



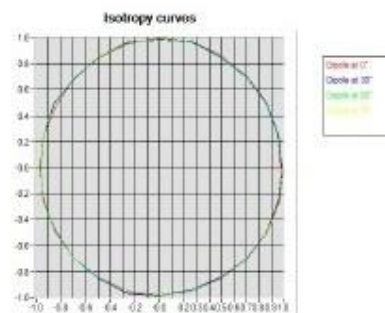
# COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.96.2.14.SATU.A

## 5.4 ISOTROPY

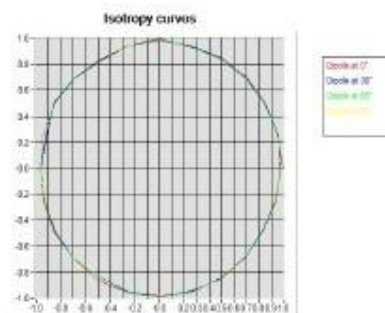
### HL900 MHz

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



### HL1800 MHz

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



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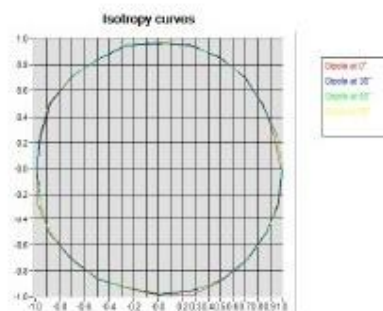


# COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR-96.2.14.SATU.A

## HL2450 MHz

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



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## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR 96.2.14.SATU.A

## 6 LIST OF EQUIPMENT

| Equipment Summary Sheet       |                      |                    |                                               |                                               |
|-------------------------------|----------------------|--------------------|-----------------------------------------------|-----------------------------------------------|
| Equipment Description         | Manufacturer / Model | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| Flat Phantom                  | Satimo               | SN-20/09-SAM71     | Validated. No cal required.                   | Validated. No cal required.                   |
| COMOSAR Test Bench            | Version 3            | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer              | Rhode & Schwarz ZVA  | SN100132           | 02/2013                                       | 02/2016                                       |
| Reference Probe               | Satimo               | EP 94 SN 37/08     | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Multimeter                    | Keithley 2000        | 1188656            | 11/2013                                       | 11/2016                                       |
| Signal Generator              | Agilent E4438C       | MY49070581         | 12/2013                                       | 12/2016                                       |
| Amplifier                     | Aethercomm           | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                   | HP E4418A            | US38261498         | 11/2013                                       | 11/2016                                       |
| Power Sensor                  | HP ECP-E26A          | US37181460         | 11/2013                                       | 11/2016                                       |
| Directional Coupler           | Narda 4216-20        | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Waveguide                     | Mega Industries      | 069Y7-158-13-712   | Validated. No cal required.                   | Validated. No cal required.                   |
| Waveguide Transition          | Mega Industries      | 069Y7-158-13-701   | Validated. No cal required.                   | Validated. No cal required.                   |
| Waveguide Termination         | Mega Industries      | 069Y7-158-13-701   | Validated. No cal required.                   | Validated. No cal required.                   |
| Temperature / Humidity Sensor | Control Company      | 11-661-9           | 3/2014                                        | 3/2016                                        |

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

Ref: ACR.96.3.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING  
(SHENZHEN) CO.,LTD****ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI  
TOWN SHENZHEN,P.R.CHINA****SATIMO COMOSAR REFERENCE DIPOLE  
FREQUENCY: 835 MHZ****Calibrated at SATIMO US  
2105 Barrett Park Dr. - Kennesaw, GA 30144****04/05/13***Summary:*

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



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.96.3.13.SATU.A

|                      | <i>Name</i>   | <i>Function</i> | <i>Date</i> | <i>Signature</i>                                                                    |
|----------------------|---------------|-----------------|-------------|-------------------------------------------------------------------------------------|
| <i>Prepared by :</i> | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Checked by :</i>  | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 4/5/2013    |  |

|                       | <i>Customer Name</i>         |
|-----------------------|------------------------------|
| <i>Distribution :</i> | Shenzhen EMC-united Co., Ltd |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A            | 4/5/2013    | Initial release      |
|              |             |                      |
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|              |             |                      |

