

## Plot 8:WCDMA850, Back, Middle

Type: Phone measurement

Date of measurement:28/09/2015

Measurement duration: 7 minutes 17 seconds

Mobile Phone IMEI number: --

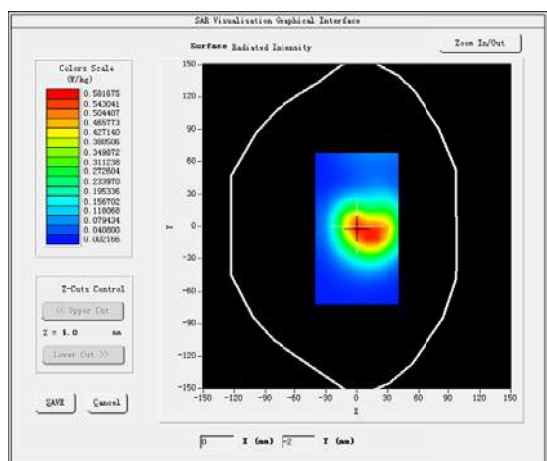
### A. Experimental conditions.

|                 |                            |
|-----------------|----------------------------|
| Area Scan       | dx=8mm dy=8mm              |
| ZoomScan        | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Phantom         | Validation plane           |
| Device Position | Back                       |
| Band            | Band5_WCDMA850             |
| Channels        | 4132                       |
| Signal          | WCDMA (Duty cycle: 1:1)    |

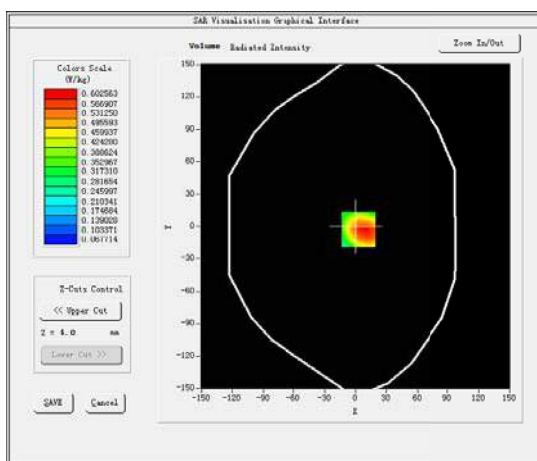
### B. SAR Measurement Results

|                                        |                       |
|----------------------------------------|-----------------------|
| E-Field Probe                          | SATIMO SN_04/13_EP166 |
| Frequency (MHz)                        | 826.4                 |
| Relative permittivity (real part)      | 54.82                 |
| Relative permittivity (imaginary part) | 20.48                 |
| Conductivity (S/m)                     | 0.95                  |
| Variation (%)                          | -0.24                 |
| ConvF:                                 | 5.82                  |

#### SURFACE SAR



#### VOLUME SAR

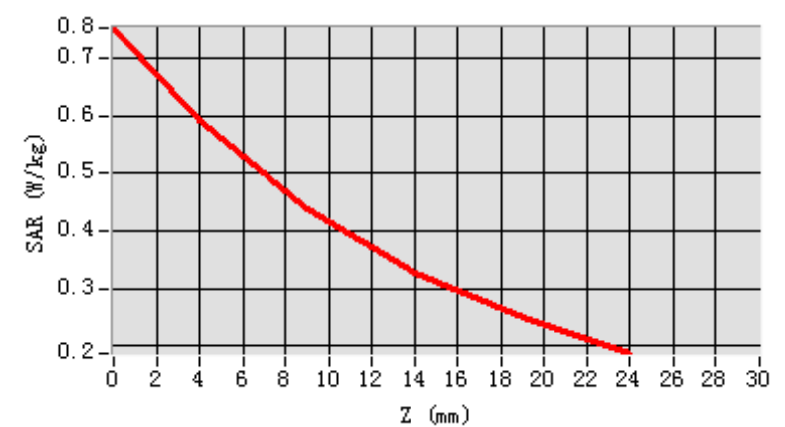


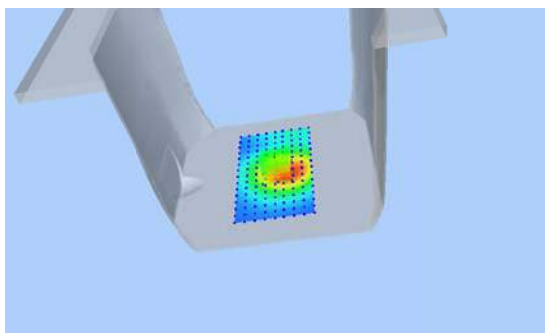
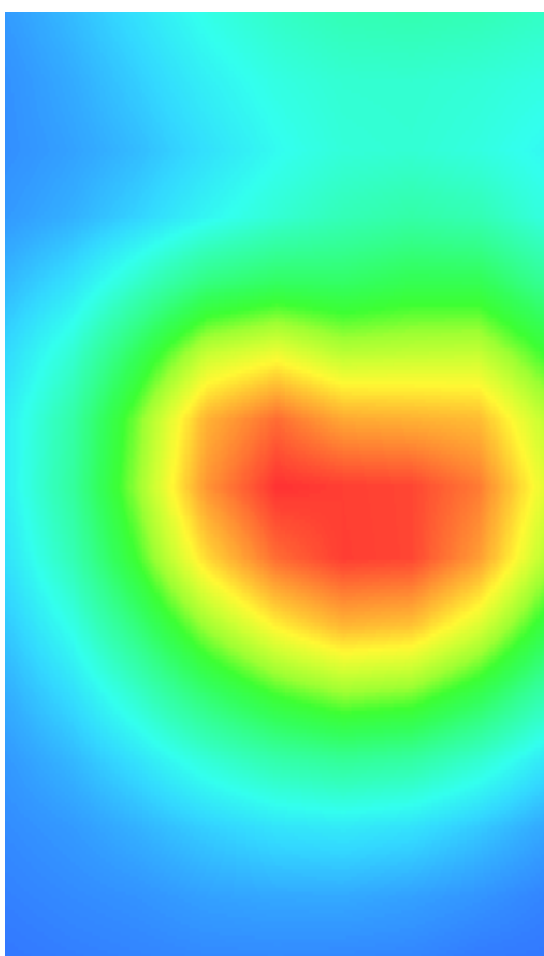
Maximum location: X=3.00, Y=-3.00

SAR Peak: 0.78 W/kg

|                |          |
|----------------|----------|
| SAR 10g (W/Kg) | 0.398587 |
| SAR 1g (W/Kg)  | 0.577940 |

| Z (mm)     | 0.00   | 4.00   | 9.00   | 14.00  | 19.00  |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 0.7526 | 0.5910 | 0.4372 | 0.3270 | 0.2480 |



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

## Plot 9: WCDMA1900, Right Cheek, High

Type: Phone measurement

Date of measurement: 29/09/2015

Measurement duration: 6 minutes 49 seconds

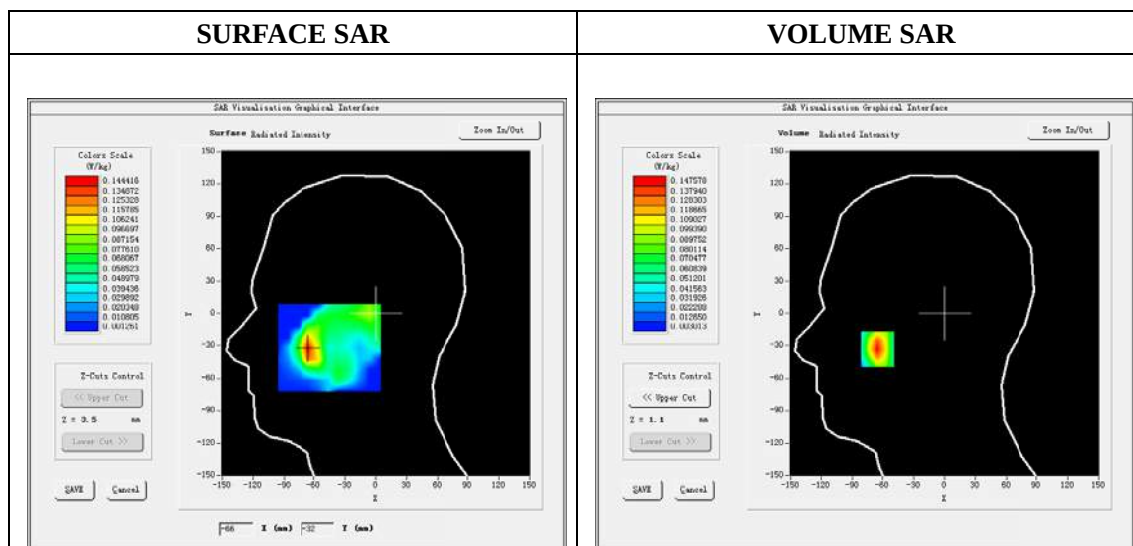
Mobile Phone IMEI number: --

### A. Experimental conditions.

|                 |                             |
|-----------------|-----------------------------|
| Area Scan       | dx=8mm dy=8mm               |
| ZoomScan        | 5x5x7, dx=8mm dy=8mm dz=5mm |
| Phantom         | Validation plane            |
| Device Position | Left head                   |
| Band            | Cheek                       |
| Channels        | 9538                        |
| Signal          | WCDMA (Duty cycle: 1:1)     |

