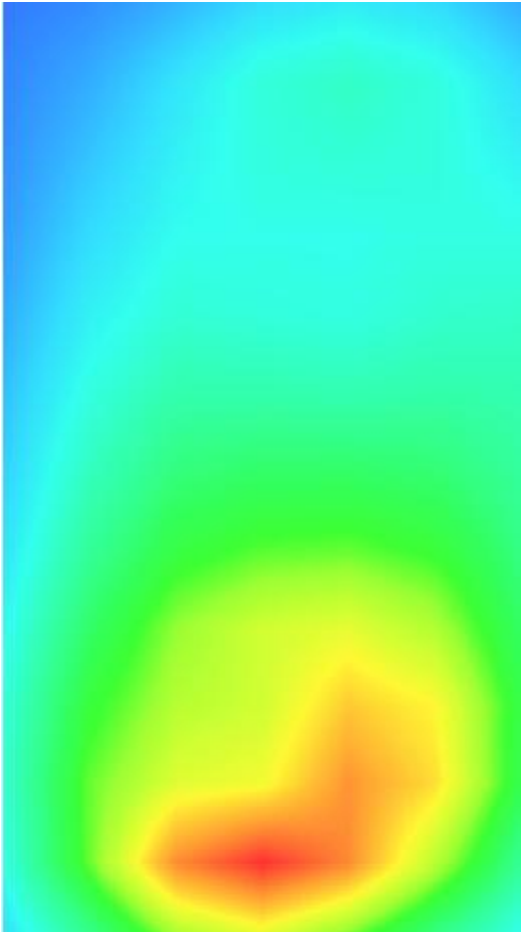


Maximum location: X=-5.00, Y=-60.00

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.614640 |
| SAR 1g (W/Kg) | 1.130835 |

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 1.8100 | 1.2214 | 0.7356 | 0.4468 | 0.2801 |



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

WCDMA1900, Face, Middle, Repeated testing

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 21/11/2014

Measurement duration: 7 minutes 37 seconds

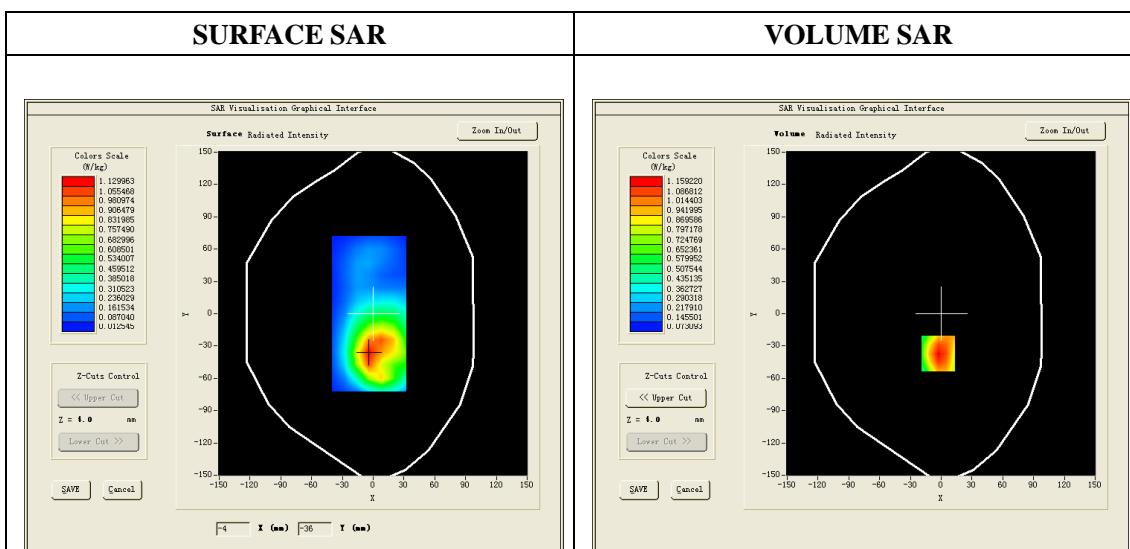
Mobile Phone IMEI number: --

A. Experimental conditions.

| | |
|------------------------|--------------------------------------|
| Area Scan | surf_sam_plan.txt |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Validation plane |
| Device Position | Back |
| Band | Band2_WCDMA1900 |
| Channels | 9400 |
| Signal | WCDMA (Duty cycle: 1:1) |

B. SAR Measurement Results

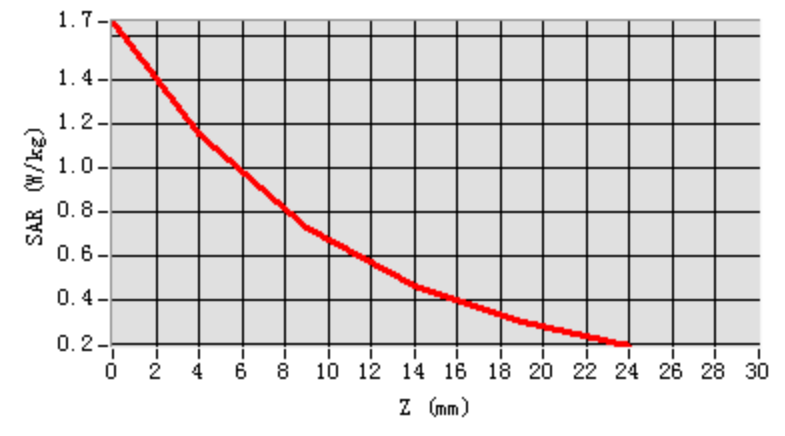
| | |
|--|----------|
| Frequency (MHz) | 1880.0 |
| Relative permittivity (real part) | 53.28 |
| Relative permittivity (imaginary) | 12.99 |
| Conductivity (S/m) | 1.53 |
| Variation (%) | 1.050000 |
| ConvF: | 5.65 |

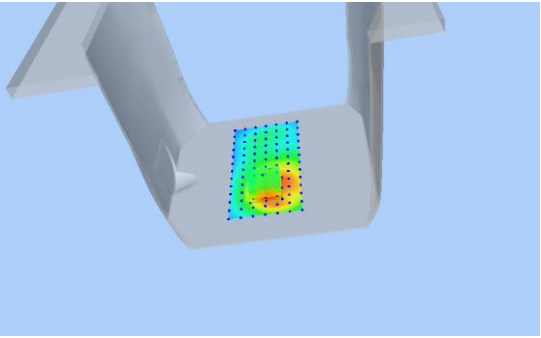
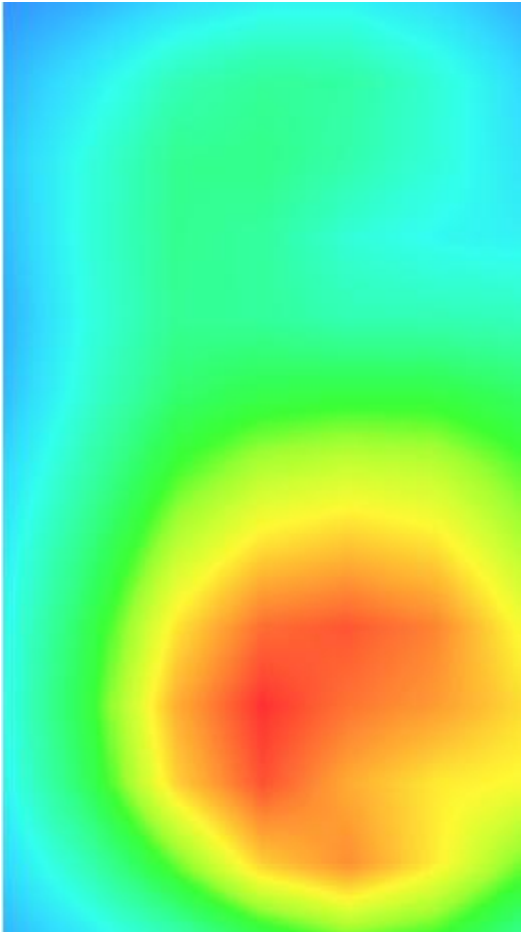


Maximum location: X=-3.00, Y=-37.00

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.675846 |
| SAR 1g (W/Kg) | 1.124327 |

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 1.6671 | 1.1595 | 0.7284 | 0.4613 | 0.2992 |



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

Wi-Fi 802.11b ,Right Cheek, Low

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 24/11/2014

Measurement duration: 7 minutes 21 seconds

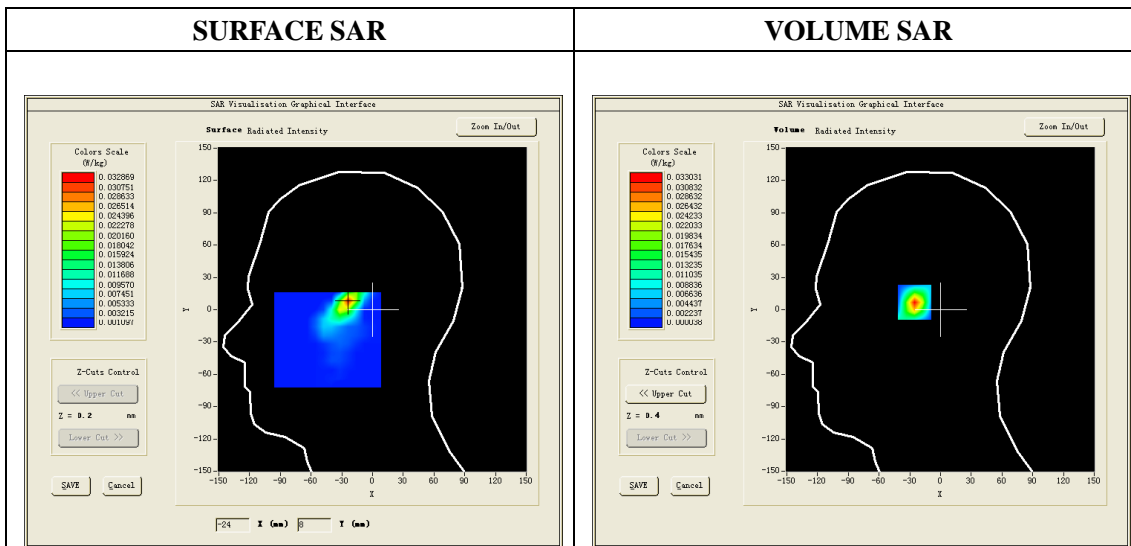
Mobile Phone IMEI number: --

A. Experimental conditions.

| | |
|------------------------|--------------------------------------|
| Area Scan | dx=8mm dy=8mm |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Right head |
| Device Position | Cheek |
| Band | IEEE 802.11b ISM |
| Channels | 1 |
| Signal | DSSS (Crest factor: 1:1) |

B. SAR Measurement Results

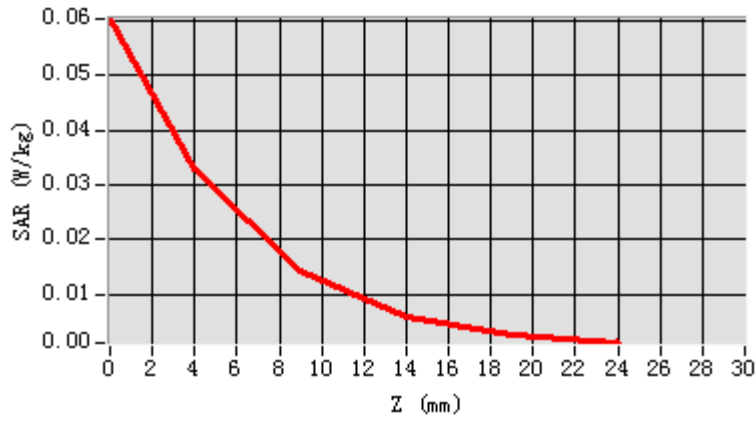
| | |
|---|----------|
| Frequency (MHz) | 2412 |
| Relative permittivity (real part) | 38.99 |
| Relative permittivity (imaginary part) | 13.19 |
| Conductivity (S/m) | 1.81 |
| Variation (%) | 3.210000 |
| ConvF: | 4.81 |



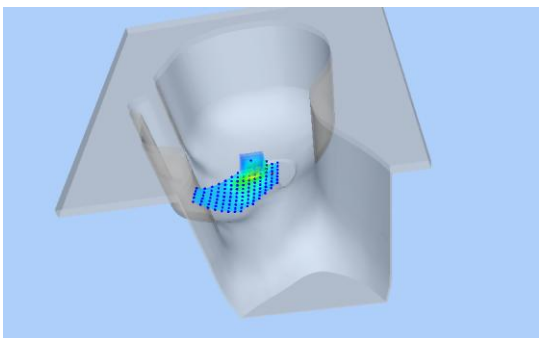
Maximum location: X=-24.00, Y=8.00

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.011458 |
| SAR 1g (W/Kg) | 0.029436 |