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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) | new                              |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

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



Figure 1 – Satimo COMOSAR Validation Dipole

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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         | 16.19 %              |
| 10 g        | 15.86 %              |

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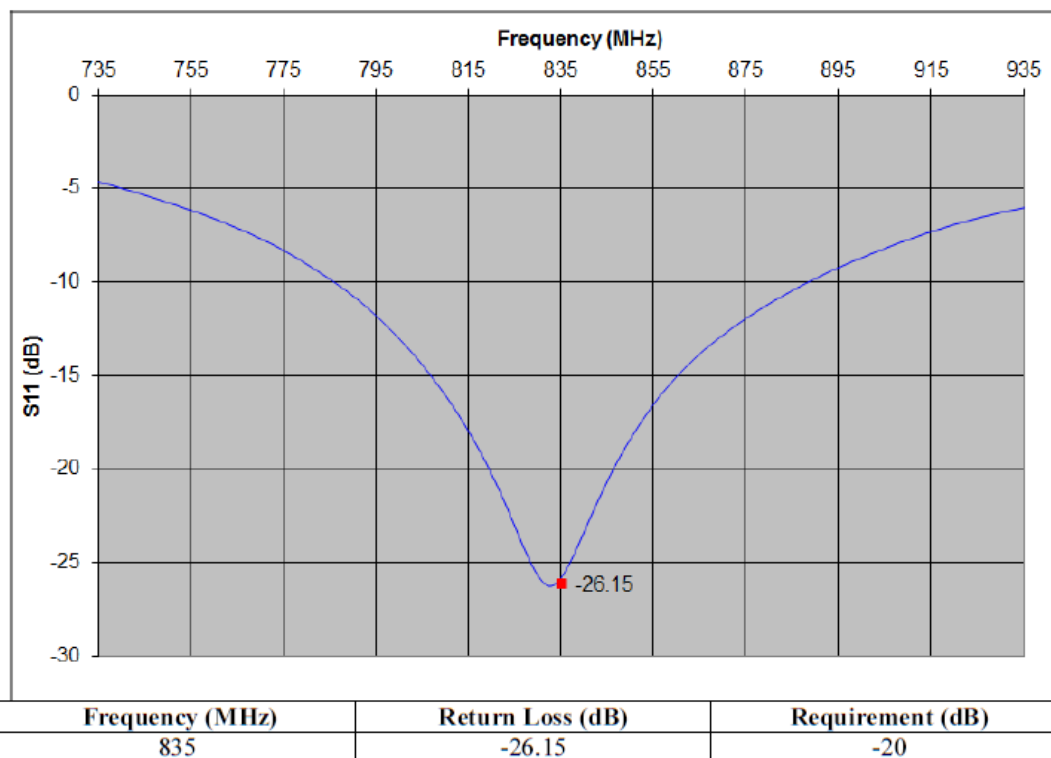


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.96.3.13.SAT.U.A

## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS



### 6.2 MECHANICAL DIMENSIONS

| Frequency MHz | L mm        |          | h mm        |          | d mm       |          |
|---------------|-------------|----------|-------------|----------|------------|----------|
|               | required    | measured | required    | measured | required   | measured |
| 300           | 420.0 ±1 %. |          | 250.0 ±1 %. |          | 6.35 ±1 %. |          |
| 450           | 290.0 ±1 %. |          | 166.7 ±1 %. |          | 6.35 ±1 %. |          |
| 750           | 176.0 ±1 %. |          | 100.0 ±1 %. |          | 6.35 ±1 %. |          |
| 835           | 161.0 ±1 %. | PASS     | 89.8 ±1 %.  | PASS     | 3.6 ±1 %.  | PASS     |
| 900           | 149.0 ±1 %. |          | 83.3 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1450          | 89.1 ±1 %.  |          | 51.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1500          | 80.5 ±1 %.  |          | 50.0 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1640          | 79.0 ±1 %.  |          | 45.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1750          | 75.2 ±1 %.  |          | 42.9 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1800          | 72.0 ±1 %.  |          | 41.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1900          | 68.0 ±1 %.  |          | 39.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1950          | 66.3 ±1 %.  |          | 38.5 ±1 %.  |          | 3.6 ±1 %.  |          |