### B. SAR Measurement Results

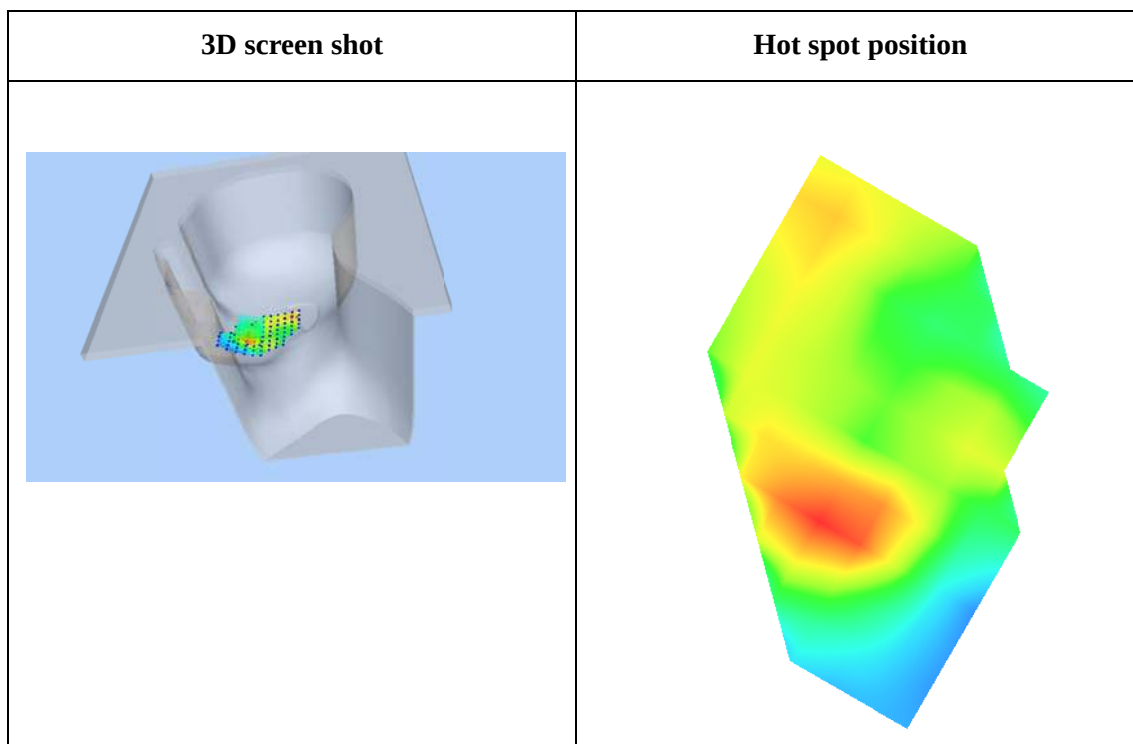
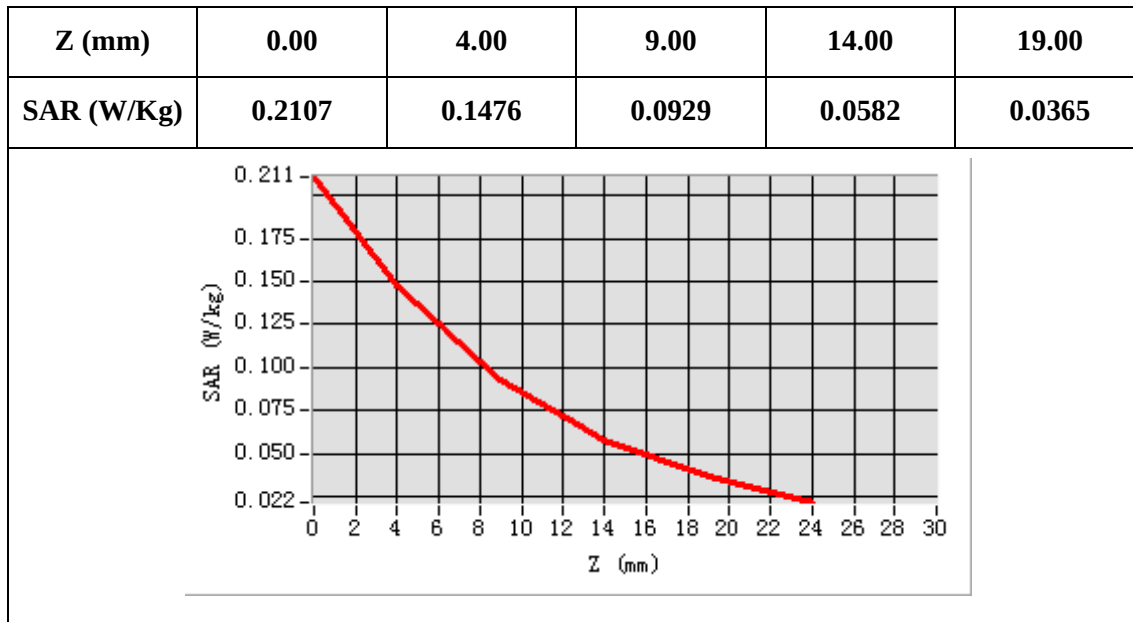
|                                   |                       |
|-----------------------------------|-----------------------|
| E-Field Probe                     | SATIMO SN_04/13_EP166 |
| Frequency (MHz)                   | 1907.6                |
| Relative permittivity (real part) | 39.84                 |
| Relative permittivity (imaginary) | 13.17                 |
| Conductivity (S/m)                | 1.39                  |
| Variation (%)                     | -1.88                 |
| ConvF:                            | 5.25                  |



Maximum location: X=-65.00, Y=-33.00

SAR Peak: 0.21 W/kg

|                |          |
|----------------|----------|
| SAR 10g (W/Kg) | 0.075953 |
| SAR 1g (W/Kg)  | 0.136114 |



## Plot 10: WCDMA1900, Back, High

Type: Phone measurement

Date of measurement: 29/09/2015

Measurement duration: 7 minutes 13 seconds

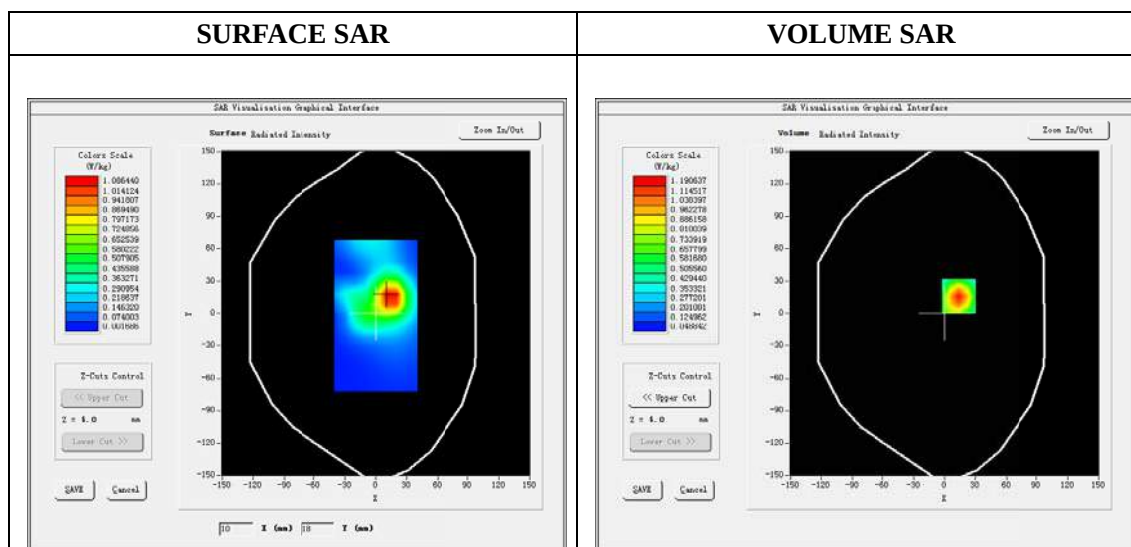
Mobile Phone IMEI number: --

### A. Experimental conditions.

|                 |                             |
|-----------------|-----------------------------|
| Area Scan       | dx=8mm dy=8mm               |
| ZoomScan        | 5x5x7, dx=8mm dy=8mm dz=5mm |
| Phantom         | Validation plane            |
| Device Position | Body                        |
| Band            | Band2_WCDMA1900             |
| Channels        | 9538                        |
| Signal          | WCDMA (Duty cycle: 1:1)     |

### B. SAR Measurement Results

|                                   |                       |
|-----------------------------------|-----------------------|
| E-Field Probe                     | SATIMO SN_04/13_EP166 |
| Frequency (MHz)                   | 1907.6                |
| Relative permittivity (real part) | 52.87                 |
| Relative permittivity (imaginary) | 14.21                 |
| Conductivity (S/m)                | 1.50                  |
| Variation (%)                     | -0.08                 |
| ConvF:                            | 5.43                  |

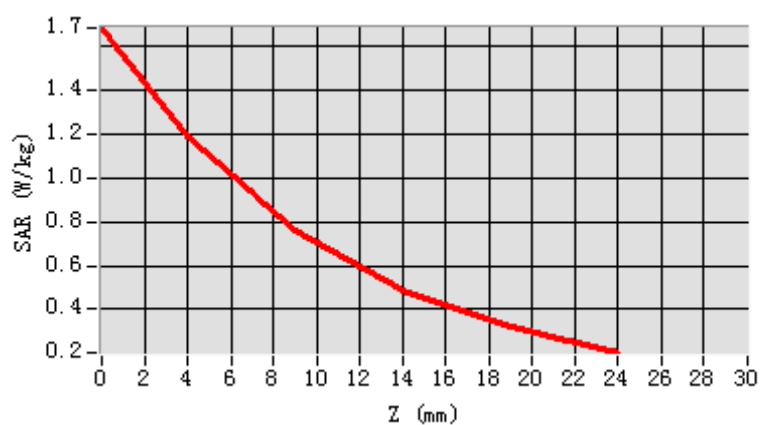


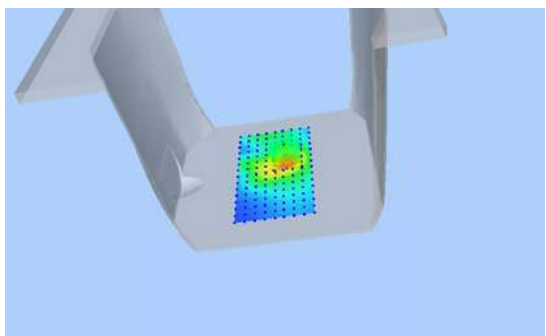
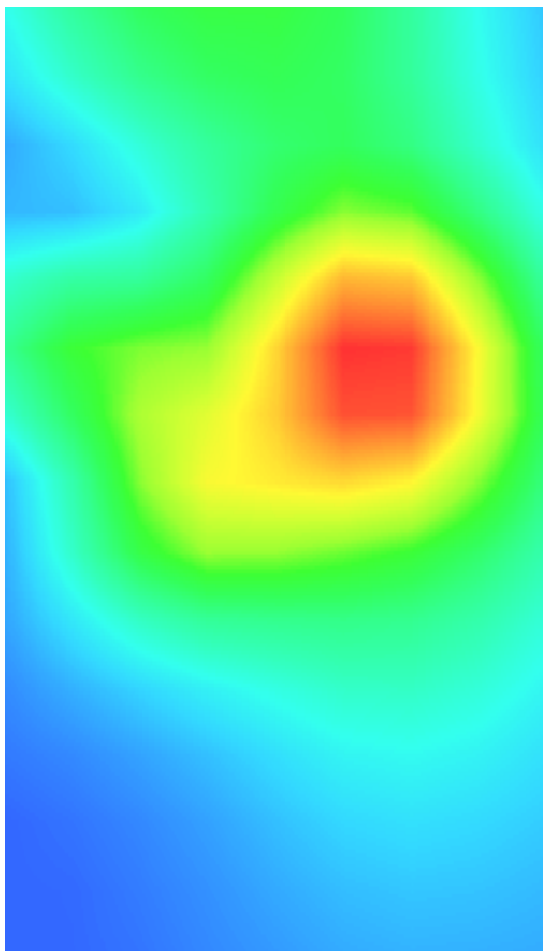
Maximum location: X=14.00, Y=16.00

SAR Peak: 1.69 W/kg

|                |          |
|----------------|----------|
| SAR 10g (W/Kg) | 0.601878 |
| SAR 1g (W/Kg)  | 1.053034 |

| Z (mm)     | 0.00   | 4.00   | 9.00   | 14.00  | 19.00  |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 1.6855 | 1.1906 | 0.7621 | 0.4898 | 0.3195 |



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

## Plot 11: Wi-Fi 802.11b ,Right Cheek, High

Type: Phone measurement ( 11 points in the volume)

Date of measurement: 30/09/2015

Measurement duration: 7 minutes 00 seconds

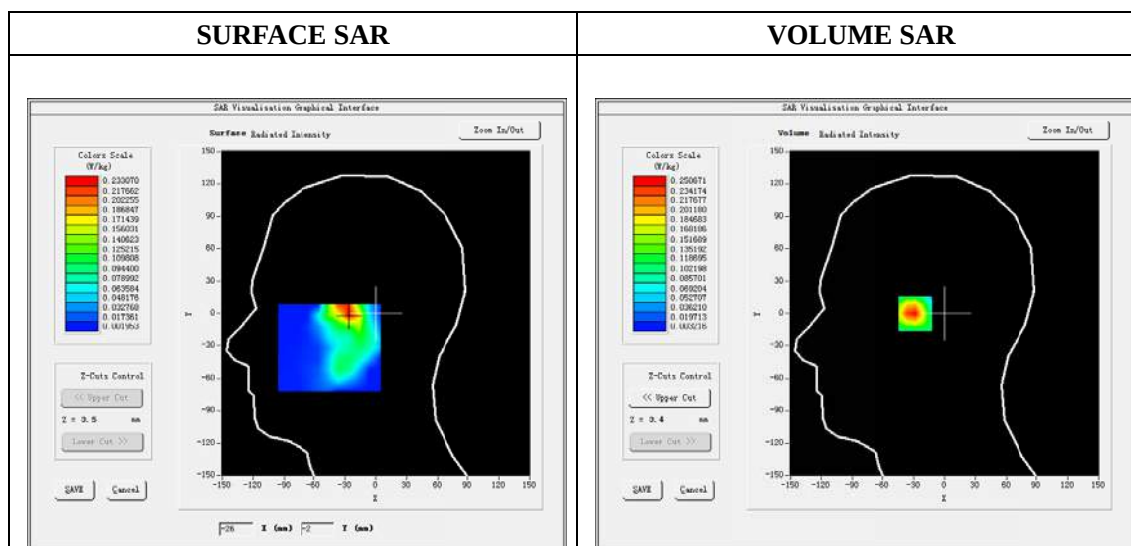
Mobile Phone IMEI number: --

### A. Experimental conditions.

|                 |                            |
|-----------------|----------------------------|
| Area Scan       | dx=8mm dy=8mm              |
| ZoomScan        | 7x7x8,dx=5mm dy=5mm dz=4mm |
| Phantom         | Right head                 |
| Device Position | Cheek                      |
| Band            | IEEE 802.11b ISM           |
| Channels        | 11                         |
| Signal          | DSSS (Crest factor: 1:1)   |