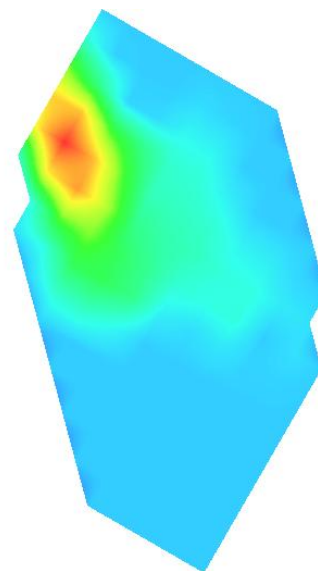
Z axis scan



3D screen shot



Hot spot position



Wi-Fi 802.11b , Back, Middle

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 24/11/2014

Measurement duration: 7 minutes 11 seconds

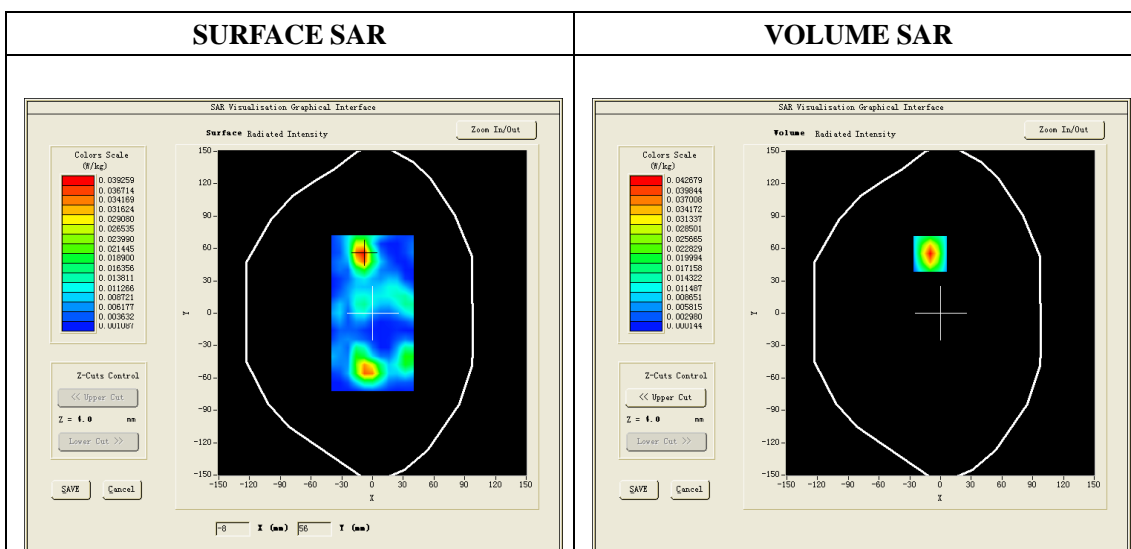
Mobile Phone IMEI number: --

A. Experimental conditions.

| | |
|------------------------|--------------------------------------|
| Area Scan | dx=8mm dy=8mm |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Validation plane |
| Device Position | Back |
| Band | IEEE 802.11b ISM |
| Channels | 1 |
| Signal | DSSS (Crest factor: 1:1) |

B. SAR Measurement Results

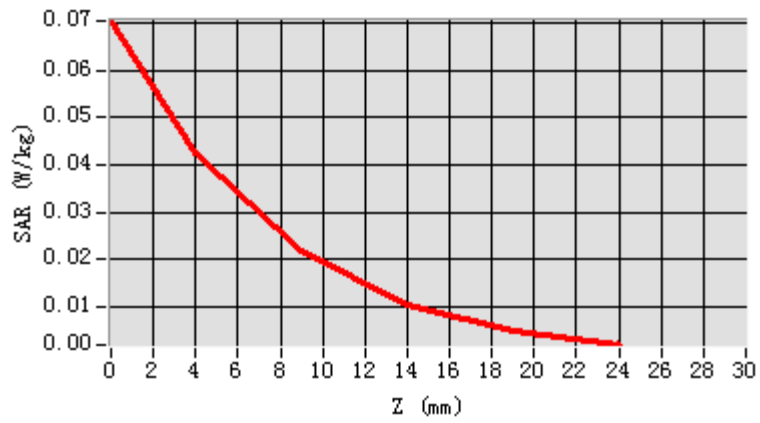
| | |
|---|----------|
| Frequency (MHz) | 2412 |
| Relative permittivity (real part) | 52.65 |
| Relative permittivity (imaginary part) | 13.02 |
| Conductivity (S/m) | 1.96 |
| Variation (%) | 0.230000 |
| ConvF: | 4.91 |



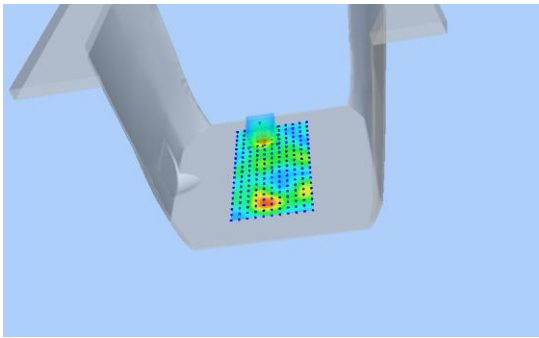
Maximum location: X=-10.00, Y=55.00

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.024563 |
| SAR 1g (W/Kg) | 0.044837 |

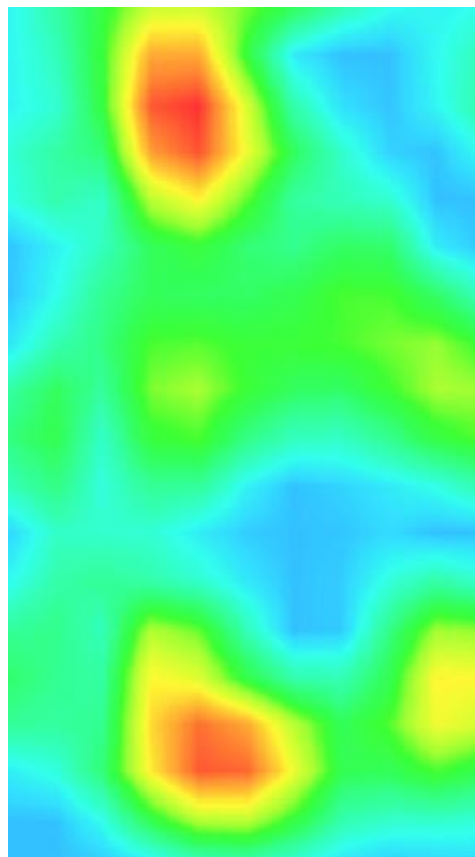
Z axis scan



3D screen shot



Hot spot position



LTE Band 4 , Right Cheek, Middle

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 20/11/2014

Measurement duration: 7 minutes 37 seconds

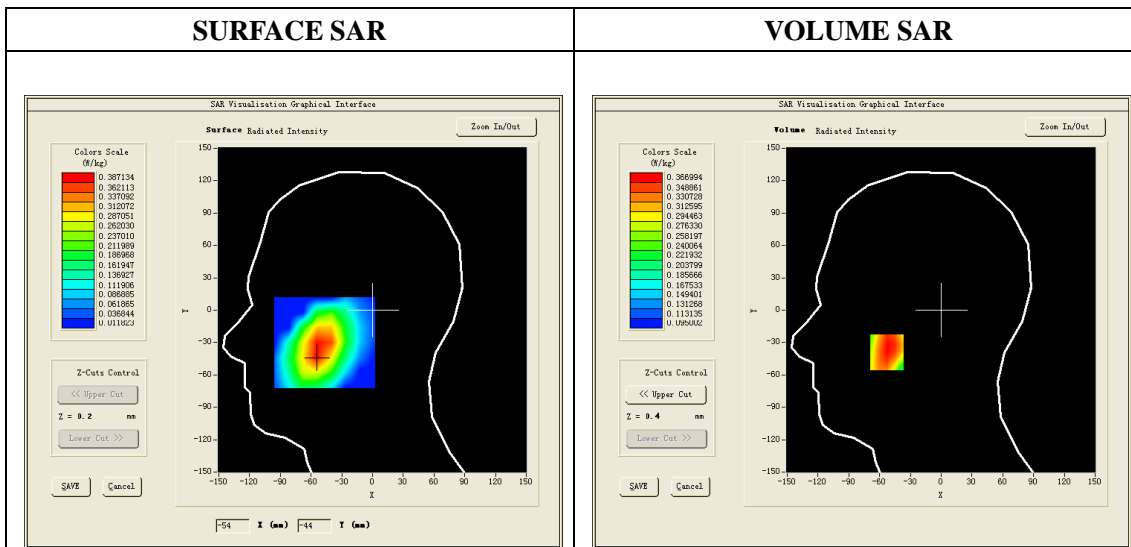
Mobile Phone IMEI number: --

A. Experimental conditions.

| | |
|-----------------|--------------------------------------|
| Area Scan | surf_sam_plan.txt |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Right head |
| Device Position | Cheek |
| Band | LTE Band4 |
| Channels | High |
| Signal | Duty cycle: 1:1 |

B. SAR Measurement Results

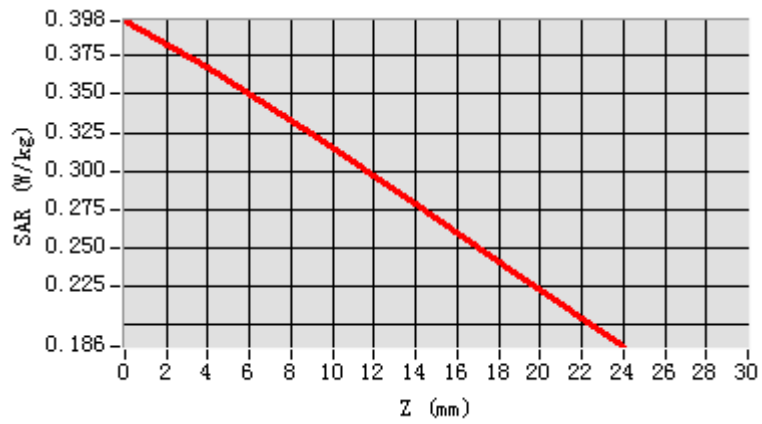
| | |
|-----------------------------------|-----------|
| Frequency (MHz) | 1745 |
| Relative permittivity (real part) | 39.979347 |
| Relative permittivity (imaginary) | 15.067700 |
| Conductivity (S/m) | 1.413587 |
| Variation (%) | -0.800000 |
| ConvF: | 4.80 |

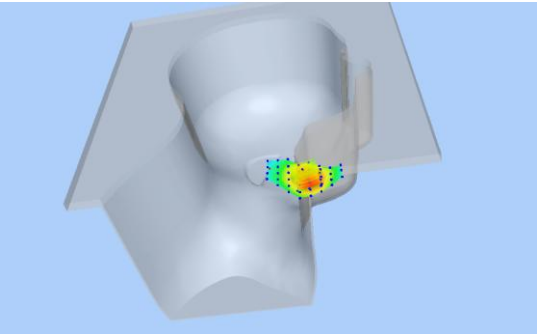
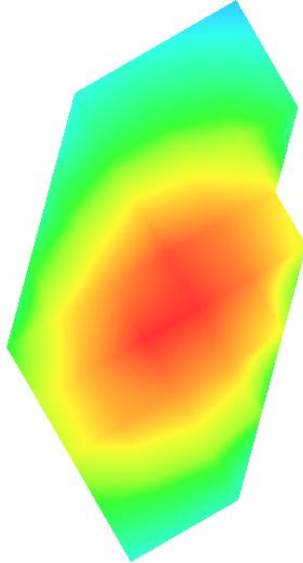


Maximum location: X=-53.00, Y=-39.00

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.285463 |
| SAR 1g (W/Kg) | 0.347346 |

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 0.3942 | 0.3650 | 0.3214 | 0.2721 | 0.2301 |