### B. SAR Measurement Results

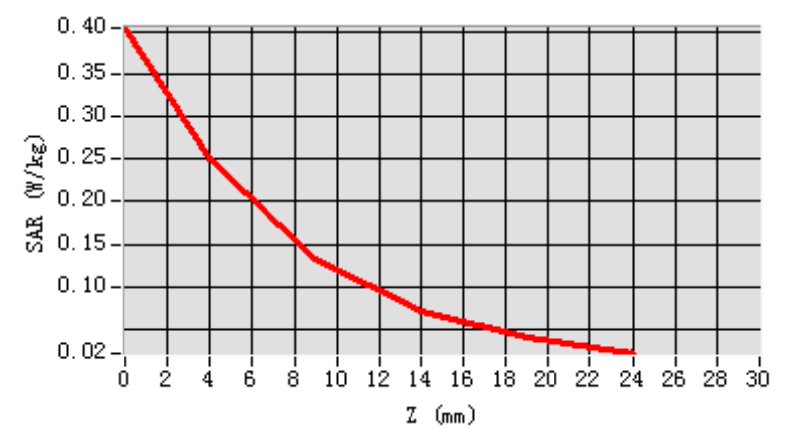
|                                        |                       |
|----------------------------------------|-----------------------|
| E-Field Probe                          | SATIMO SN_04/13_EP166 |
| Frequency (MHz)                        | 2462                  |
| Relative permittivity (real part)      | 38.96                 |
| Relative permittivity (imaginary part) | 13.22                 |
| Conductivity (S/m)                     | 1.80                  |
| Variation (%)                          | -1.19                 |
| ConvF:                                 | 4.93                  |

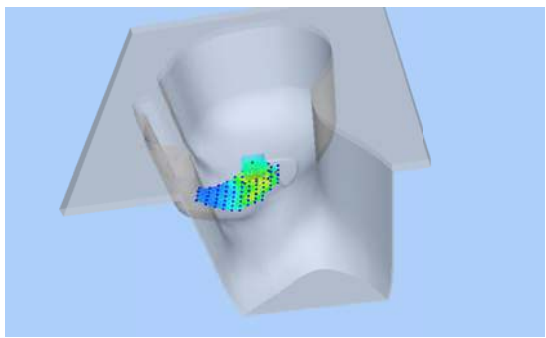
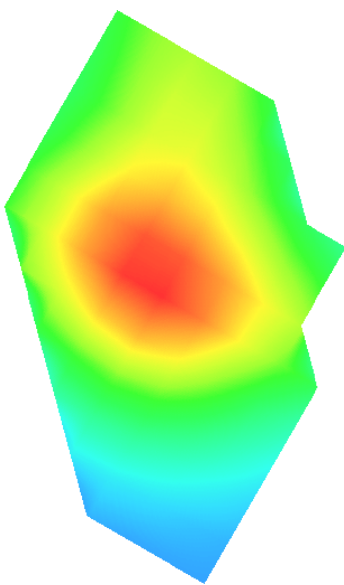


Maximum location: X=-26.00, Y=1.00  
SAR Peak: 0.41 W/kg

|                |          |
|----------------|----------|
| SAR 10g (W/Kg) | 0.117778 |
| SAR 1g (W/Kg)  | 0.234961 |

| Z (mm)     | 0.00   | 4.00   | 9.00   | 14.00  | 19.00  |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 0.4047 | 0.2507 | 0.1329 | 0.0703 | 0.0388 |



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



## Plot 12: Wi-Fi 802.11b , Back, High

Type: Phone measurement

Date of measurement: 30/09/2015

Measurement duration: 7 minutes 11 seconds

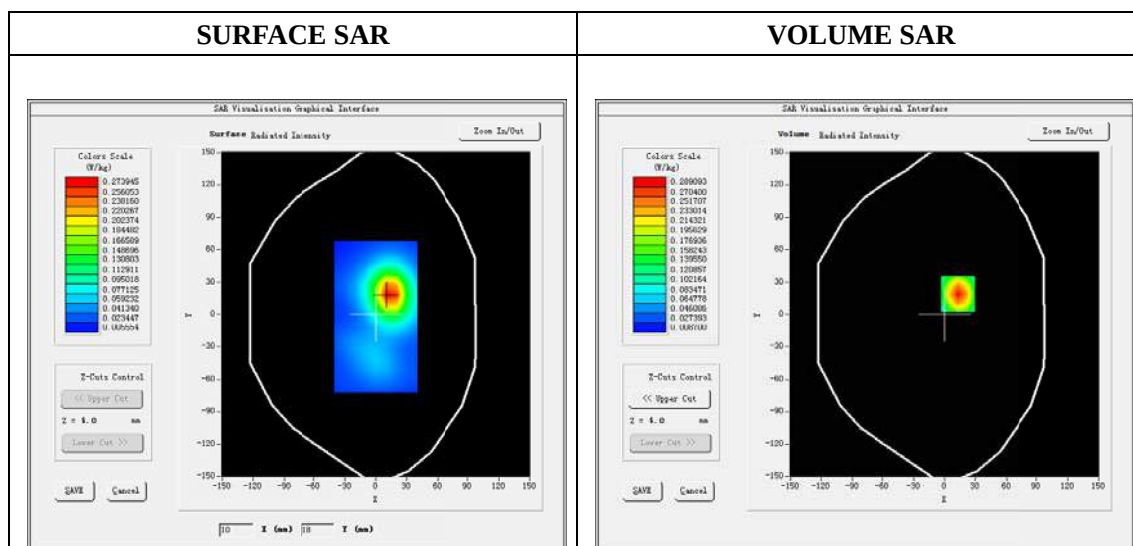
Mobile Phone IMEI number: --

### A. Experimental conditions.

|                 |                            |
|-----------------|----------------------------|
| Area Scan       | dx=8mm dy=8mm              |
| ZoomScan        | 7x7x8,dx=5mm dy=5mm dz=4mm |
| Phantom         | Validation plane           |
| Device Position | Body                       |
| Band            | IEEE 802.11b               |
| Channels        | 11                         |
| Signal          | DSSS (Crest factor: 1:1)   |

### B. SAR Measurement Results

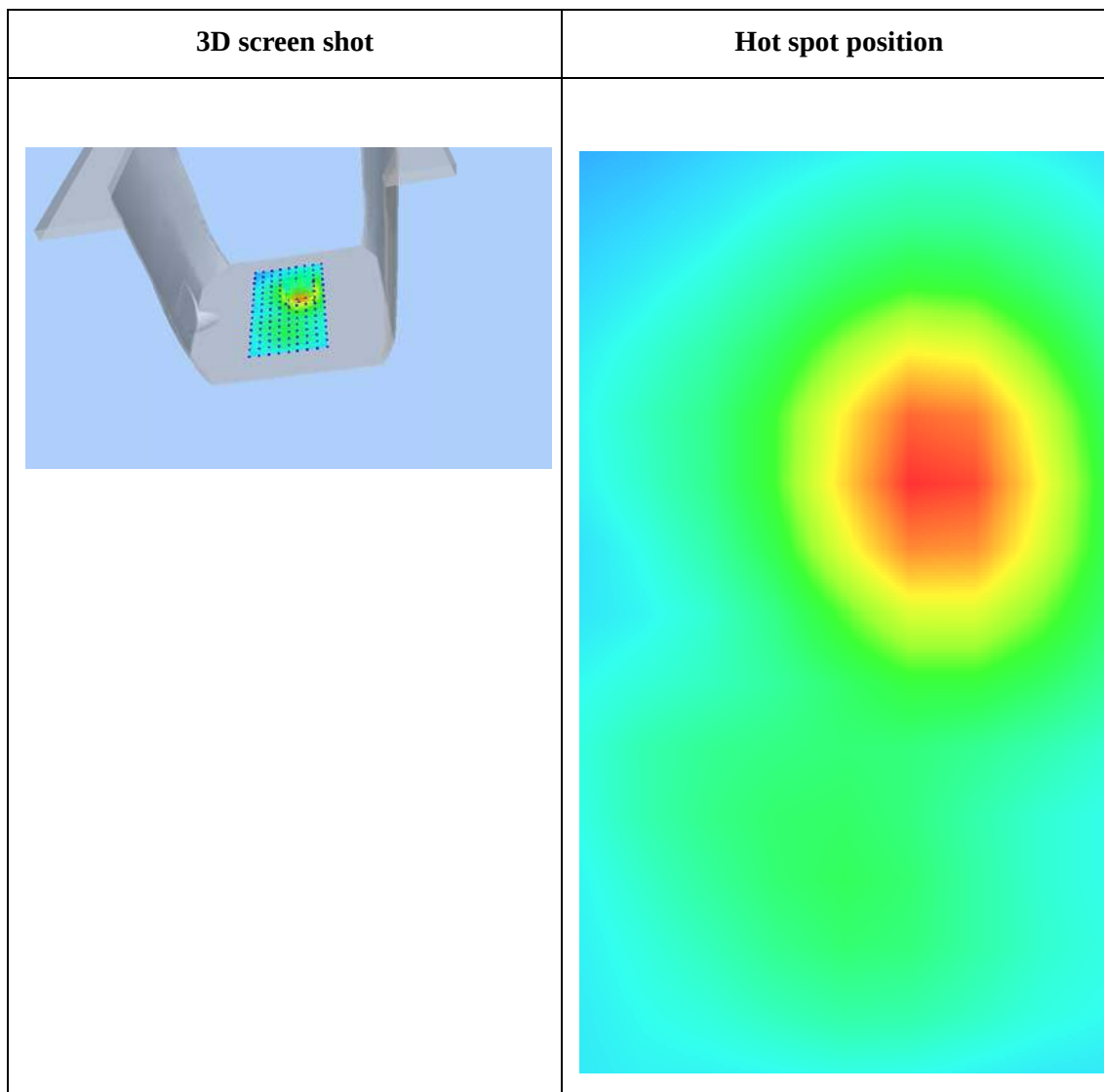
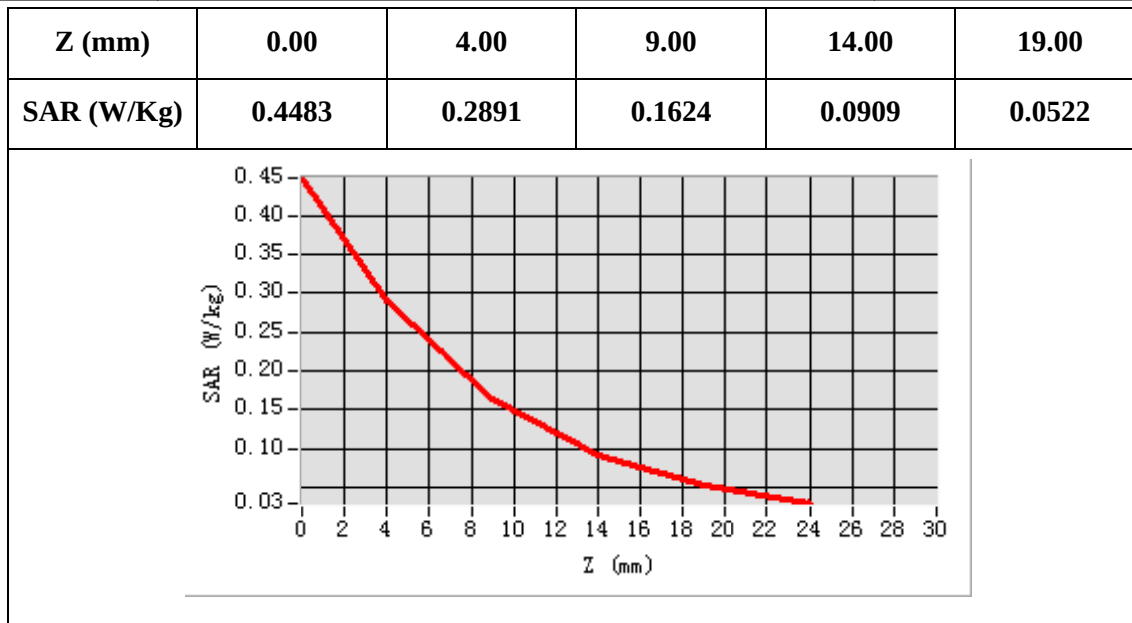
|                                        |                       |
|----------------------------------------|-----------------------|
| E-Field Probe                          | SATIMO SN_04/13_EP166 |
| Frequency (MHz)                        | 2462                  |
| Relative permittivity (real part)      | 52.47                 |
| Relative permittivity (imaginary part) | 14.25                 |
| Conductivity (S/m)                     | 1.94                  |
| Variation (%)                          | -0.22                 |
| ConvF:                                 | 5.09                  |