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

LTE Band 4 , Back, Middle

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 20/11/2014

Measurement duration: 7 minutes 37 seconds

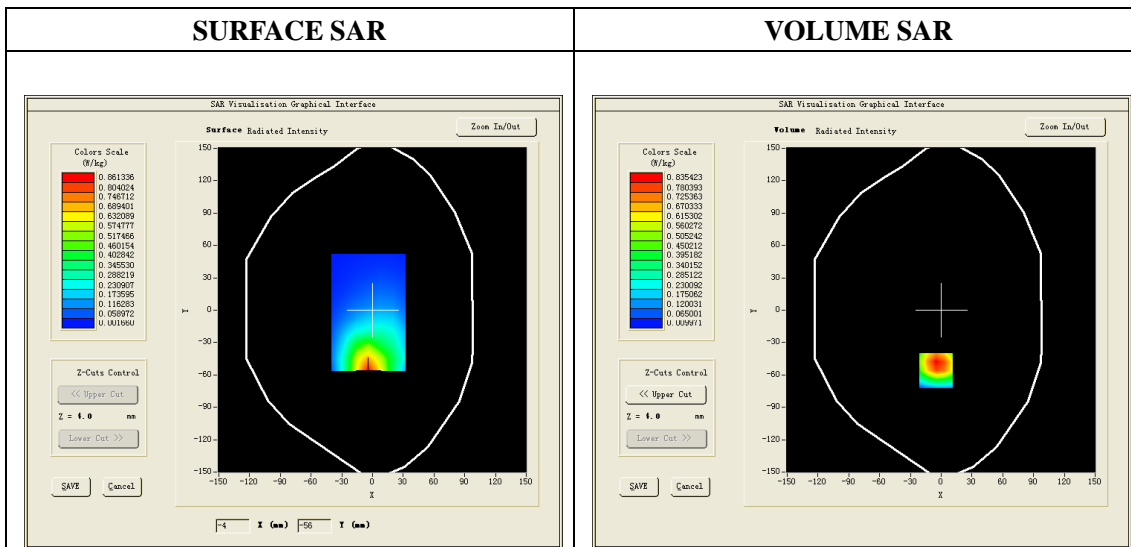
Mobile Phone IMEI number: --

A. Experimental conditions.

| | |
|------------------------|--------------------------------------|
| Area Scan | surf_sam_plan.txt |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Validation plane |
| Device Position | Back |
| Band | LTE Band4 |
| Channels | High |
| Signal | Duty cycle: 1:1 |

B. SAR Measurement Results

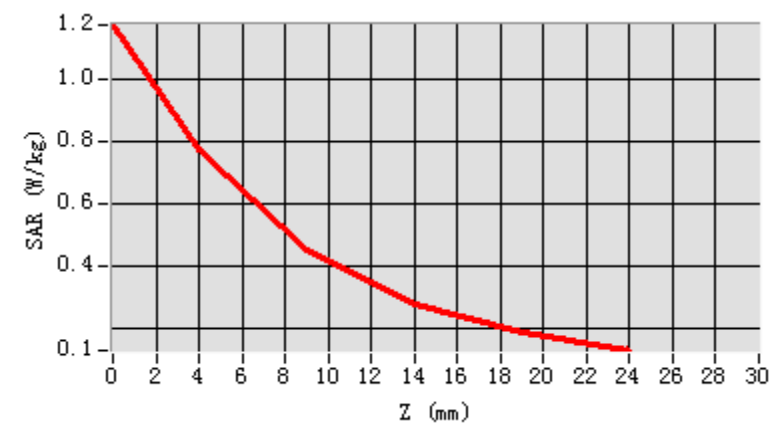
| | |
|--|-----------|
| Frequency (MHz) | 1745 |
| Relative permittivity (real part) | 53.890442 |
| Relative permittivity (imaginary) | 14.070000 |
| Conductivity (S/m) | 1.529512 |
| Variation (%) | 1.140000 |
| ConvF: | 4.94 |

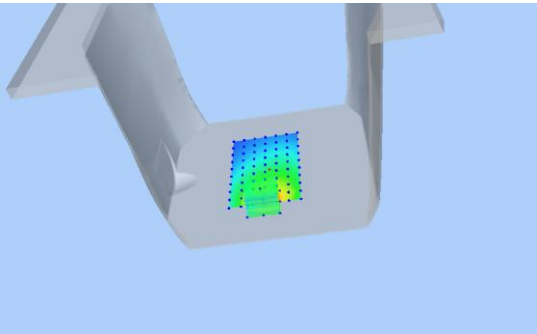
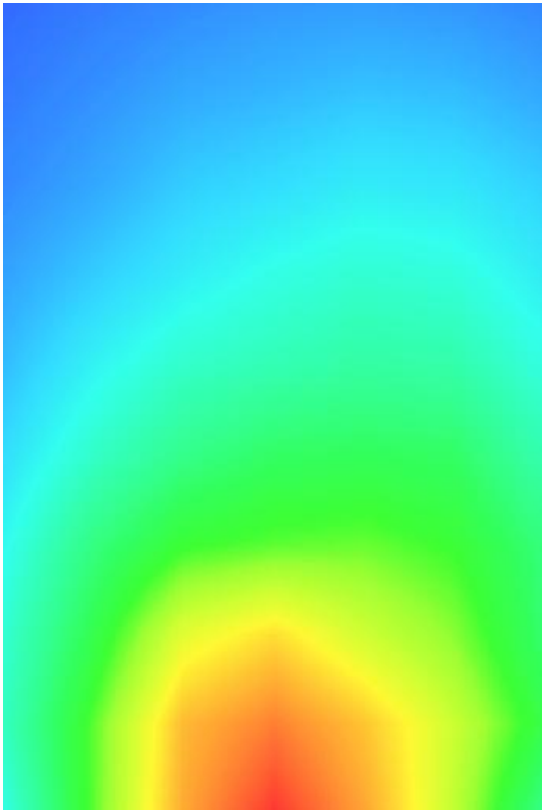


Maximum location: X=-5.00, Y=-56.00

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.425731 |
| SAR 1g (W/Kg) | 0.709754 |

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 1.1245 | 0.7568 | 0.4438 | 0.2657 | 0.1756 |



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

LTE Band17, Right Cheek, Middle

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 25/11/2014

Measurement duration: 6 minutes 35 seconds

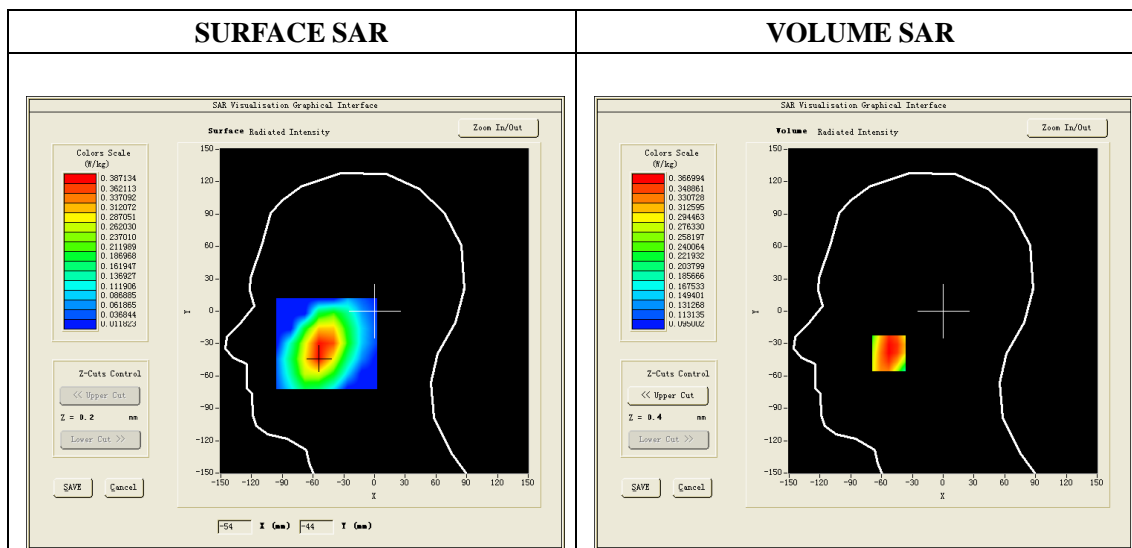
Mobile Phone IMEI number: --

A. Experimental conditions.

| | |
|-----------------|--------------------------------------|
| Area Scan | sam_direct_droit2_surf8mm.txt |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Right head |
| Device Position | Cheek |
| Band | LTE Band17 |
| Channels | Low |
| Signal | Duty cycle: 1:1 |

B. SAR Measurement Results

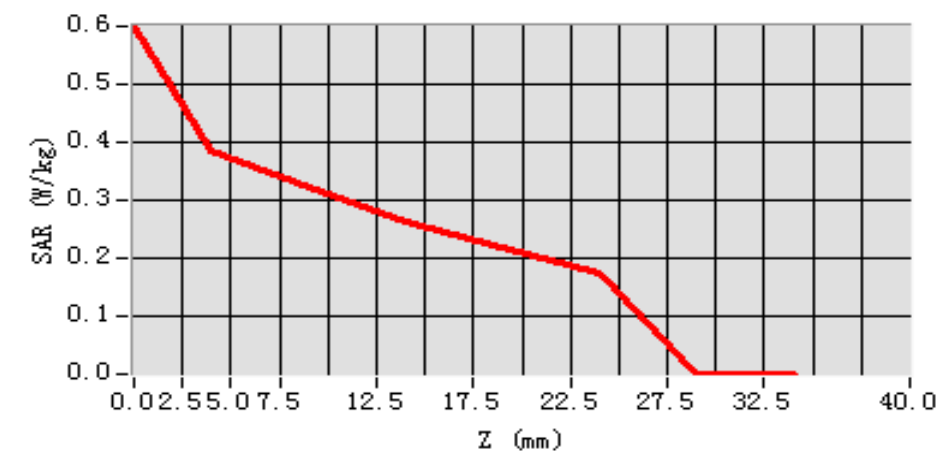
| | |
|--|-----------|
| Frequency (MHz) | 709 |
| Relative permittivity (real part) | 41.46 |
| Relative permittivity (imaginary part) | 15.07 |
| Conductivity (S/m) | 0.91 |
| Variation (%) | -3.900000 |
| ConvF: | 22.51 |

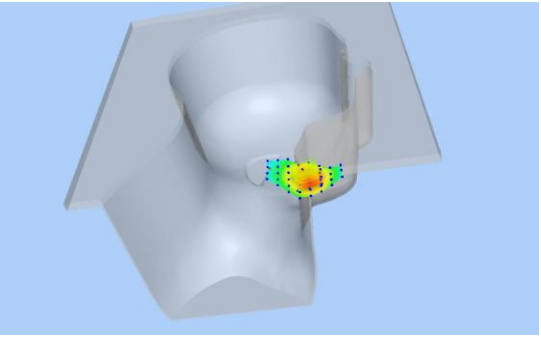
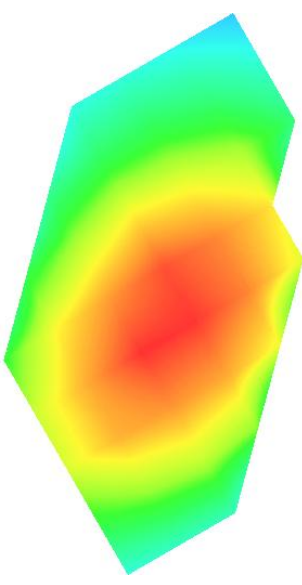


Maximum location: X=-53.00, Y=-39.00

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.304649 |
| SAR 1g (W/Kg) | 0.429603 |

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 0.3976 | 0.3670 | 0.3246 | 0.2785 | 0.2311 |



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

LTE Band17, Back, Middle

Type: Phone measurement (Very fast, 11 points in the volume)

Date of measurement: 25/11/2014

Measurement duration: 7 minutes 32 seconds

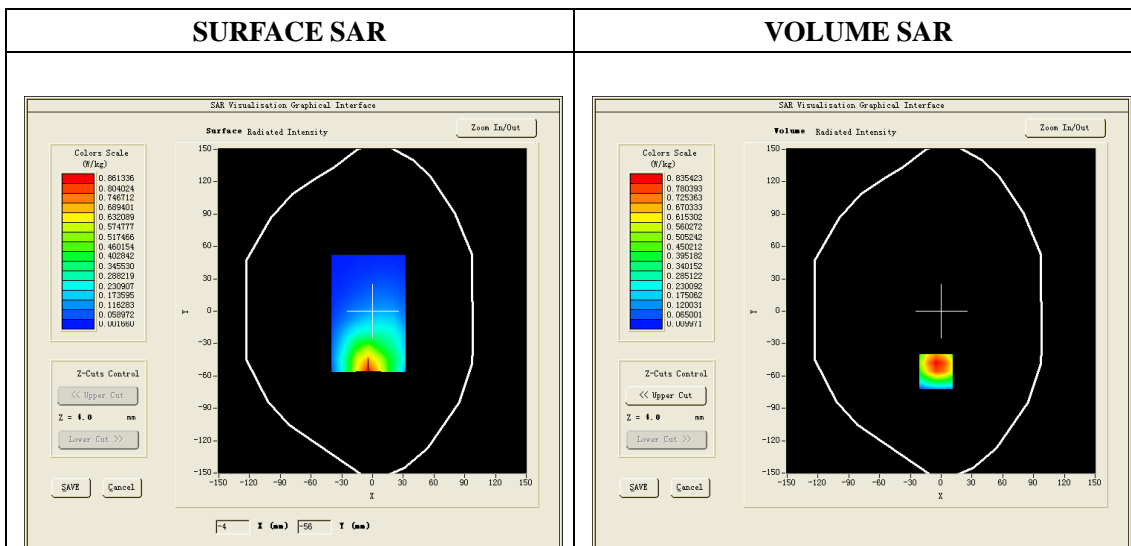
Mobile Phone IMEI number: --

A. Experimental conditions.

| | |
|-----------------|--------------------------------------|
| Area Scan | surf_sam_plan.txt |
| ZoomScan | 5x5x7,dx=8mm dy=8mm dz=5mm,Very fast |
| Phantom | Validation plane |
| Device Position | Back |
| Band | LTE Band17 |
| Channels | Low |
| Signal | Duty cycle: 1:1 |

B. SAR Measurement Results

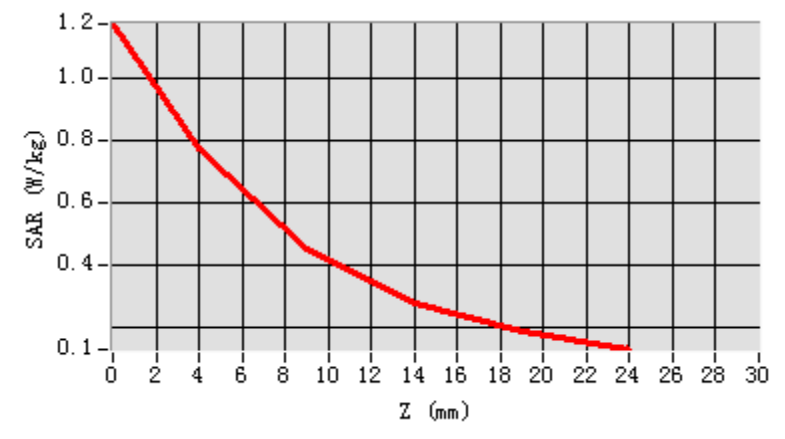
| | |
|--|-----------|
| Frequency (MHz) | 709 |
| Relative permittivity (real part) | 55.531170 |
| Relative permittivity (imaginary part) | 24.594805 |
| Conductivity (S/m) | 1.024784 |
| Variation (%) | 0.22 |
| ConvF: | 23.36 |

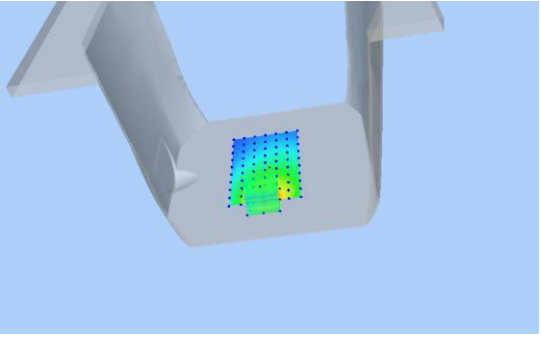
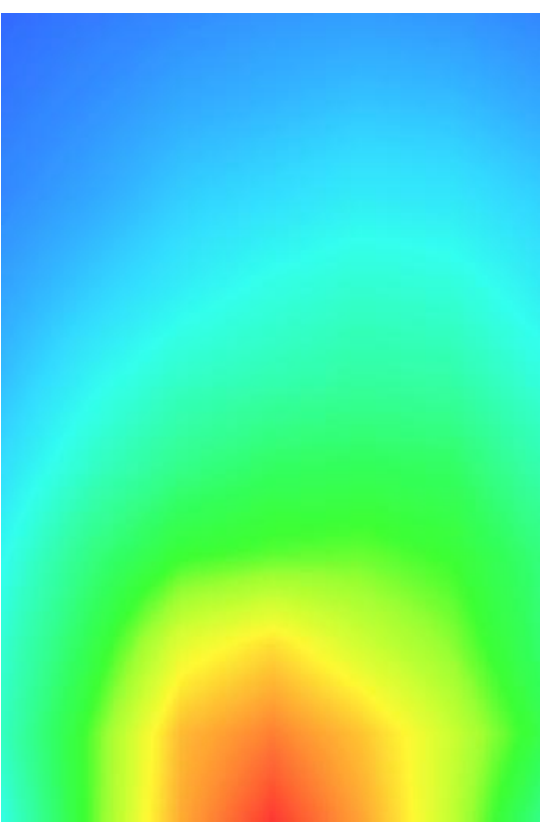


Maximum location: X=-5.00, Y=-56.00

| | |
|----------------|----------|
| SAR 10g (W/Kg) | 0.526593 |
| SAR 1g (W/Kg) | 0.701701 |

| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 1.1744 | 0.7720 | 0.4540 | 0.2776 | 0.1847 |



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



ANNEX E

of

CCIC-SET

CONFORMANCE TEST REPORT FOR

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS

SET2014-13062

LTE Mobile Phone

Type Name: M4 SS4445

Hardware Version: A-V1.0

Software Version: M4_SS4445_S10_VER200

Calibration Certificate of Probe and Dipoles

This Annex consists of 45 pages

Date of Report: 2014-12-11

Probe Calibration Certificate**COMOSAR E-Field Probe Calibration Report**

Ref : ACR.96.2.14.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT
TESTING (SHENZHEN) Co., Ltd**
ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI
TOWN, SHENZHEN, P.R. CHINA (POST CODE:518055)
SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 09/13 EP169

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



04/05/14

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.



COMOSARE-FIELD PROBE CALIBRATION REPORT

Ref: ACR.96.2.14.SATU.A

| | <i>Name</i> | <i>Function</i> | <i>Date</i> | <i>Signature</i> |
|----------------------|---------------|-----------------|-------------|----------------------|
| <i>Prepared by :</i> | Jérôme LUC | Product Manager | 04/05/2014 | <i>JLS</i> |
| <i>Checked by :</i> | Jérôme LUC | Product Manager | 04/05/2014 | <i>JLS</i> |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 04/08/2014 | <i>Kim Rutkowski</i> |

| | <i>Customer Name</i> |
|-----------------------|---|
| <i>Distribution :</i> | CCIC Southern Electronic Product Testing (Shenzhen) Co., Ltd |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A | 04/08/2014 | Initial release |
| | | |
| | | |
| | | |

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.



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 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.



1 DEVICE UNDER TEST

| Device Under Test | |
|--|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | Satimo |
| Model | SSE5 |
| Serial Number | SN 09/13 EP169 |
| Product Condition (new / used) | new |
| Frequency Range of Probe | 0.7 GHz-3GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.223 MΩ Dipole 2: R2=0.233 MΩ Dipole 3: R3=0.222 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 | 1.733% |
| Reflected power | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.733% |
| Liquid conductivity | 5.00% | Rectangular | $\sqrt{3}$ | 1 | 2.886% |
| Liquid permittivity | 4.00% | Rectangular | $\sqrt{3}$ | 1 | 2.310% |
| Field homogeneity | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.733% |
| Field probe positioning | 5.00% | Rectangular | $\sqrt{3}$ | 1 | 2.886% |
| Field probe linearity | 3.00% | Rectangular | $\sqrt{3}$ | 1 | 1.733% |

Page: 5/10

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.

| | | | | | |
|---|--|--|--|--|--------|
| Combined standard uncertainty | | | | | 5.832% |
| Expanded uncertainty 95 % confidence level k = 2 | | | | | 12.1% |

5 CALIBRATION MEASUREMENT RESULTS

| Calibration Parameters | |
|------------------------|-------|
| Liquid Temperature | 23 °C |
| Lab Temperature | 23 °C |
| Lab Humidity | 58 % |

5.1 SENSITIVITY IN AIR

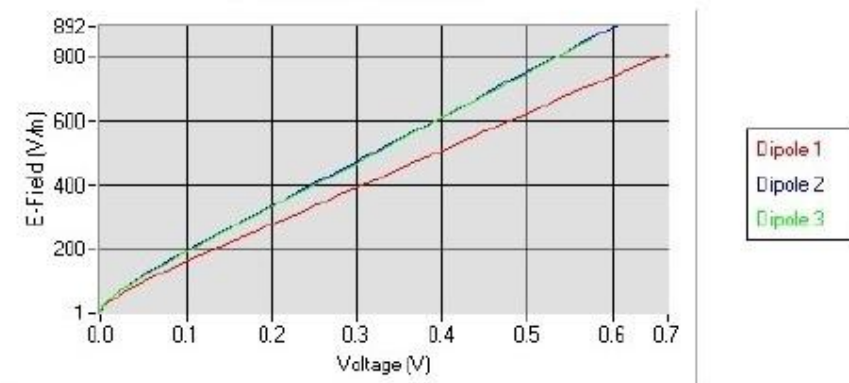
| Normx dipole 1 ($\mu\text{V}/(\text{V}/\text{m})^2$) | Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$) | Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$) |
|---|---|---|
| 7.23 | 6.10 | 5.74 |

| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|----------------------|----------------------|----------------------|
| 93.2 | 93.1 | 90.2 |

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

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

Calibration curves



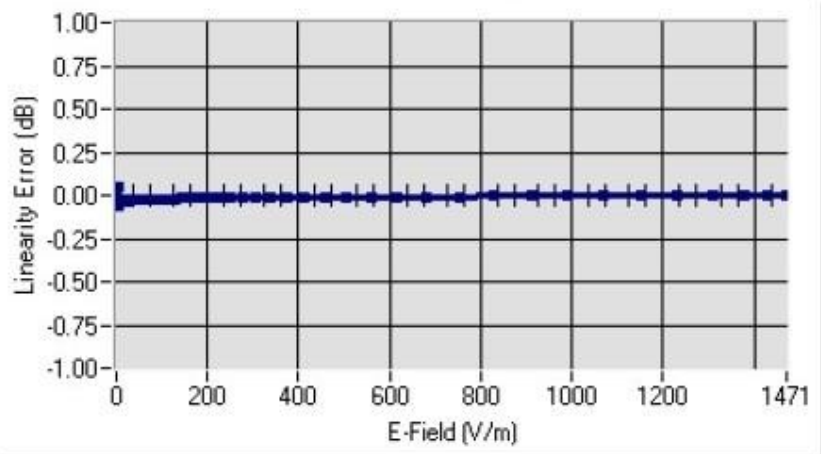
Page: 6/10

*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.*



5.2 LINEARITY

Linearity



Linearity: $\pm 1.42\%$ ($\pm 0.06\text{dB}$)

5.3 SENSITIVITY IN LIQUID

| Liquid | Frequency (MHz +/- 100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|--------|----------------------------|--------------|---------------|-------|
| HL850 | 835 | 42.56 | 0.87 | 5.51 |
| BL850 | 835 | 55.26 | 0.97 | 5.68 |
| HL900 | 900 | 41.79 | 0.97 | 5.20 |
| BL900 | 900 | 55.98 | 1.05 | 5.33 |
| HL1800 | 1750 | 40.17 | 1.39 | 4.80 |
| BL1800 | 1750 | 52.05 | 1.49 | 4.94 |
| HL1900 | 1880 | 39.80 | 1.45 | 5.49 |
| BL1900 | 1880 | 52.55 | 1.52 | 5.65 |
| HL2000 | 1950 | 38.93 | 1.42 | 4.80 |
| BL2000 | 1950 | 53.12 | 1.50 | 5.02 |
| HL2450 | 2450 | 38.64 | 1.83 | 4.81 |
| BL2450 | 2450 | 52.02 | 1.95 | 4.91 |

LOWER DETECTION LIMIT: 9mW/kg

Page: 7/10

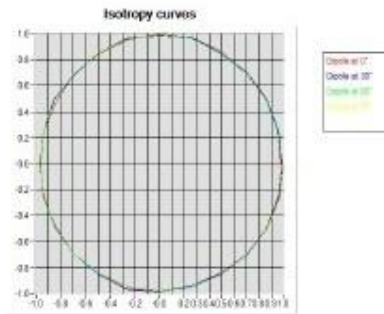
This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.