Maximum location: X=13.00, Y=19.00

SAR Peak: 0.45 W/kg

|                |          |
|----------------|----------|
| SAR 10g (W/Kg) | 0.142969 |
| SAR 1g (W/Kg)  | 0.268568 |



**ANNEX D**  
**of**  
**CCIC-SET**

**CONFORMANCE TEST REPORT FOR**  
**HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS**

**SET2015-14879**

**Connected Handheld RFID Reader**

**Type Name: ALR-H450**

**Hardware Version: C4050\_MB\_V5.0**

**Software Version: V1.0.0\_10040006582\_20151221**

**Calibration Certificate of Probe and Dipoles**

**This Annex consists of 49 pages**

**Date of Report: 2015-10-20**

## Probe Calibration Certificate

**COMOSAR E-Field Probe Calibration Report**

Ref : ACR.227.15.14.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 04/13 EP166**

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

**08/10/2015***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.

|                      | <i>Name</i>   | <i>Function</i> | <i>Date</i> | <i>Signature</i>                                                                    |
|----------------------|---------------|-----------------|-------------|-------------------------------------------------------------------------------------|
| <i>Prepared by :</i> | Jérôme LUC    | Product Manager | 8/11/2015   |  |
| <i>Checked by :</i>  | Jérôme LUC    | Product Manager | 8/11/2015   |  |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 8/11/2015   |  |

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

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A            | 8/11/2015   | Initial release      |
|              |             |                      |
|              |             |                      |

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## 1 DEVICE UNDER TEST

| Device Under Test                        |                                                                                                                      |
|------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Device Type                              | COMOSAR DOSIMETRIC E FIELD PROBE                                                                                     |
| Manufacturer                             | Satimo                                                                                                               |
| Model                                    | SSE5                                                                                                                 |
| Serial Number                            | SN 04/13 EP166                                                                                                       |
| Product Condition (new / used)           | Used                                                                                                                 |
| Frequency Range of Probe                 | 0.7 GHz-3 GHz                                                                                                        |
| Resistance of Three Dipoles at Connector | Dipole 1: $R1=0.231 \text{ M}\Omega$<br>Dipole 2: $R2=0.225 \text{ M}\Omega$<br>Dipole 3: $R3=0.228 \text{ M}\Omega$ |

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.

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### 3.2 SENSITIVITY

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

### 3.3 LOWER DETECTION LIMIT

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

### 3.4 ISOTROPY

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

### 3.5 BOUNDARY EFFECT

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

## 4 MEASUREMENT UNCERTAINTY

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

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

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|                                                     |  |  |  |  |        |
|-----------------------------------------------------|--|--|--|--|--------|
| Combined standard uncertainty                       |  |  |  |  | 5.831% |
| Expanded uncertainty<br>95 % confidence level k = 2 |  |  |  |  | 12.0%  |

## 5 CALIBRATION MEASUREMENT RESULTS

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

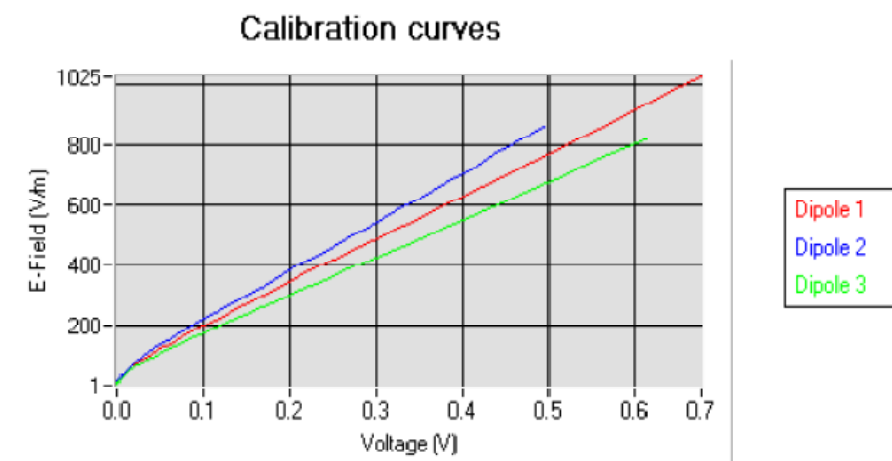
### 5.1 SENSITIVITY IN AIR

| Normx dipole<br>1 ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) | Normy dipole<br>2 ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) | Normz dipole<br>3 ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) |
|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|
| 8.57                                                      | 4.83                                                      | 7.15                                                      |

| DCP dipole 1<br>(mV) | DCP dipole 2<br>(mV) | DCP dipole 3<br>(mV) |
|----------------------|----------------------|----------------------|
| 92                   | 90                   | 95                   |

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

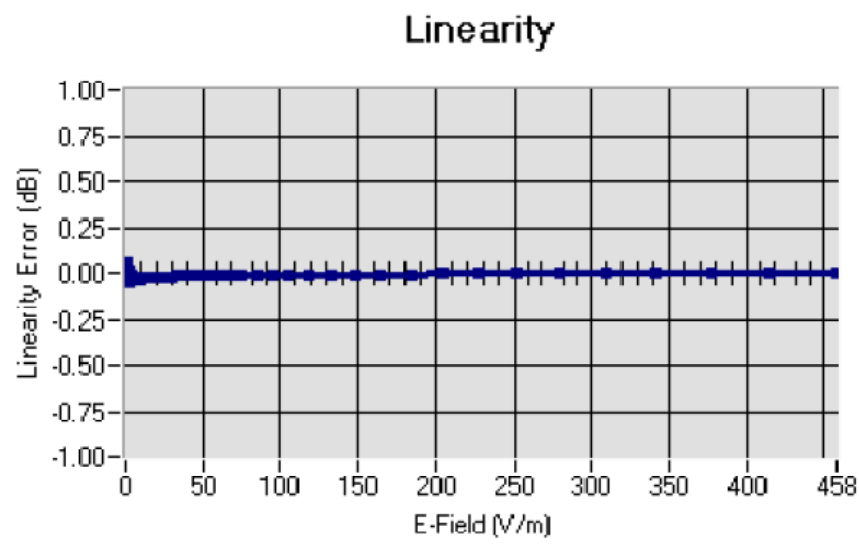
$$E = \sqrt{E_1^2 + E_2^2 + E_3^2}$$



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## 5.2 LINEARITY



Linearity:  $\pm 1.55\%$  ( $\pm 0.07\text{dB}$ )

## 5.3 SENSITIVITY IN LIQUID

| Liquid | Frequency<br>(MHz $\pm$ 100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|--------|---------------------------------|--------------|---------------|-------|
| HL850  | 835                             | 42.80        | 0.89          | 5.69  |
| BL850  | 835                             | 53.45        | 0.96          | 5.82  |
| HL900  | 900                             | 42.47        | 0.96          | 5.34  |
| BL900  | 900                             | 56.68        | 1.08          | 5.55  |
| HL1800 | 1800                            | 41.30        | 1.38          | 4.75  |
| BL1800 | 1800                            | 53.27        | 1.51          | 4.96  |
| HL1900 | 1900                            | 41.09        | 1.42          | 5.25  |
| BL1900 | 1900                            | 54.20        | 1.54          | 5.43  |
| HL2000 | 2000                            | 39.72        | 1.43          | 4.81  |
| BL2000 | 2000                            | 53.90        | 1.53          | 4.95  |
| HL2450 | 2450                            | 39.05        | 1.77          | 4.93  |
| BL2450 | 2450                            | 52.98        | 1.93          | 5.09  |
| HL2600 | 2600                            | 38.35        | 1.92          | 5.08  |
| BL2600 | 2600                            | 51.82        | 2.19          | 5.22  |

LOWER DETECTION LIMIT: 7mW/kg

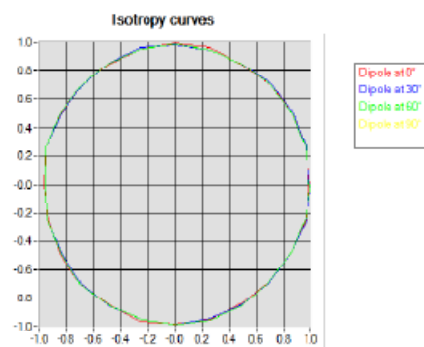
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#### 5.4 ISOTROPY

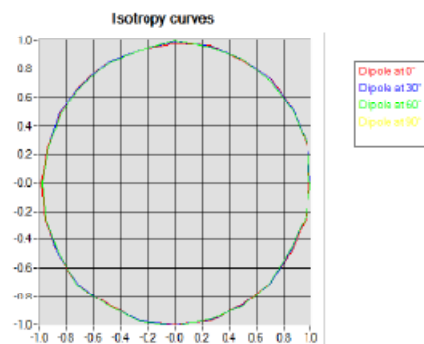
##### HL900 MHz

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



##### HL1300 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.07 dB



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**6 LIST OF EQUIPMENT**

| Equipment Summary Sheet       |                      |                    |                                               |                                               |
|-------------------------------|----------------------|--------------------|-----------------------------------------------|-----------------------------------------------|
| Equipment Description         | Manufacturer / Model | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| Flat Phantom                  | Satimo               | SN-20/09-SAM71     | Validated. No cal required.                   | Validated. No cal required.                   |
| COMOSAR Test Bench            | Version 3            | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer              | Rhode & Schwarz ZVA  | SN100132           | 02/2013                                       | 02/2016                                       |
| Reference Probe               | Satimo               | EP 94 SN 37/08     | 10/2014                                       | 10/2015                                       |
| Multimeter                    | Keithley 2000        | 1188658            | 12/2013                                       | 12/2016                                       |
| Signal Generator              | Agilent E4438C       | MY49070581         | 12/2013                                       | 12/2016                                       |
| Amplifier                     | Aethercomm           | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                   | HP E4418A            | US38261498         | 12/2013                                       | 12/2016                                       |
| Power Sensor                  | HP ECP-E26A          | US37181460         | 12/2013                                       | 12/2016                                       |
| Directional Coupler           | Narda 4216-20        | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Waveguide                     | Mega Industries      | 069Y7-158-13-712   | Validated. No cal required.                   | Validated. No cal required.                   |
| Waveguide Transition          | Mega Industries      | 069Y7-158-13-701   | Validated. No cal required.                   | Validated. No cal required.                   |
| Waveguide Termination         | Mega Industries      | 069Y7-158-13-701   | Validated. No cal required.                   | Validated. No cal required.                   |
| Temperature / Humidity Sensor | Control Company      | 11-661-9           | 8/2013                                        | 8/2016                                        |

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**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

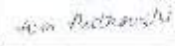
*Summary:*

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.240.1.14.SATU.a

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

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

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

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## 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.