5.4 ISOTROPY

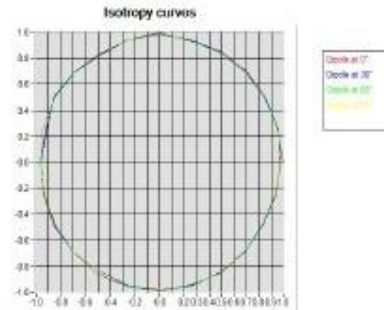
HL900 MHz

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



HL1800 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.06 dB

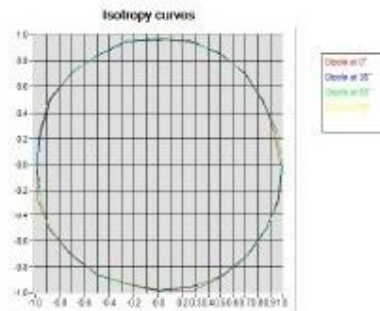


Page: 8/10

*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.*

**HL2450 MHz**

- Axial isotropy: 0.07 dB
- Hemispherical isotropy: 0.08 dB



Page: 9/10

*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.*



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 | Characterized prior to test. No cal required | Characterized prior to test. No cal required. |
| Multimeter | Keithley 2000 | 1188656 | 11/2013 | 11/2016 |
| 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 | 11/2013 | 11/2016 |
| Power Sensor | HP ECP-E26A | US37181460 | 11/2013 | 11/2016 |
| 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 | 3/2014 | 3/2016 |

Page: 10/10

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.

Probe Calibration Certificate**COMOSAR E-Field Probe Calibration Report**

Ref : ACR.155.1.14.SATU.A

SHENZHEN BALUN TECHNOLOGY Co.,Ltd.
BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY
PARK, SHAHE XI ROAD,
NANSHAN DISTRICT, SHENZHEN, GUANGDONG
PROVINCE, P.R. CHINA 518055
SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 27/14 EPG210

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



05/16/2014

Summary:

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



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.155 LI4.SATU.A

| | <i>Name</i> | <i>Function</i> | <i>Date</i> | <i>Signature</i> |
|----------------------|---------------|-----------------|-------------|--------------------|
| <i>Prepared by :</i> | Jérôme LUC | Product Manager | 6/4/2014 | <i>[Signature]</i> |
| <i>Checked by :</i> | Jérôme LUC | Product Manager | 6/4/2014 | <i>[Signature]</i> |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 6/4/2014 | <i>[Signature]</i> |

| | <i>Customer Name</i> |
|----------------------|---|
| <i>Distributor :</i> | ChengNing (Shenzhen) Electronics Co., Ltd. |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A | 6/4/2014 | Initial release |
| | | |
| | | |
| | | |

Page: 2/19

*This document shall not be reproduced, stored 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.*



TABLE OF CONTENTS

- 1 Device Under Test 1
- 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 10

1 DEVICE UNDER TEST

| Device Under Test | |
|--|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | Satimo |
| Model | SSE2 |
| Serial Number | SN 27/14 EPG210 |
| Product Condition (new / used) | New |
| Frequency Range of Probe | 0.3 GHz-6GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.197 M Ω Dipole 2: R2=0.220 M Ω Dipole 3: R3=0.241 M Ω |

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 CENELEC 62209 standards.



Figure 1 – Satimo COMOSAR Dosimetric E field Dipole

| | |
|--|--------|
| Probe Length | 330 mm |
| Length of Individual Dipoles | 2 mm |
| Maximum external diameter | 8 mm |
| Probe Tip External Diameter | 2.5 mm |
| Distance between dipoles / probe extremity | 1 mm |

3 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C, CENELEC EN50261 and CENELEC 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 0.01 W/kg to 100 W/kg.

Page: 4/10

*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.*

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 IEC 61028, OET 65 Bulletin C, CEENELEC EN50361 and CE/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 | c_i | 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% |

Page: 3/16

*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 treated in whole or in part without written approval of SATIMO.*

| | | | | | |
|---|--|--|--|--|--------|
| 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 % |

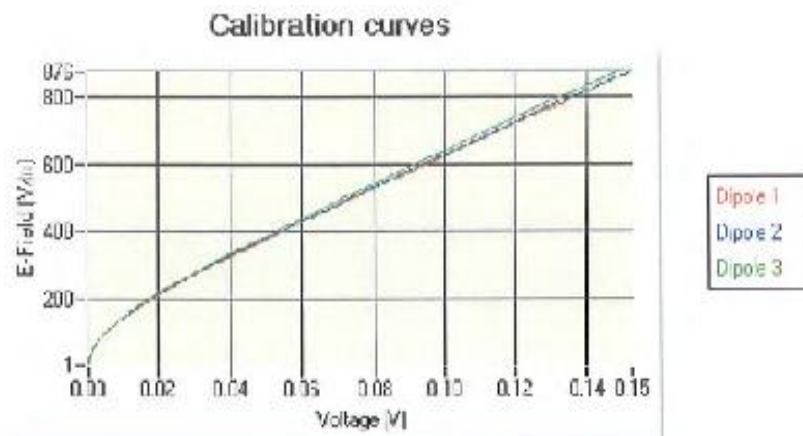
5.1 SENSITIVITY IN AIR

| Norm x dipole 1 ($\mu\text{V}/(\text{V}/\text{m})^2$) | Norm y dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$) | Norm z dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$) |
|--|--|--|
| 0.44 | 0.54 | 0.52 |

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

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

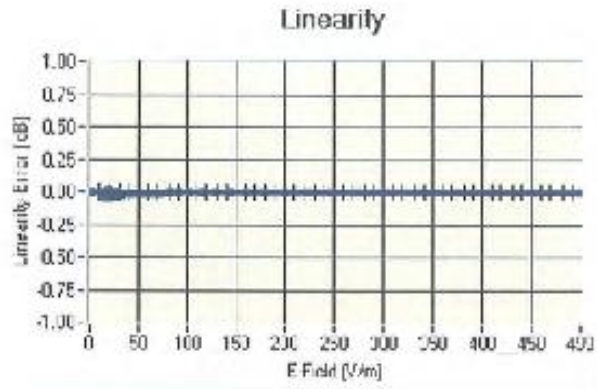
$$E = \sqrt{E_1^2 + E_2^2 + E_3^2}$$



Page: 6/10

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.

5.2 LINEARITY



Linearity: $\pm 1.25\%$ ($\pm 0.05\text{dB}$)

5.3 SENSITIVITY IN LIQUID

| Liquid | Frequency (MHz \pm 100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|--------|------------------------------|--------------|---------------|-------|
| HL450 | 450 | 43.02 | 0.85 | 30.15 |
| BL450 | 450 | 57.52 | 0.96 | 31.02 |
| HL750 | 750 | 42.10 | 0.88 | 22.51 |
| BL750 | 750 | 54.79 | 0.95 | 23.36 |
| HL850 | 855 | 43.05 | 0.87 | 25.67 |
| BL850 | 855 | 53.35 | 0.95 | 26.58 |
| HL900 | 900 | 42.29 | 0.95 | 23.35 |
| BL900 | 900 | 56.82 | 1.06 | 24.10 |
| HL1800 | 1800 | 40.93 | 1.35 | 23.21 |
| BL1800 | 1800 | 52.57 | 1.47 | 23.69 |
| HL1900 | 1900 | 40.92 | 1.45 | 26.70 |
| BL1900 | 1900 | 53.60 | 1.52 | 27.67 |
| HL2000 | 2000 | 39.36 | 1.44 | 25.28 |
| BL2000 | 2000 | 52.17 | 1.53 | 26.28 |
| HL2450 | 2450 | 39.12 | 1.78 | 25.25 |
| BL2450 | 2450 | 52.17 | 1.90 | 26.09 |
| HL2600 | 2600 | 38.46 | 1.92 | 25.94 |
| BL2600 | 2600 | 51.76 | 2.19 | 26.66 |
| HL5200 | 5200 | 36.47 | 4.91 | 22.36 |
| BL5200 | 5200 | 51.18 | 4.84 | 22.88 |
| HL5400 | 5400 | 36.85 | 5.02 | 25.63 |
| BL5400 | 5400 | 48.35 | 5.81 | 26.47 |
| HL5600 | 5600 | 35.39 | 5.49 | 24.82 |
| BL5600 | 5600 | 49.05 | 6.17 | 25.66 |
| HL5800 | 5800 | 34.91 | 5.76 | 22.60 |
| BL5800 | 5800 | 47.18 | 6.32 | 23.20 |

LOWER DETECTION LIMIT: 7mW/kg

Page: 7/10

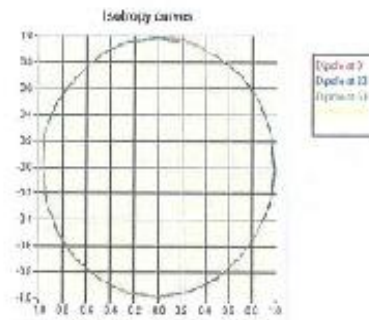
This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or in part without written approval of SATIMO.



5.4 ISOTROPY

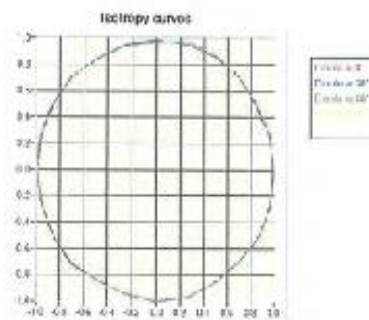
HL900 MHz

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



HL1800 MHz

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.08 dB

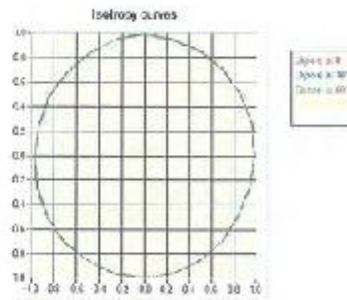


Page 8/10

*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 it does not
be returned in whole or part without written approval of SATIMO.*

**HL5400 MHz**

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.10 dB



Page: 9/10

*This document should 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.*



6 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|-------------------------------|----------------------|--------------------|---|---|
| Equipment Description | Manufacturer / Model | Identification No. | Current Calibration Date | Next Calibration Date |
| Flat Phantom | Satimo | SN 20X09-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 | 02/2013 |
| Reference Probe | Satimo | EP 94 SN 37/08 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Multimeter | Keithley 2000 | 1188656 | 12/2013 | 12/2016 |
| Signal Generator | Agilent E4438C | MY48070531 | 12/2013 | 12/2016 |
| Amplifier | Aethercomm | SN 016 | 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 | US57181460 | 12/2013 | 12/2016 |
| Directional Coupler | Narda 4213-20 | 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 |

Page: 16/16

*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.*

SID835 Dipole Calibration Certificate**SAR Reference Dipole Calibration Report**

Ref: ACR.240.1.14.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT
TESTING (SHENZHEN) CO., LTD
ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI
TOWN
SHENZHEN, P.R. CHINA (POST CODE:518055)
SATIMO COMOSAR REFERENCE DIPOLE
FREQUENCY: 835 MHZ
SERIAL NO.: SN 09/13 DIP0G835-217**

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



08/28/14

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.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.249.1.14.SATU.A

| | <i>Name</i> | <i>Function</i> | <i>Date</i> | <i>Signature</i> |
|----------------------|---------------|-----------------|-------------|--------------------|
| <i>Prepared by :</i> | Jérôme LUC | Product Manager | 8/29/2014 | <i>[Signature]</i> |
| <i>Checked by :</i> | Jérôme LUC | Product Manager | 8/29/2014 | <i>[Signature]</i> |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 8/29/2014 | <i>[Signature]</i> |

| | |
|-----------------------|---|
| <i>Distribution :</i> | <i>Customer Name</i> CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd |
|-----------------------|---|

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A | 8/29/2014 | Initial release |
| | | |
| | | |



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 In Head Liquid | 6 |
| 6.2 | Return Loss and Impedance In Body Liquid | 6 |
| 6.3 | Mechanical Dimensions | 6 |
| 7 | Validation measurement | 7 |
| 7.1 | Head Liquid Measurement | 7 |
| 7.2 | SAR Measurement Result With Head Liquid | 8 |
| 7.3 | Body Liquid Measurement | 9 |
| 7.4 | SAR Measurement Result With Body Liquid | 10 |
| 8 | List of Equipment | 11 |



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 835 MHz REFERENCE DIPOLE |
| Manufacturer | Satimo |
| Model | SID835 |
| Serial Number | SN 09/13 DIP0G835-217 |
| 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

Page: 4/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



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 constructed 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 % |

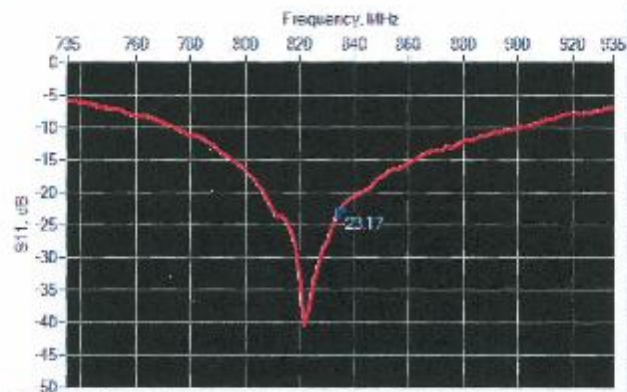
Page: 3/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



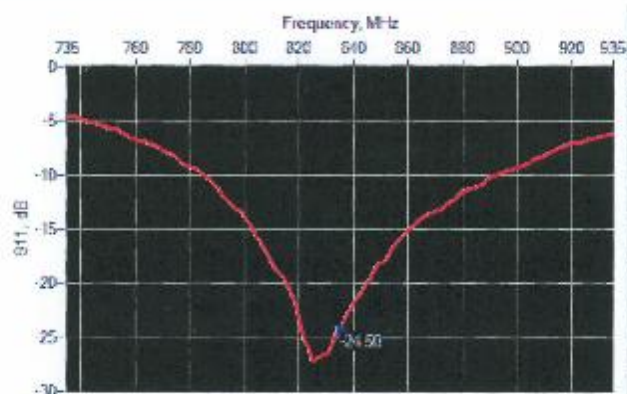
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------------------|
| 835 | -23.17 | -20 | $57.4 \Omega - 0.2 j\Omega$ |

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------------------|
| 835 | -24.50 | -20 | $55.0 \Omega + 3.9 j\Omega$ |

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 % | | 256.7 ±1 % | | 6.35 ±1 % | |
| 750 | 176.0 ±1 % | | 200.0 ±1 % | | 6.35 ±1 % | |
| 835 | 161.0 ±1 % | PASS | 89.8 ±1 % | PASS | 3.6 ±1 % | PASS |

Page: 6/11

This document shall not be reproduced, stored in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.240.1.14.SATIMA

| | | | | | |
|------|------------|--|-----------|--|----------|
| 900 | 149.0 ±1 % | | 89.9 ±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 % | | 30.4 ±1 % | | 3.6 ±1 % |
| 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_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 % | PASS | 0.90 ±5 % | PASS |
| 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 % | |

Page: 7/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.240.1.14.SATU.A

| | | | | |
|------|-----------|--|-----------|--|
| 2100 | 39.8 ±5 % | | 1.49 ±5 % | |
| 2300 | 39.5 ±5 % | | 1.67 ±5 % | |
| 2450 | 39.2 ±5 % | | 1.80 ±5 % | |
| 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: $\epsilon_r' : 42.3$ $\sigma : 0.92$ |
| Distance between dipole center and liquid | 15.0 mm |
| Area scan resolution | $dx=8mm/dy=8mm$ |
| Zoon Scan Resolution | $dx=8mm/dy=8mm/dz=5mm$ |
| Frequency | 835 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 | 9.77 (0.98) | 6.22 | 6.30 (0.63) |
| 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 | |

Page: 8/11

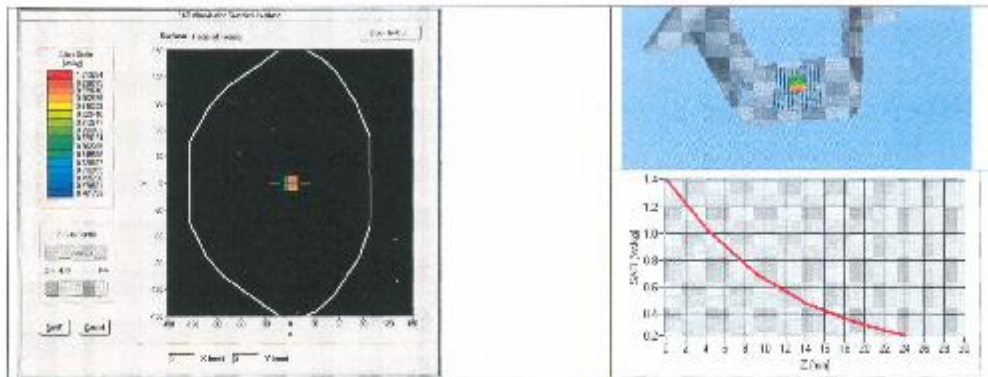
This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.240.1.14.SATIM.A

| | | | |
|------|------|--|------|
| 2450 | 52.4 | | 24 |
| 2620 | 55.3 | | 24.6 |
| 3020 | 63.8 | | 25.7 |
| 3520 | 67.1 | | 25 |



7.3 BODY LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity (ϵ_r) | | 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 % | PASS | 0.97 ±5 % | PASS |
| 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 % | | 1.95 ±5 % | |
| 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 % | |

Page: 9/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

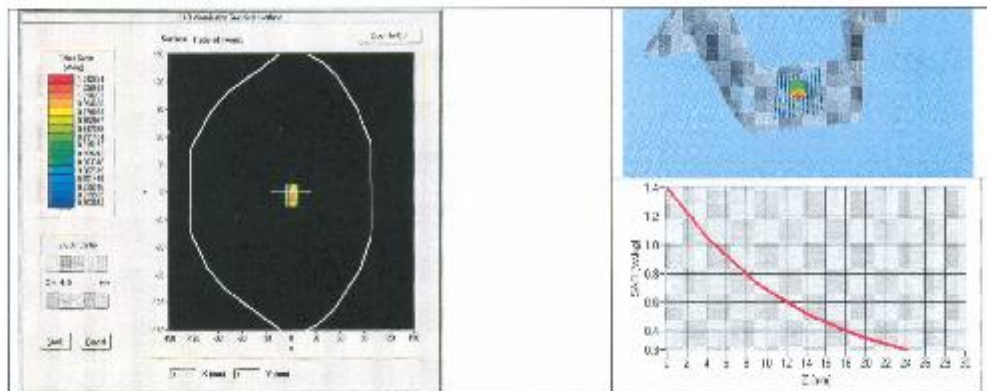
Ref. ACR 340 1 14 SATUA

| | | | | |
|------|------------|--|------------|--|
| 5500 | 48.5 ±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 18:1 EPG122 |
| Liquid | Body Liquid Values: eps' : 54.1 sigma : 0.97 |
| Distance between dipole center and liquid | 15.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8m/dz=5mm |
| Frequency | 835 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 |
| 835 | 10.31 (1.03) | 6.74 (0.67) |





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 | 11-861-9 | 8/2012 | 8/2015 |

Page: 11/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.

SID1900 Dipole Calibration Certificate**SAR Reference Dipole Calibration Report**

Ref : ACR.240.4.14.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT
TESTING (SHENZHEN) CO., LTD
ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI
TOWN
SHENZHEN, P.R. CHINA (POST CODE:518055)
SATIMO COMOSAR REFERENCE DIPOLE
FREQUENCY: 1900 MHZ
SERIAL NO.: SN 09/13 DIP1G900-218**

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

**08/28/14***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.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.240.4.14.SAT01.A

| | <i>Name</i> | <i>Function</i> | <i>Date</i> | <i>Signature</i> |
|----------------------|---------------|-----------------|-------------|----------------------|
| <i>Prepared by :</i> | Jérôme LUC | Product Manager | 8/29/2014 | <i>JLS</i> |
| <i>Checked by :</i> | Jérôme LUC | Product Manager | 8/29/2014 | <i>JLS</i> |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 8/29/2014 | <i>Kim Rutkowski</i> |

| | <i>Customer Name</i> |
|-----------------------|---|
| <i>Distribution :</i> | CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A | 8/29/2014 | Initial release |
| | | |
| | | |



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 In Head Liquid 6
 - 6.2 Return Loss and Impedance In Body Liquid 6
 - 6.3 Mechanical Dimensions 6
- 7 Validation measurement 7
 - 7.1 Head Liquid Measurement 7
 - 7.2 SAR Measurement Result With Head Liquid 8
 - 7.3 Body Liquid Measurement 9
 - 7.4 SAR Measurement Result With Body Liquid 10
- 8 List of Equipment 11



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 1900 MHz REFERENCE DIPOLE |
| Manufacturer | Satimo |
| Model | SID1900 |
| Serial Number | SN 09/13 DIP1G900-218 |
| 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



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 constructed 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 % |

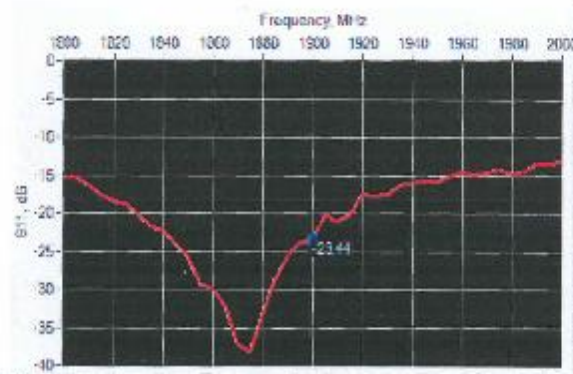
Page: 5/11

This document shall not be reproduced, copied 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.



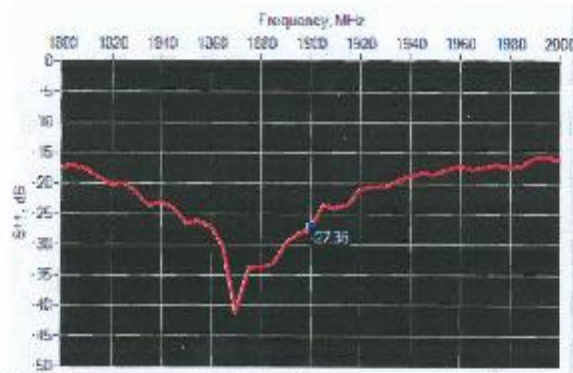
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------------------|
| 1900 | -23.44 | -20 | $55.4 \Omega + 5.2 j\Omega$ |

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------------------|
| 1900 | -27.36 | -20 | $51.7 \Omega + 4.4 j\Omega$ |

6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm | | h mm | | d mm | |
|---------------|------------------|----------|------------------|----------|-----------------|----------|
| | required | measured | required | measured | required | measured |
| 300 | $420.0 \pm 1 \%$ | | $750.0 \pm 1 \%$ | | $6.35 \pm 1 \%$ | |
| 450 | $290.0 \pm 1 \%$ | | $106.7 \pm 1 \%$ | | $6.35 \pm 1 \%$ | |
| 750 | $176.0 \pm 1 \%$ | | $100.0 \pm 1 \%$ | | $6.35 \pm 1 \%$ | |
| 835 | $161.0 \pm 1 \%$ | | $89.8 \pm 1 \%$ | | $3.5 \pm 1 \%$ | |

Page: 6/11

This document shall not be reproduced, stored 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.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.200.0.10.SATIM.6

| | | | | | | |
|------|------------|------|-----------|------|----------|------|
| 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 % | PASS | 39.5 ±1 % | PASS | 3.6 ±1 % | PASS |
| 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 % | | 30.4 ±1 % | | 3.6 ±1 % | |
| 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_r) | | Conductivity (σ) S/m | |
|------------------|--|----------|-------------------------------|----------|
| | required | measured | required | measured |
| 300 | 45.3 ±5 % | | 0.87 ±5 % | |
| 450 | 43.5 ±5 % | | 0.87 ±5 % | |
| 750 | 41.5 ±5 % | | 0.89 ±5 % | |
| 835 | 41.5 ±5 % | | 0.90 ±5 % | |
| 900 | 41.5 ±5 % | | 0.97 ±5 % | |
| 1450 | 40.5 ±5 % | | 1.70 ±5 % | |
| 1500 | 40.4 ±5 % | | 1.23 ±5 % | |
| 1560 | 40.2 ±5 % | | 1.31 ±5 % | |
| 1750 | 40.1 ±5 % | | 1.37 ±5 % | |
| 1800 | 40.3 ±5 % | | 1.40 ±5 % | |
| 1900 | 40.0 ±5 % | PASS | 1.40 ±5 % | PASS |
| 1950 | 40.0 ±5 % | | 1.40 ±5 % | |
| 2000 | 40.0 ±5 % | | 1.40 ±5 % | |