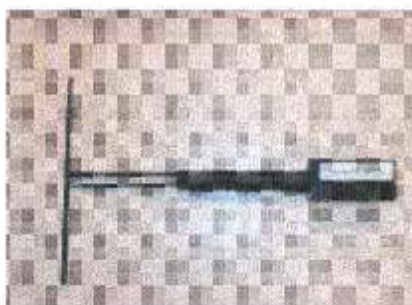


Figure 1 – Satimo COMOSAR Validation Dipole





#### 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 %               |

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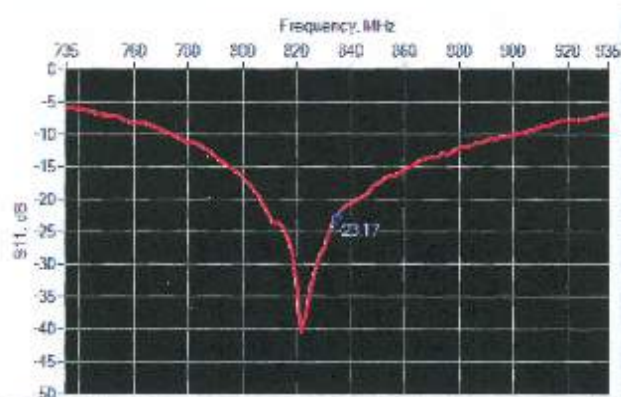


# SAR REFERENCE DIPOLE CALIBRATION REPORT

R&amp;E ACR.240.1.14.SATULA

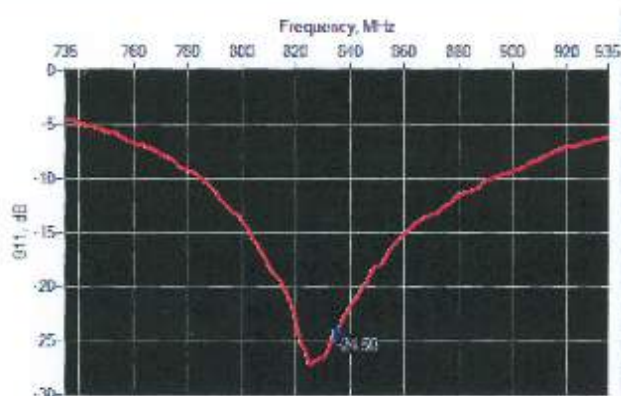
## 6 CALIBRATION MEASUREMENT RESULTS

### 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           | 230.0 ±1 % |          | 156.7 ±1 % |          | 6.35 ±1 % |          |
| 750           | 176.0 ±1 % |          | 100.0 ±1 % |          | 6.35 ±1 % |          |
| 835           | 161.0 ±1 % | PASS     | 89.8 ±1 %  | PASS     | 3.6 ±1 %  | PASS     |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

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|      |            |  |           |  |          |  |
|------|------------|--|-----------|--|----------|--|
| 900  | 149.0 ±1 % |  | 89.3 ±1 % |  | 3.6 ±1 % |  |
| 1450 | 89.1 ±1 %  |  | 51.7 ±1 % |  | 3.6 ±1 % |  |
| 1500 | 80.5 ±1 %  |  | 50.0 ±1 % |  | 3.6 ±1 % |  |
| 1640 | 79.0 ±1 %  |  | 45.7 ±1 % |  | 3.6 ±1 % |  |
| 1750 | 75.2 ±1 %  |  | 42.9 ±1 % |  | 3.6 ±1 % |  |
| 1800 | 72.0 ±1 %  |  | 41.7 ±1 % |  | 3.6 ±1 % |  |
| 1900 | 68.0 ±1 %  |  | 39.5 ±1 % |  | 3.6 ±1 % |  |
| 1950 | 66.3 ±1 %  |  | 38.5 ±1 % |  | 3.6 ±1 % |  |
| 2000 | 64.5 ±1 %  |  | 37.5 ±1 % |  | 3.6 ±1 % |  |
| 2100 | 61.0 ±1 %  |  | 35.7 ±1 % |  | 3.6 ±1 % |  |
| 2300 | 55.5 ±1 %  |  | 32.6 ±1 % |  | 3.6 ±1 % |  |
| 2450 | 51.5 ±1 %  |  | 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<br>MHz | Relative permittivity ( $\epsilon_r$ ) |          | Conductivity ( $\sigma$ ) 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 %                     |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.240.1.14.SATUA

|      |           |  |           |  |
|------|-----------|--|-----------|--|
| 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                                  | OPEN SAR 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                      | $dx = 8mm/dy = 8mm$                                     |
| Zoan 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<br>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             | 9.72 (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              |             |

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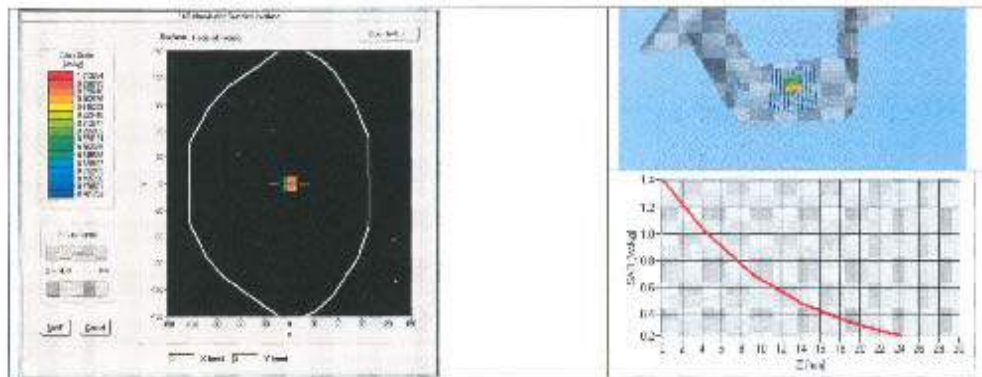
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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.240.1.14.SATU.A

|      |      |  |      |  |
|------|------|--|------|--|
| 2450 | 52.4 |  | 24   |  |
| 2600 | 55.3 |  | 24.6 |  |
| 3000 | 63.8 |  | 25.7 |  |
| 3500 | 67.1 |  | 25   |  |



## 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|----------------------------------------|----------|-------------------------------|----------|
|                  | required                               | measured | required                      | measured |
| 150              | 61.9 $\pm$ 5 %                         |          | 0.80 $\pm$ 5 %                |          |
| 300              | 58.2 $\pm$ 5 %                         |          | 0.92 $\pm$ 5 %                |          |
| 450              | 56.7 $\pm$ 5 %                         |          | 0.94 $\pm$ 5 %                |          |
| 750              | 55.5 $\pm$ 5 %                         |          | 0.96 $\pm$ 5 %                |          |
| 835              | 55.2 $\pm$ 5 %                         | PASS     | 0.97 $\pm$ 5 %                | PASS     |
| 900              | 55.0 $\pm$ 5 %                         |          | 1.05 $\pm$ 5 %                |          |
| 915              | 55.0 $\pm$ 5 %                         |          | 1.06 $\pm$ 5 %                |          |
| 1450             | 54.0 $\pm$ 5 %                         |          | 1.30 $\pm$ 5 %                |          |
| 1610             | 53.8 $\pm$ 5 %                         |          | 1.40 $\pm$ 5 %                |          |
| 1800             | 53.3 $\pm$ 5 %                         |          | 1.52 $\pm$ 5 %                |          |
| 1900             | 53.3 $\pm$ 5 %                         |          | 1.52 $\pm$ 5 %                |          |
| 2000             | 53.3 $\pm$ 5 %                         |          | 1.52 $\pm$ 5 %                |          |
| 2100             | 53.2 $\pm$ 5 %                         |          | 1.62 $\pm$ 5 %                |          |
| 2450             | 52.7 $\pm$ 5 %                         |          | 1.85 $\pm$ 5 %                |          |
| 2600             | 52.5 $\pm$ 5 %                         |          | 2.16 $\pm$ 5 %                |          |
| 3000             | 52.0 $\pm$ 5 %                         |          | 2.73 $\pm$ 5 %                |          |
| 3500             | 51.3 $\pm$ 5 %                         |          | 3.31 $\pm$ 5 %                |          |
| 5200             | 49.0 $\pm$ 10 %                        |          | 5.30 $\pm$ 10 %               |          |
| 5300             | 48.9 $\pm$ 10 %                        |          | 5.42 $\pm$ 10 %               |          |
| 5400             | 48.7 $\pm$ 10 %                        |          | 5.53 $\pm$ 10 %               |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

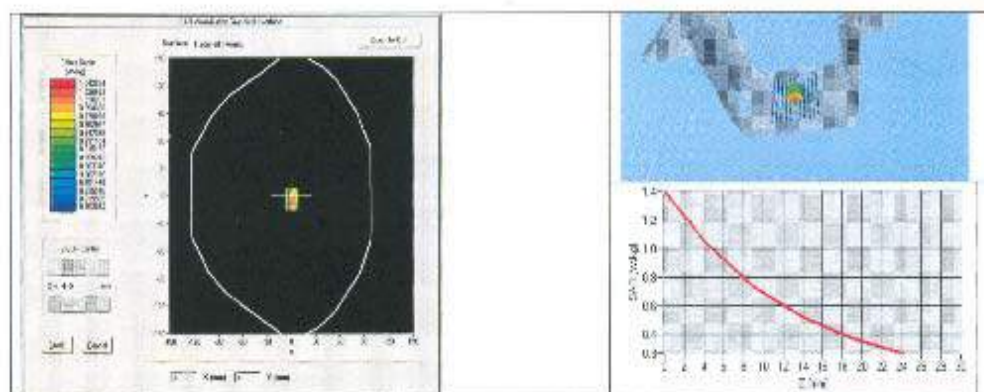
Ref: ACR 340 1 14 SATU.A

|      |            |  |            |  |
|------|------------|--|------------|--|
| 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 8:1 EPG122                                             |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}^1$ : 54.1 sigma : 0.97 |
| Distance between dipole center and liquid | 15.0 mm                                                   |
| Area scan resolution                      | $dx=8mm/dy=8mm$                                           |
| Zoon Scan Resolution                      | $dx=8mm/dy=8mm/dz=5mm$                                    |
| Frequency                                 | 835 MHz                                                   |
| Input power                               | 20 dBm                                                    |
| Liquid Temperature                        | 21 °C                                                     |
| Lab Temperature                           | 21 °C                                                     |
| Lab Humidity                              | 45 %                                                      |

| Frequency<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 835              | 10.31 (1.03)     | 6.74 (0.67)       |



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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 240114 SATUJA

## 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                                        |

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**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.SATU.A

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

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

| Issue | Date      | Modifications   |
|-------|-----------|-----------------|
| A     | 8/29/2014 | Initial release |
|       |           |                 |
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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: MCR 2404-14 SATULA

### 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

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#### 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 %               |