Page: 7/11

This document shall not be reproduced, copied 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 retained in whole or part without written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR-2014-14 SATULA

| | | |
|------|-----------|-----------|
| 2100 | 39.8 ±5 % | 1.49 ±5 % |
| 2300 | 39.5 ±5 % | 1.67 ±5 % |
| 2450 | 39.2 ±5 % | 1.80 ±5 % |
| 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 30009 SAM71 |
| Probe | SN 18/11 EPG122 |
| Liquid | Head Liquid Values: eps' : 41.1 sigma : 1.42 |
| Distance between dipole center and liquid | 13.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8m/dz=5mm |
| Frequency | 1900 MHz |
| Input power | 23 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 | | 1.04 | |
| 450 | 4.58 | | 3.26 | |
| 750 | 8.49 | | 5.55 | |
| 835 | 9.56 | | 5.27 | |
| 900 | 10.9 | | 5.99 | |
| 1450 | 29 | | 16 | |
| 1500 | 30.5 | | 16.8 | |
| 1640 | 34.2 | | 18.4 | |
| 1750 | 36.4 | | 19.2 | |
| 1800 | 38.4 | | 20.1 | |
| 1900 | 39.7 | 40.97 (4.04) | 20.5 | 20.62 (2.06) |
| 1950 | 40.5 | | 20.9 | |
| 2000 | 41.1 | | 21.1 | |
| 2100 | 43.6 | | 21.9 | |
| 2300 | 48.7 | | 23.3 | |

Page: 8/11

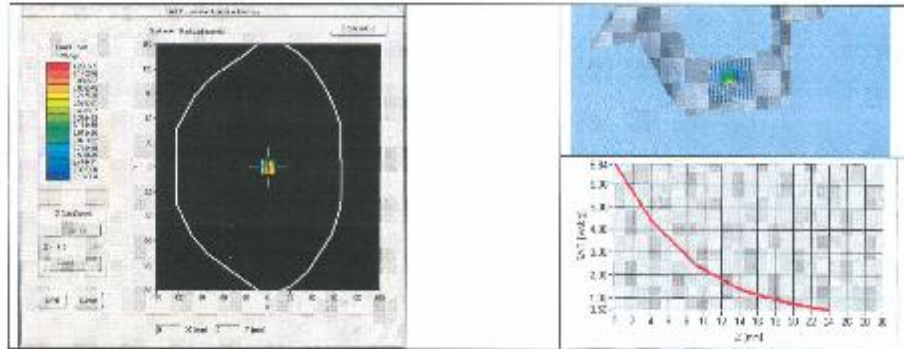
This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR240414SATU.A

| | | | | |
|------|------|--|------|--|
| 2450 | 52.4 | | 24 | |
| 2500 | 55.3 | | 24.6 | |
| 3000 | 63.8 | | 25.7 | |
| 3500 | 67.1 | | 25 | |



7.3 BODY LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity (ϵ_r) | | Conductivity (σ) S/m | |
|---------------|--|----------|-------------------------------|----------|
| | required | measured | required | measured |
| 150 | 61.9 ±5 % | | 0.80 ±5 % | |
| 300 | 58.7 ±5 % | | 0.93 ±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 % | PASS | 1.52 ±5 % | PASS |
| 2000 | 53.3 ±5 % | | 1.52 ±5 % | |
| 2100 | 53.2 ±5 % | | 1.62 ±5 % | |
| 2450 | 52.7 ±5 % | | 1.95 ±5 % | |
| 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 % | |

Page: 9/11

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.



SAR REFERENCE DIPOLE CALIBRATION REPORT

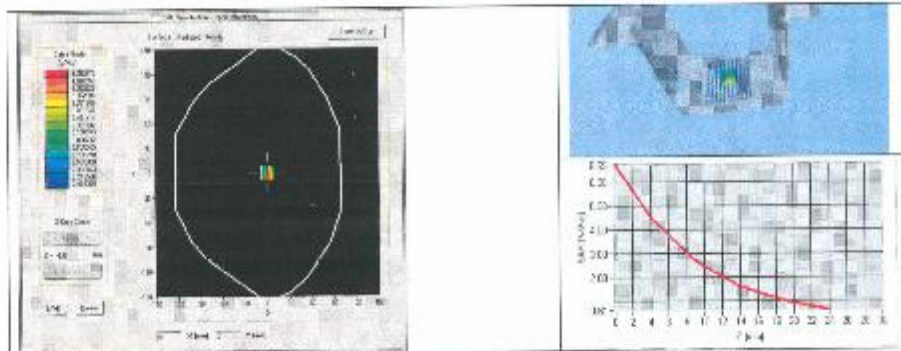
Ref. ACR 060 4 14 SAT/JJA

| | | | |
|------|------------|--|------------|
| 5500 | 48.6 ±10 % | | 5.55 ±10 % |
| 5600 | 48.5 ±10 % | | 5.77 ±10 % |
| 5800 | 48.2 ±10 % | | 5.00 ±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' : 54.2 sigma : 1.54 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zona Scan Resolution | dx=8mm/dy=8mm/dz=5mm |
| Frequency | 1900 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 |
| 1900 | 40.81 [4.08] | 71.21 [2.12] |



Page: 10/11

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.



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 | Camera | 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 | MY45070581 | 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-E28A | 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 |

Page: 11/11

*This document shall not be reproduced, stored 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.*

SID2450 Dipole Calibration Certificate**SAR Reference Dipole Calibration Report**

Ref : ACR.240.6.14.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT
TESTING (SHENZHEN) CO., LTD**
ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI
TOWN
SHENZHEN, P.R. CHINA (POST CODE:518055)
SATIMO COMOSAR REFERENCE DIPOLE
FREQUENCY: 2450 MHZ
SERIAL NO.: SN 09/13 DIP2G450-220

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



08/28/14

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.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 240 6 14 SATJA

| | <i>Name</i> | <i>Function</i> | <i>Date</i> | <i>Signature</i> |
|----------------------|---------------|-----------------|-------------|----------------------|
| <i>Prepared by :</i> | Jérôme LUC | Product Manager | 8/29/2014 | <i>JL</i> |
| <i>Checked by :</i> | Jérôme LUC | Product Manager | 8/29/2014 | <i>JL</i> |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 8/29/2014 | <i>Kim Rutkowski</i> |

| | <i>Customer Name</i> |
|-----------------------|---|
| <i>Distribution :</i> | CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A | 8/29/2014 | Initial release |
| | | |
| | | |



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 In Head Liquid 6

 6.2 Return Loss and Impedance In Body Liquid 6

 6.3 Mechanical Dimensions 6

7 Validation measurement 7

 7.1 Head Liquid Measurement 7

 7.2 SAR Measurement Result With Head Liquid 8

 7.3 Body Liquid Measurement 9

 7.4 SAR Measurement Result With Body Liquid 10

8 List of Equipment 11



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 09/13 DIP2G450-220 |
| 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

Page: 4/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C and CEI/TEC 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 constructed as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/TEC 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/TEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

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

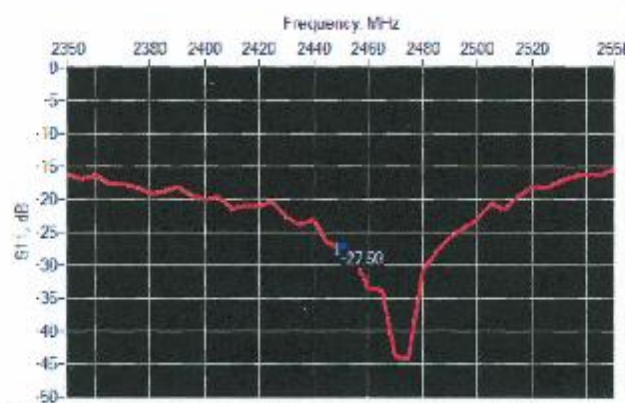
Page: 5/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



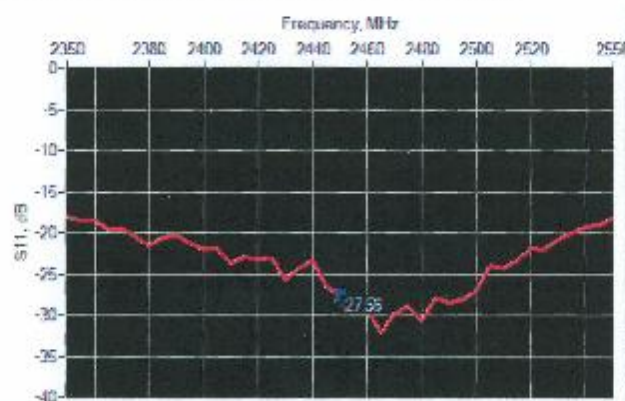
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------------------|
| 2450 | -27.50 | -20 | $51.7 \Omega + 3.8 j\Omega$ |

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------------------|
| 2450 | -27.56 | -20 | $54.3 \Omega + 0.9 j\Omega$ |

6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm | | h mm | | d mm | |
|---------------|------------------|----------|------------------|----------|-----------------|----------|
| | required | measured | required | measured | required | measured |
| 300 | $420.0 \pm 1 \%$ | | $250.0 \pm 1 \%$ | | $6.35 \pm 1 \%$ | |
| 450 | $290.0 \pm 1 \%$ | | $166.7 \pm 1 \%$ | | $6.35 \pm 1 \%$ | |
| 750 | $176.0 \pm 1 \%$ | | $100.0 \pm 1 \%$ | | $6.35 \pm 1 \%$ | |
| 835 | $161.0 \pm 1 \%$ | | $89.8 \pm 1 \%$ | | $3.6 \pm 1 \%$ | |

Page: 6/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.240.6.14.SATU.A

| | | | | | | |
|------|------------|------|-----------|------|----------|------|
| 900 | 149.0 ±1 % | | 83.3 ±1 % | | 3.6 ±1 % | |
| 1450 | 85.1 ±1 % | | 51.7 ±1 % | | 3.6 ±1 % | |
| 1500 | 80.5 ±1 % | | 50.0 ±1 % | | 3.6 ±1 % | |
| 1640 | 75.0 ±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 % | | 32.5 ±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_r) | | Conductivity (σ) S/m | |
|------------------|--|----------|-------------------------------|----------|
| | required | measured | required | measured |
| 300 | 45.5 ±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 % | |

Page: 7/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 240.e.14.SATU.A

| | | | | |
|------|-----------|------|-----------|------|
| 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: ϵ_{ps}^1 : 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=8mm/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 | | 21.3 | |

Page: 8/11

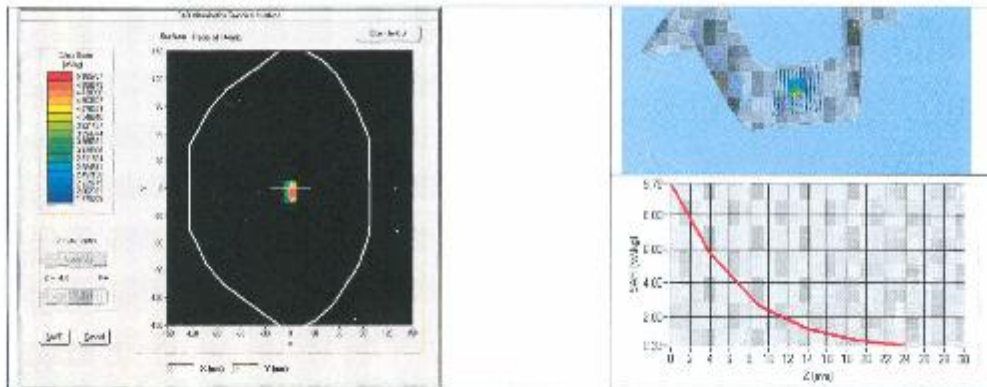
This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.249.6.14.SATU.A

| | | | | |
|------|------|--------------|------|--------------|
| 2450 | 52.4 | 53.60 (5.36) | 24 | 23.77 (2.38) |
| 2600 | 55.3 | | 24.6 | |
| 3000 | 53.8 | | 25.7 | |
| 3500 | 67.1 | | 25 | |



7.3 BODY LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity (ϵ_r') | | 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 % | |

Page: 9/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

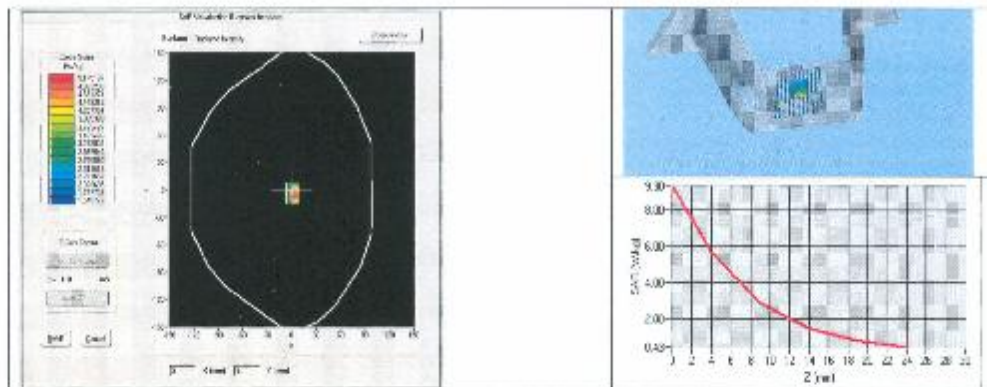
Ref: ACR.240.6.14.SATU.A

| | | | |
|------|------------|--|------------|
| 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 |
| Zoom Scan Resolution | dx=8mm/dy=8mm/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 | 52.66 (5.27) | 23.73 (2.37) |



Page: 10/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



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 | US38261488 | 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 |

Page: 11/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.

SID1800 Dipole Calibration Certificate**SAR Reference Dipole Calibration Report**

Ref : ACR.240.3.14.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT
TESTING (SHENZHEN) CO., LTD
ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI
TOWN
SHENZHEN, P.R. CHINA (POST CODE:518055)
SATIMO COMOSAR REFERENCE DIPOLE
FREQUENCY: 1800 MHZ
SERIAL NO.: SN 09/13 DIPIG800-216**

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



08/28/14

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.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.240.5.14.SATU.A

| | <i>Name</i> | <i>Function</i> | <i>Date</i> | <i>Signature</i> |
|----------------------|---------------|-----------------|-------------|--------------------|
| <i>Prepared by :</i> | Jérôme LUC | Product Manager | 8/29/2014 | <i>[Signature]</i> |
| <i>Checked by :</i> | Jérôme LUC | Product Manager | 8/29/2014 | <i>[Signature]</i> |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 8/29/2014 | <i>[Signature]</i> |

| | <i>Customer Name</i> |
|-----------------------|---|
| <i>Distribution :</i> | CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A | 8/29/2014 | Initial release |
| | | |
| | | |



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 In Head Liquid 6

 6.2 Return Loss and Impedance In Body Liquid 6

 6.3 Mechanical Dimensions 6

7 Validation measurement 7

 7.1 Head Liquid Measurement 7

 7.2 SAR Measurement Result With Head Liquid 8

 7.3 Body Liquid Measurement 9

 7.4 SAR Measurement Result With Body Liquid 10

8 List of Equipment 11



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 1800 MHz REFERENCE DIPOLE |
| Manufacturer | Satimo |
| Model | SID1800 |
| Serial Number | SN 09/13 DIP1G800-216 |
| 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

Page: 4/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



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 constructed 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.

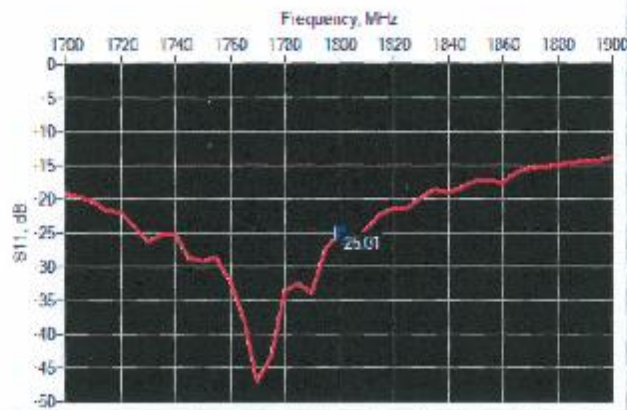
| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
| 1 g | 20.3 % |
| 10 g | 20.1 % |

Page: 5/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.

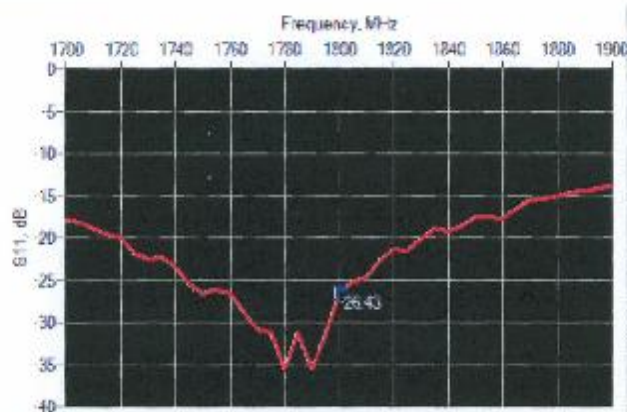
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------------------|
| 1800 | -25.01 | -20 | $46.7 \Omega + 4.5 j\Omega$ |

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|-----------------|------------------|------------------|-----------------------------|
| 1800 | -26.43 | -20 | $45.8 \Omega + 1.3 j\Omega$ |

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 % | | 165.7 ±1 % | | 6.35 ±1 % | |
| 750 | 176.0 ±1 % | | 100.0 ±1 % | | 6.35 ±1 % | |
| 835 | 161.0 ±1 % | | 89.8 ±1 % | | 3.6 ±1 % | |

Page: 6/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 2403.14-SATUA

| | | | | | | |
|------|------------|------|-----------|------|----------|------|
| 900 | 149.0 ±1 % | | 83.3 ±1 % | | 3.6 ±1 % | |
| 1450 | 89.1 ±1 % | | 51.7 ±1 % | | 3.6 ±1 % | |
| 1520 | 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 % | PASS | 41.7 ±1 % | PASS | 3.6 ±1 % | PASS |
| 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 % | | 32.5 ±1 % | | 3.6 ±1 % | |
| 2450 | 51.5 ±1 % | | 30.4 ±1 % | | 3.6 ±1 % | |
| 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 CEM/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_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 % | PASS | 1.40 ±5 % | PASS |
| 1900 | 40.0 ±5 % | | 1.40 ±5 % | |
| 1950 | 40.0 ±5 % | | 1.40 ±5 % | |
| 2000 | 40.0 ±5 % | | 1.40 ±5 % | |

Page 7/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.240.3.14.SATU.A

| | | | |
|------|-----------|--|-----------|
| 2100 | 39.8 ±5 % | | 1.49 ±5 % |
| 2300 | 39.5 ±5 % | | 1.67 ±5 % |
| 2450 | 39.2 ±5 % | | 1.80 ±5 % |
| 2600 | 39.0 ±5 % | | 1.95 ±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 CEM/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' : 41.5 sigma : 1.38 |
| 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 | 1800 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 21 °C |
| Lab Temperature | 21 °C |
| Lab Humidity | 45 % |

| Frequency MHz | 1 µ SAR (W/kg/W) | | 10 µ 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 | 38.67 (3.87) | 20.1 | 20.30 (2.03) |
| 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 | |

Page: 8/11

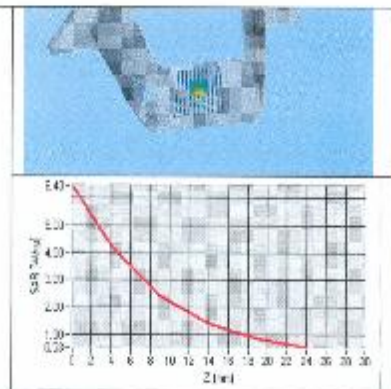
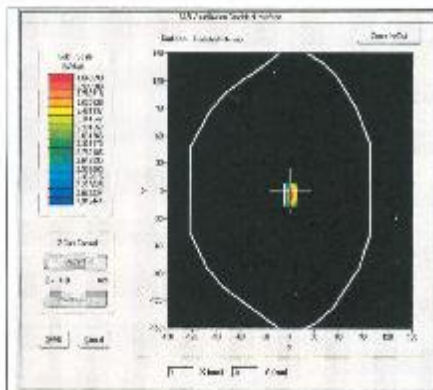
This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 740.3.14.SATULA

| | | |
|------|------|------|
| 2450 | 52.4 | 24 |
| 2600 | 55.3 | 24.6 |
| 3000 | 53.8 | 25.7 |
| 3500 | 57.1 | 25 |



7.3 BODY LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity (ε _r) | | Conductivity (σ) S/m | |
|------------------|---|----------|----------------------|----------|
| | required | measured | required | measured |
| 150 | 61.9 ±5 % | | 0.80 ±5 % | |
| 300 | 58.2 ±5 % | | 0.32 ±5 % | |
| 450 | 56.7 ±5 % | | 0.34 ±5 % | |
| 750 | 55.5 ±5 % | | 0.36 ±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 % | PASS | 1.52 ±5 % | PASS |
| 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 % | | 1.95 ±5 % | |
| 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 % | |

Page: 9/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
 No part of this document may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or by any information storage and retrieval system, without the prior written permission of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

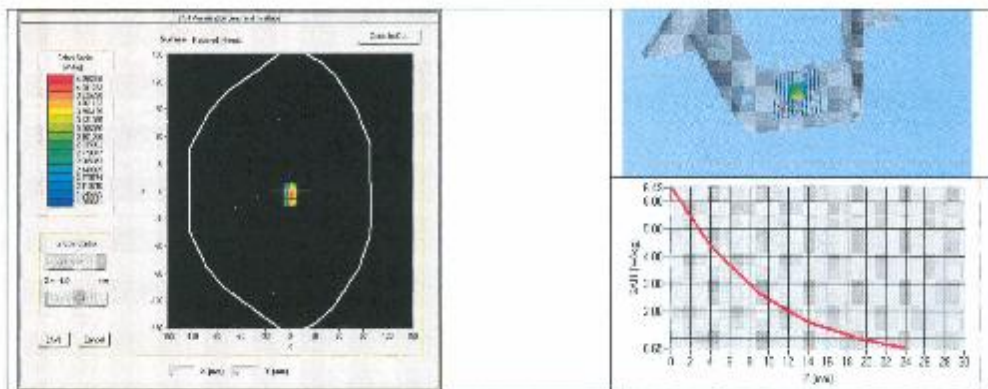
Ref: ACR.240.3.14.SATU.A

| | | | |
|------|------------|--|------------|
| 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: ϵ_r : 53.3 σ : 1.51 |
| 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 | 1800 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 |
| 1800 | 40.07 (4.02) | 21.27 (2.13) |



Page: 10/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.



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 |
| Mu timer | 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 |

Page: 11/11

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.

SID750 Dipole Calibration Certificate**SAR Reference Dipole Calibration Report**

Ref: ACR.219.3.13.SA10.A

SHENZHEN BALUN TECHNOLOGY CO., LTD.
BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY
PARK, SHAHE XI ROAD, NANSHAN DISTRICT,
SHENZHEN, GUANGDONG PROVINCE, 518055 P. R. CHINA
SATIMO COMOSAR REFERENCE DIPOLE
FREQUENCY: 750 MHZ
SERIAL NO.: SN 25/13 DIP 0G750-253

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



17/08/2014

Summary:

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



SAR REFERENCE DIPOLE CALIBRATION REPORT

REF: AL 12/P/11/USA 1. A

| | <i>Name</i> | <i>Function</i> | <i>Date</i> | <i>Signature</i> |
|----------------------|---------------|-----------------|-------------|----------------------|
| <i>Prepared by :</i> | Jérôme LUC | Product Manager | 8/17/2014 | <i>JS</i> |
| <i>Checked by :</i> | Jérôme LUC | Product Manager | 8/17/2014 | <i>JS</i> |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 8/17/2014 | <i>Kim Rutkowski</i> |

| | <i>Customer Name</i> |
|-----------------------|------------------------------------|
| <i>Distribution :</i> | Shenzhen Balun Technology Co.,Ltd. |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A | 8/17/2014 | Initial release |
| | | |
| | | |

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 it may be released in whole or part without written approval of SATIMO.