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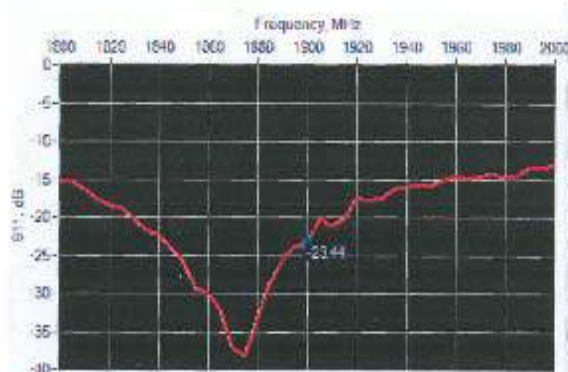
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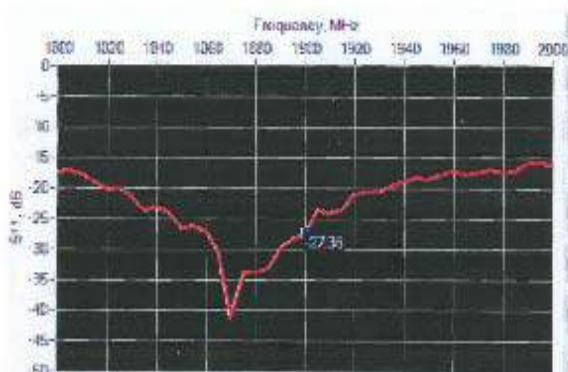
## 6 CALIBRATION MEASUREMENT RESULTS

### 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           | $420.0 \pm 1 \%$ |          | $250.0 \pm 1 \%$ |          | $6.35 \pm 1 \%$ |          |
| 450           | $250.0 \pm 1 \%$ |          | $166.7 \pm 1 \%$ |          | $6.35 \pm 1 \%$ |          |
| 750           | $176.0 \pm 1 \%$ |          | $100.0 \pm 1 \%$ |          | $6.35 \pm 1 \%$ |          |
| 835           | $161.0 \pm 1 \%$ |          | $89.8 \pm 1 \%$  |          | $3.5 \pm 1 \%$  |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACS-2015-19 SATIM

|      |            |      |           |      |          |      |
|------|------------|------|-----------|------|----------|------|
| 900  | 149.3 ±1 % |      | 85.3 ±1 % |      | 3.6 ±1 % |      |
| 1450 | 89.1 ±1 %  |      | 51.7 ±1 % |      | 3.0 ±1 % |      |
| 1500 | 80.5 ±1 %  |      | 50.0 ±1 % |      | 3.6 ±1 % |      |
| 1640 | 79.0 ±1 %  |      | 45.7 ±1 % |      | 4.0 ±1 % |      |
| 1750 | 75.2 ±1 %  |      | 42.9 ±1 % |      | 3.8 ±1 % |      |
| 1800 | 72.0 ±1 %  |      | 41.7 ±1 % |      | 3.0 ±1 % |      |
| 1900 | 68.0 ±1 %  | PASS | 39.5 ±1 % | PASS | 3.5 ±1 % | PASS |
| 1950 | 66.3 ±1 %  |      | 38.5 ±1 % |      | 3.0 ±1 % |      |
| 2000 | 64.5 ±1 %  |      | 37.5 ±1 % |      | 3.0 ±1 % |      |
| 2100 | 61.0 ±1 %  |      | 35.7 ±1 % |      | 3.6 ±1 % |      |
| 2300 | 55.5 ±1 %  |      | 32.6 ±1 % |      | 3.0 ±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 % |      | 3.0 ±1 % |      |
| 3500 | 37.0 ±1 %  |      | 26.4 ±1 % |      | 3.6 ±1 % |      |
| 3700 | 34.7 ±1 %  |      | 26.4 ±1 % |      | 3.0 ±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<br>MHz | Relative permittivity ( $\epsilon_r$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|----------------------------------------|----------|-------------------------------|----------|
|                  | required                               | measured | required                      | measured |
| 300              | 45.3 ±5 %                              |          | 0.87 ±5 %                     |          |
| 450              | 43.5 ±5 %                              |          | 0.87 ±5 %                     |          |
| 750              | 41.5 ±5 %                              |          | 0.85 ±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 %                     |          |
| 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 %                              | PASS     | 1.40 ±5 %                     | PASS     |
| 1950             | 40.0 ±5 %                              |          | 1.40 ±5 %                     |          |
| 2000             | 40.0 ±5 %                              |          | 1.40 ±5 %                     |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR2015-15 SATU.A

|      |           |  |           |  |
|------|-----------|--|-----------|--|
| 2100 | 59.8 ±5 % |  | 1.49 ±5 % |  |
| 2300 | 59.5 ±5 % |  | 1.67 ±5 % |  |
| 2450 | 59.7 ±5 % |  | 1.80 ±5 % |  |
| 2600 | 59.0 ±5 % |  | 1.96 ±5 % |  |
| 3000 | 58.5 ±5 % |  | 2.40 ±5 % |  |
| 3500 | 57.9 ±5 % |  | 2.51 ±5 % |  |

## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CENELEC 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 3009 SAM71                                                  |
| Probe                                     | SN 1871 EPG122                                                 |
| Liquid                                    | Head Liquid Values: $\epsilon_{\text{eff}} = 41.1$ sigma: 1.42 |
| Distance between dipole center and liquid | 13.0 mm                                                        |
| Area scan resolution                      | $d_x=8\text{mm}/d_y=8\text{mm}$                                |
| Zoon Scan Resolution                      | $d_x=8\text{mm}/d_y=8\text{mm}/d_z=5\text{mm}$                 |
| Frequency                                 | 1900 MHz                                                       |
| Input power                               | 20 dBm                                                         |
| Liquid Temperature                        | 21 °C                                                          |
| Lab Temperature                           | 21 °C                                                          |
| Lab Humidity                              | 45 %                                                           |

| Frequency<br>MHz | 1 g SAR (W/kg/W) |              | 10 g SAR (W/kg/W) |              |
|------------------|------------------|--------------|-------------------|--------------|
|                  | required         | measured     | required          | measured     |
| 300              | 2.85             |              | 1.34              |              |
| 450              | 4.58             |              | 3.26              |              |
| 750              | 8.49             |              | 5.55              |              |
| 835              | 9.56             |              | 5.77              |              |
| 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             | 40.37 (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              |              |

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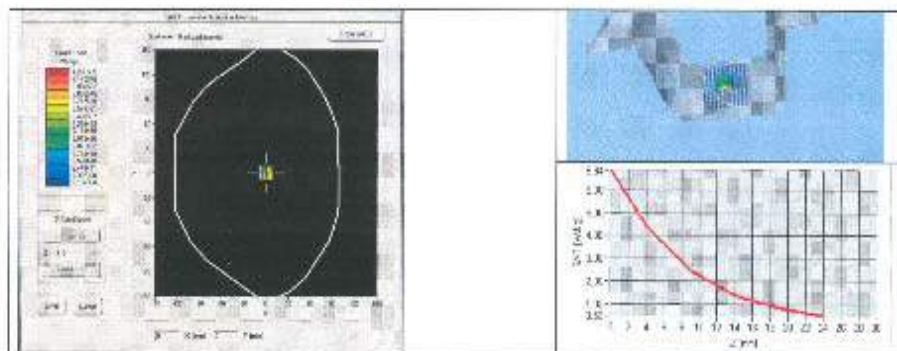




# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR-240, F-14 SATULA

|      |      |  |      |  |
|------|------|--|------|--|
| 2450 | 52.4 |  | 24   |  |
| 2600 | 55.3 |  | 24.6 |  |
| 3000 | 63.8 |  | 25.7 |  |
| 3500 | 67.1 |  | 25   |  |



## 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|----------------------------------------|----------|-------------------------------|----------|
|                  | required                               | measured | required                      | measured |
| 150              | 61.9 $\pm$ 5 %                         |          | 0.80 $\pm$ 5 %                |          |
| 300              | 58.7 $\pm$ 5 %                         |          | 0.93 $\pm$ 5 %                |          |
| 450              | 56.7 $\pm$ 5 %                         |          | 0.94 $\pm$ 5 %                |          |
| 750              | 55.5 $\pm$ 5 %                         |          | 0.96 $\pm$ 5 %                |          |
| 835              | 55.2 $\pm$ 5 %                         |          | 0.97 $\pm$ 5 %                |          |
| 900              | 55.0 $\pm$ 5 %                         |          | 1.05 $\pm$ 5 %                |          |
| 915              | 55.0 $\pm$ 5 %                         |          | 1.06 $\pm$ 5 %                |          |
| 1450             | 54.0 $\pm$ 5 %                         |          | 1.30 $\pm$ 5 %                |          |
| 1610             | 53.8 $\pm$ 5 %                         |          | 1.40 $\pm$ 5 %                |          |
| 1800             | 53.3 $\pm$ 5 %                         |          | 1.52 $\pm$ 5 %                |          |
| 1900             | 53.3 $\pm$ 5 %                         | PASS     | 1.52 $\pm$ 5 %                | PASS     |
| 2000             | 53.3 $\pm$ 5 %                         |          | 1.52 $\pm$ 5 %                |          |
| 2100             | 53.2 $\pm$ 5 %                         |          | 1.62 $\pm$ 5 %                |          |
| 2450             | 52.7 $\pm$ 5 %                         |          | 1.95 $\pm$ 5 %                |          |
| 2600             | 52.5 $\pm$ 5 %                         |          | 2.16 $\pm$ 5 %                |          |
| 3000             | 52.0 $\pm$ 5 %                         |          | 2.73 $\pm$ 5 %                |          |
| 3500             | 51.3 $\pm$ 5 %                         |          | 3.31 $\pm$ 5 %                |          |
| 5200             | 49.0 $\pm$ 10 %                        |          | 5.20 $\pm$ 10 %               |          |
| 5300             | 48.8 $\pm$ 10 %                        |          | 5.42 $\pm$ 10 %               |          |
| 5400             | 48.7 $\pm$ 10 %                        |          | 5.53 $\pm$ 10 %               |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

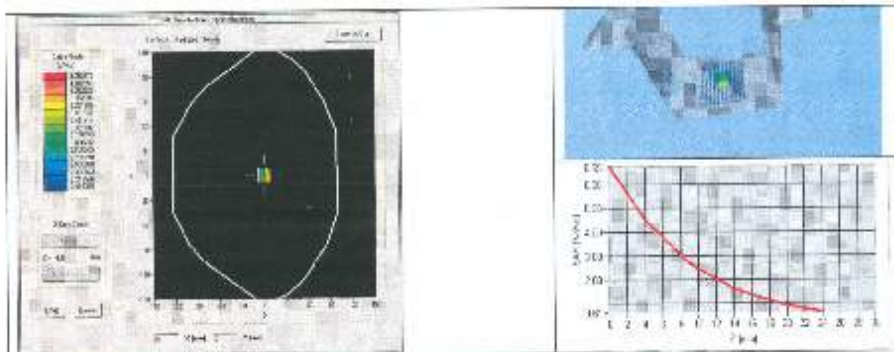
Ref: ACR 160414-SATIM

|      |            |  |            |  |
|------|------------|--|------------|--|
| 5500 | 48.5 ±10 % |  | 5.55 ±10 % |  |
| 5600 | 48.5 ±10 % |  | 5.77 ±10 % |  |
| 5800 | 48.2 ±10 % |  | 6.50 ±10 % |  |

## 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                              |
|-------------------------------------------|----------------------------------------------|
| Software                                  | OPENSAR V4                                   |
| Phantom                                   | SN 20/09 SAM71                               |
| Probe                                     | SN 18/11 EPG1122                             |
| 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 dBrm                                      |
| 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]     | 21.21 [2.12]      |



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## 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.                   |
| CCMOSAR Test Bench              | Version 3            | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer                | Rhode & Schwarz ZVA  | SN100132           | 02/2013                                       | 02/2016                                       |
| Calipers                        | Cariera              | 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            | US38251498         | 12/2013                                       | 12/2016                                       |
| Power Sensor                    | HP ECP-E28A          | US37181480         | 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                                        |

**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:*

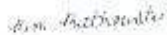
This document presents the method and results from an accredited SAR reference dipole calibration performed in SATIMO USA using the COMOSAR test bench. All calibration results are traceable to national metrology institutions.





## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 740 e 14.8ATJJA

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

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

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

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| 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



#### 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 %               |

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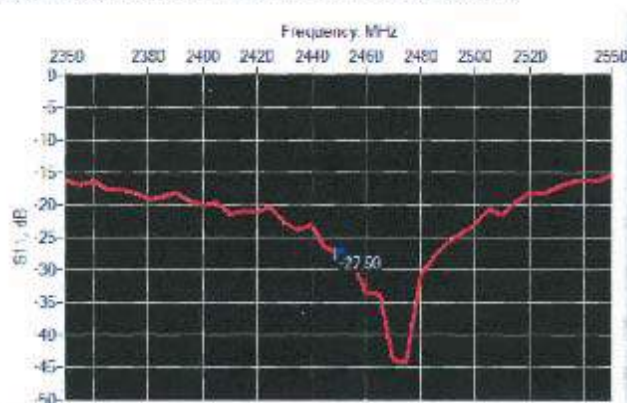


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 240.6.14.SATJ.A

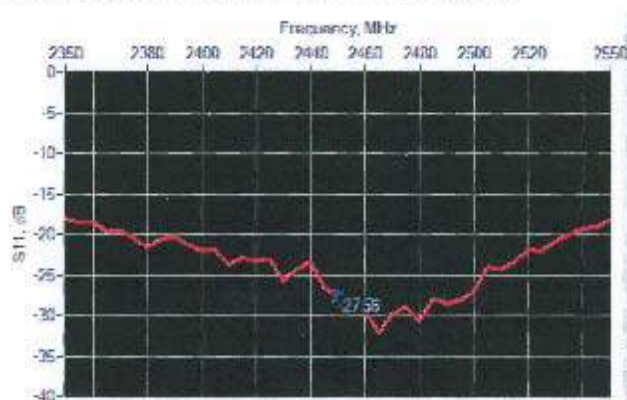
### 6 CALIBRATION MEASUREMENT RESULTS

#### 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           | $161.0 \pm 1 \%$ |          | $89.8 \pm 1 \%$  |          | $3.6 \pm 1 \%$  |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.249.6.14.SATU.A

|      |            |      |           |      |          |      |
|------|------------|------|-----------|------|----------|------|
| 900  | 149.0 ±1 % |      | 83.3 ±1 % |      | 3.6 ±1 % |      |
| 1450 | 88.1 ±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 CE/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<br>MHz | Relative permittivity ( $\epsilon_r$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|----------------------------------------|----------|-------------------------------|----------|
|                  | required                               | measured | required                      | measured |
| 300              | 45.3 ±5 %                              |          | 0.87 ±5 %                     |          |
| 450              | 43.5 ±5 %                              |          | 0.87 ±5 %                     |          |
| 750              | 41.9 ±5 %                              |          | 0.89 ±5 %                     |          |
| 835              | 41.5 ±5 %                              |          | 0.90 ±5 %                     |          |
| 900              | 41.5 ±5 %                              |          | 0.97 ±5 %                     |          |
| 1450             | 40.5 ±5 %                              |          | 1.20 ±5 %                     |          |
| 1500             | 40.4 ±5 %                              |          | 1.23 ±5 %                     |          |
| 1640             | 40.2 ±5 %                              |          | 1.31 ±5 %                     |          |
| 1750             | 40.1 ±5 %                              |          | 1.37 ±5 %                     |          |
| 1800             | 40.0 ±5 %                              |          | 1.40 ±5 %                     |          |
| 1900             | 40.0 ±5 %                              |          | 1.40 ±5 %                     |          |
| 1950             | 40.0 ±5 %                              |          | 1.40 ±5 %                     |          |
| 2000             | 40.0 ±5 %                              |          | 1.40 ±5 %                     |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 340.6.14 SATU.A

|      |           |      |           |      |
|------|-----------|------|-----------|------|
| 2100 | 35.8 ±5 % |      | 1.49 ±5 % |      |
| 2300 | 35.5 ±5 % |      | 1.67 ±5 % |      |
| 2450 | 39.2 ±5 % | PASS | 1.80 ±5 % | PASS |
| 2600 | 35.0 ±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: $\epsilon_{ps}^1$ : 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 cBm                                                    |
| 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            | 46.7             |          | 23.1              |          |

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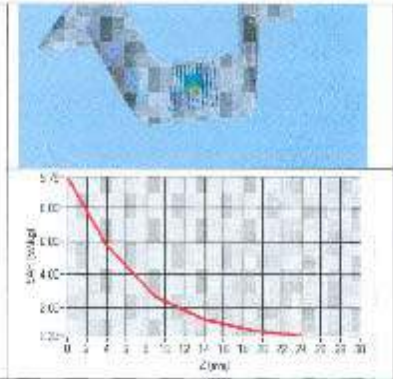
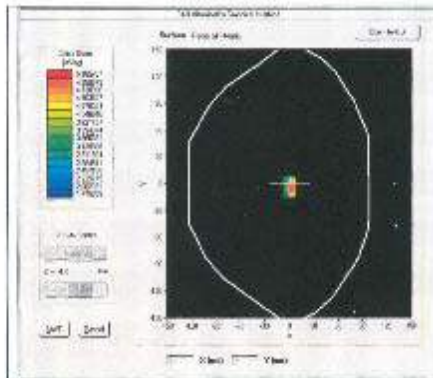
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|      |      |              |      |              |
|------|------|--------------|------|--------------|
| 2450 | 52.4 | 53.60 (5.36) | 24   | 23.77 (2.38) |
| 2600 | 55.3 |              | 24.6 |              |
| 3000 | 63.8 |              | 25.7 |              |
| 3500 | 67.1 |              | 25   |              |



## 7.3 BODY LIQUID MEASUREMENT

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

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

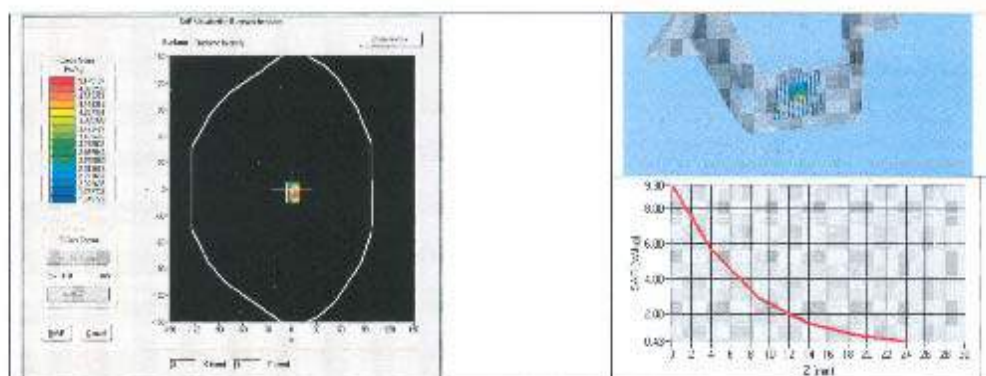
Ref: ACR.246.6.14.SATU.A

|      |            |  |            |  |
|------|------------|--|------------|--|
| 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: $\epsilon_{ps}^*$ : 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<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 2450             | 52.66 (5.27)     | 23.73 (2.37)      |



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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.210.6.14.SATILA

## 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 ECF-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                                        |

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### <Justification of the extended calibration>

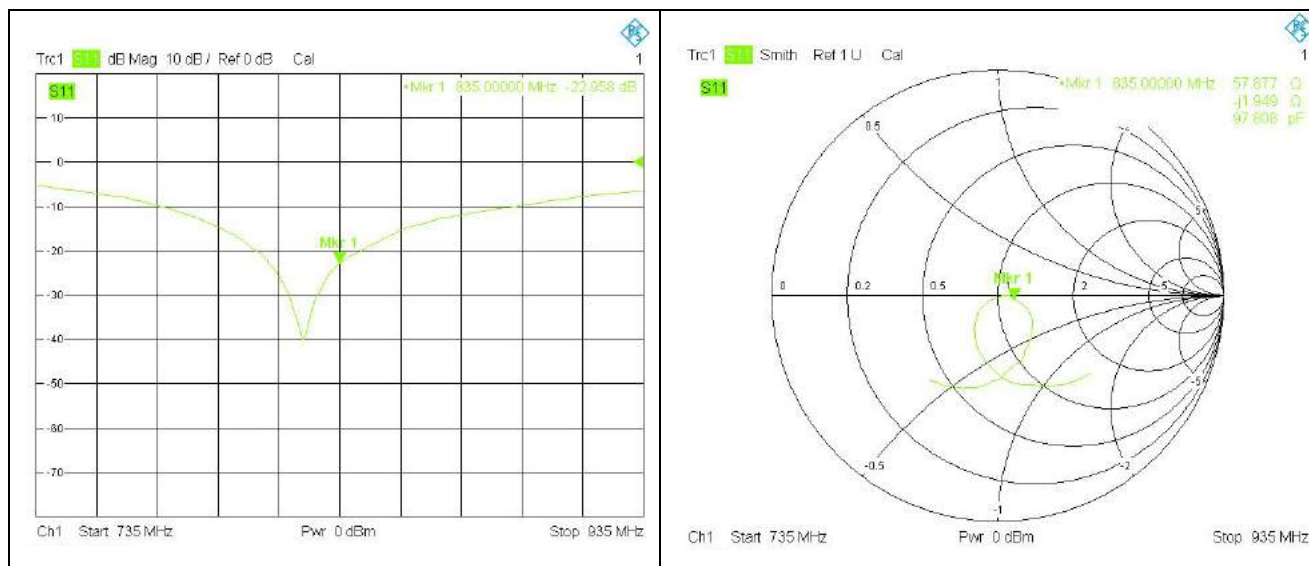
Referring to KDB 450824, if dipoles are verified in return loss(<-20dB, within 20% of prior calibration),and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| Head 835MHz         |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2014.08.28          | -23.17           | -         | 57.40     | -          |
| 2015.08.26          | -22.96           | 4.95      | 57.88     | 0.48       |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

### <Dipole Verification Data>

#### Head 835MHz

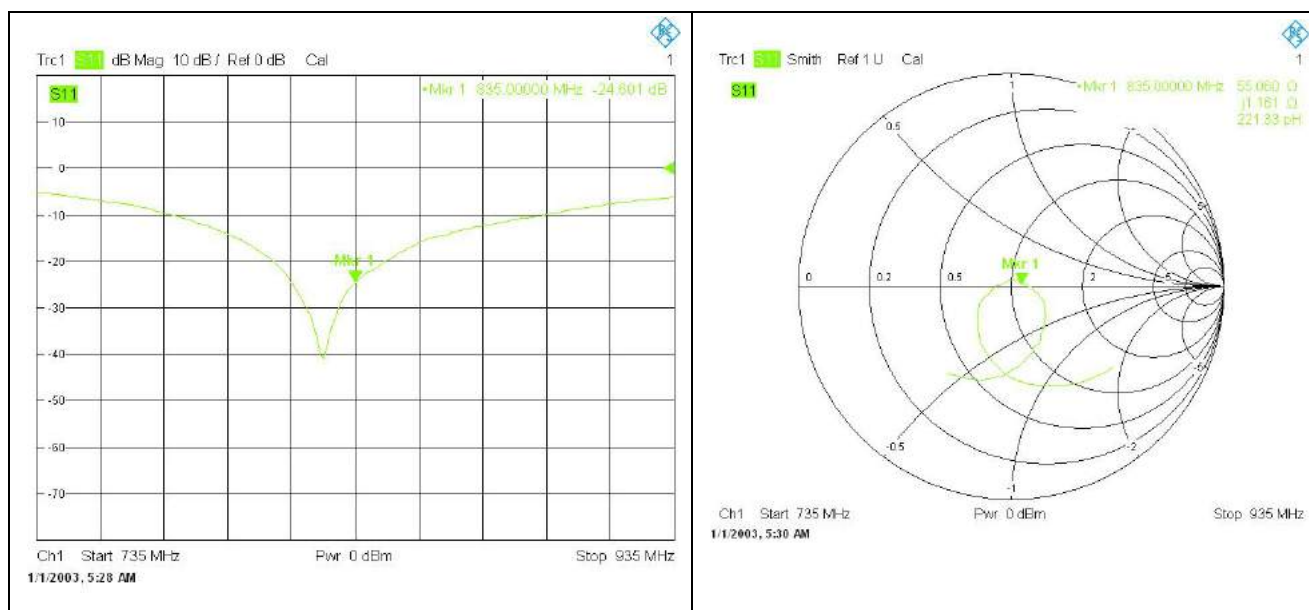


| Body 835MHz         |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2014.08.28          | -24.50           | -         | 55.00     | -          |
| 2015.08.26          | -24.60           | -2.28     | 55.06     | 0.06       |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

#### <Dipole Verification Data>

#### Body 835MHz

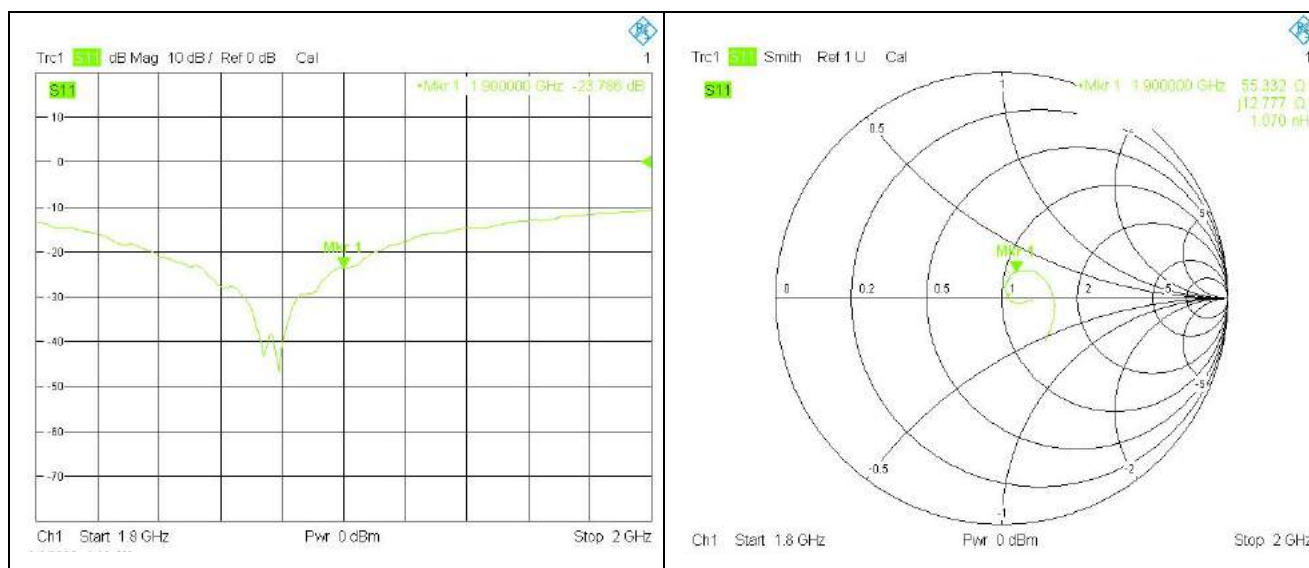


| Head 1900MHz        |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2014.08.28          | -23.44           | -         | 55.40     | -          |
| 2015.08.26          | -23.79           | -7.74     | 55.33     | -0.07      |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

### <Dipole Verification Data>

#### Head 1900MHz



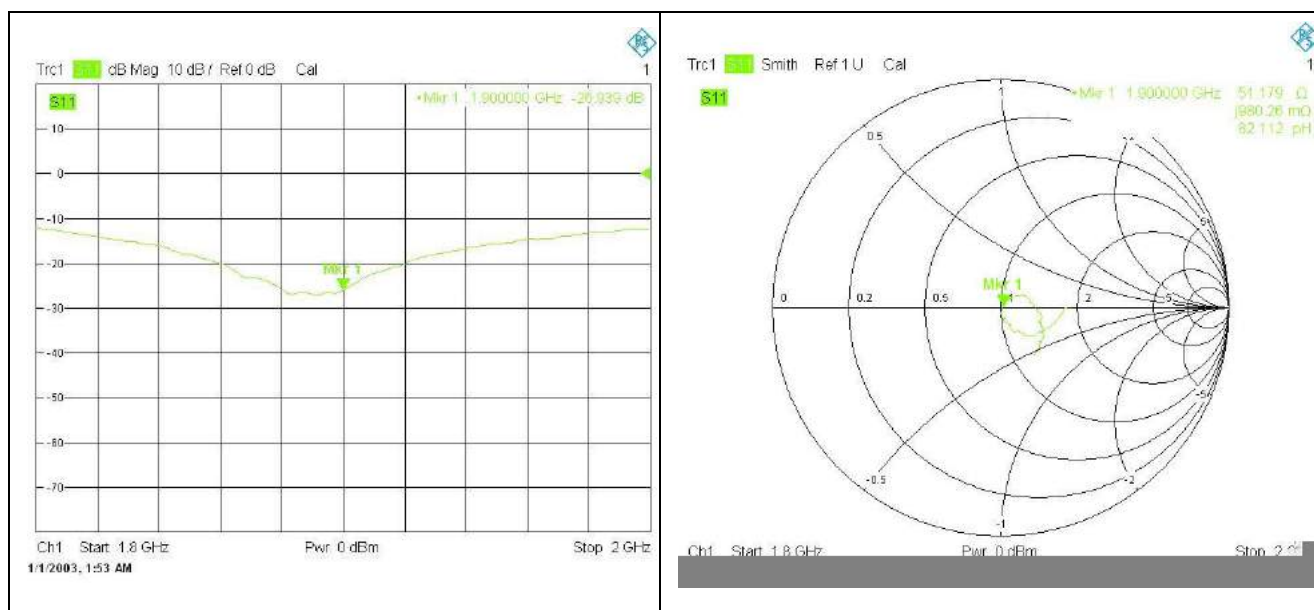


| Body 1900MHz        |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2014.08.28          | -27.36           | -         | 51.70     | -          |
| 2015.08.26          | -26.94           | 10.15     | 51.18     | -0.52      |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

### <Dipole Verification Data>

#### Body 1900MHz

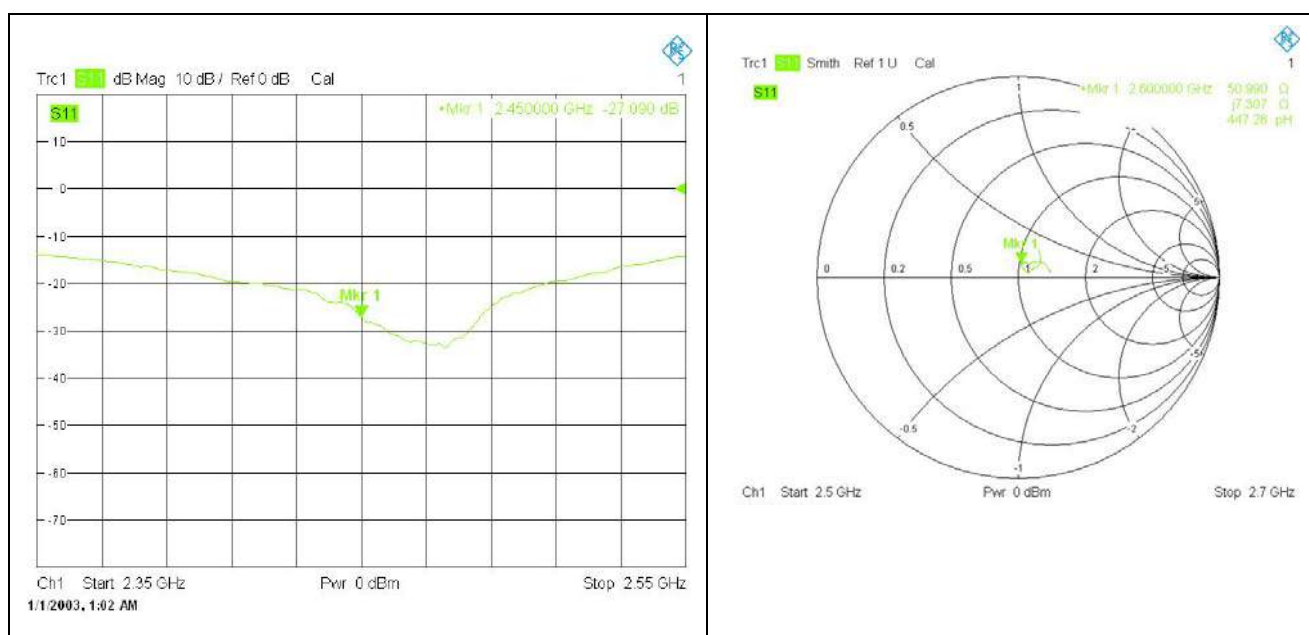


| Head 2450MHz        |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2014.08.28          | -27.50           | -         | 51.70     | -          |
| 2015.08.26          | -27.09           | 9.90      | 50.99     | -0.71      |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

### <Dipole Verification Data>

#### Head 2450MHz

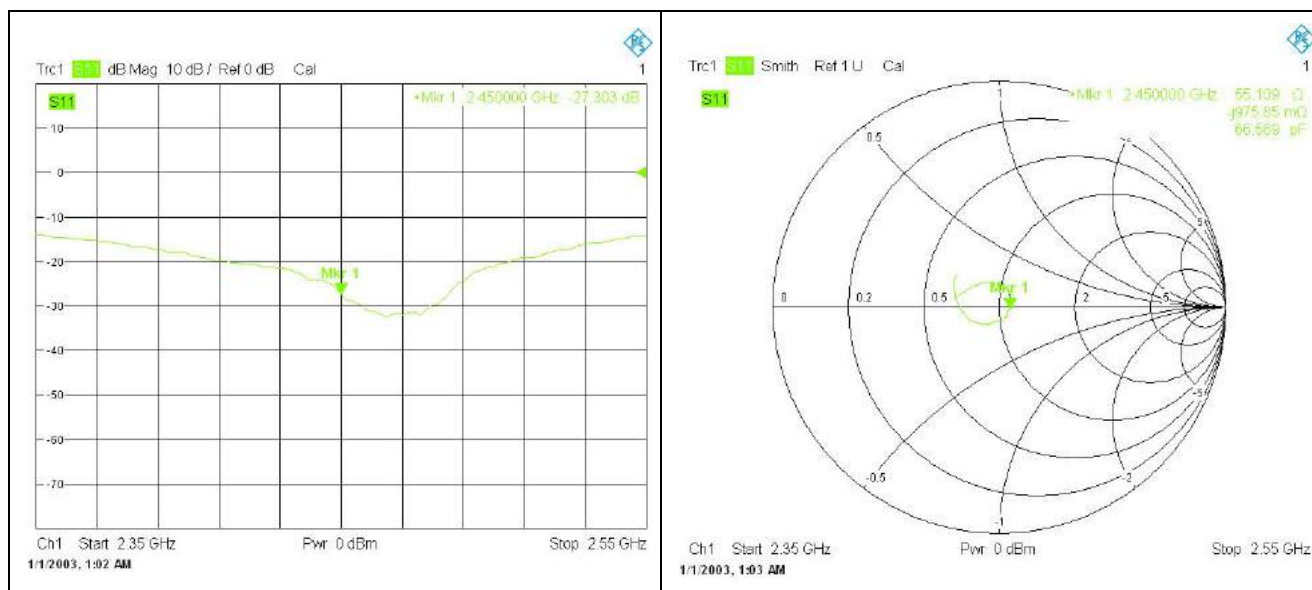


| Body 2450MHz        |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2014.08.28          | -27.56           | -         | 54.30     | -          |
| 2015.08.26          | -27.30           | 6.17      | 55.11     | 0.81       |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

### <Dipole Verification Data>

#### Body 2450MHz



————End of the Report————