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.3.13.SATU.A

|      |           |  |           |  |          |  |
|------|-----------|--|-----------|--|----------|--|
| 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 MEASUREMENT CONDITION

|                                           |                                                        |
|-------------------------------------------|--------------------------------------------------------|
| Software                                  | OPENSAR V4                                             |
| Phantom                                   | SN 20/09 SAM71                                         |
| Probe                                     | SN 18/11 EPG122                                        |
| Liquid                                    | Head Liquid Values: $\epsilon_s^*$ : 42.6 sigma : 0.88 |
| Distance between dipole center and liquid | 15.0 mm                                                |
| Area scan resolution                      | dx=8mm/dy=8mm                                          |
| Zoon Scan Resolution                      | dx=8mm/dy=8m/dz=5mm                                    |
| Frequency                                 | 835 MHz                                                |
| Input power                               | 20 dBm                                                 |
| Liquid Temperature                        | 21 °C                                                  |
| Lab Temperature                           | 21 °C                                                  |
| Lab Humidity                              | 45 %                                                   |

#### 7.2 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 %                     |          |

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.3.13.SATU.A

|      |            |  |            |  |
|------|------------|--|------------|--|
| 1900 | 40.0 ± 5 % |  | 1.40 ± 5 % |  |
| 1950 | 40.0 ± 5 % |  | 1.40 ± 5 % |  |
| 2000 | 40.0 ± 5 % |  | 1.40 ± 5 % |  |
| 2100 | 39.8 ± 5 % |  | 1.49 ± 5 % |  |
| 2300 | 39.5 ± 5 % |  | 1.67 ± 5 % |  |
| 2450 | 39.2 ± 5 % |  | 1.80 ± 5 % |  |
| 2600 | 39.0 ± 5 % |  | 1.96 ± 5 % |  |
| 3000 | 38.5 ± 5 % |  | 2.40 ± 5 % |  |
| 3500 | 37.9 ± 5 % |  | 2.91 ± 5 % |  |

### 7.3 MEASUREMENT RESULT

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

| Frequency<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 (0.97) | 6.22              | 6.28 (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              |             |
| 2450             | 52.4             |             | 24                |             |
| 2600             | 55.3             |             | 24.6              |             |
| 3000             | 63.8             |             | 25.7              |             |
| 3500             | 67.1             |             | 25                |             |

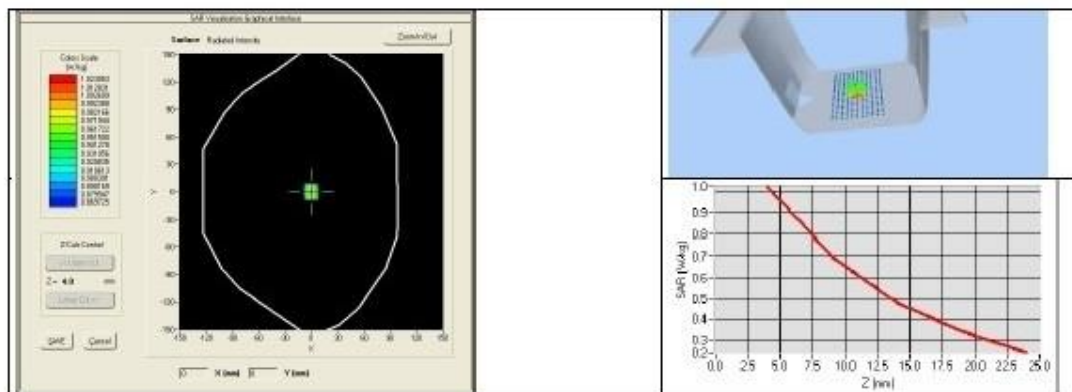
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# SAR REFERENCE DIPOLE CALIBRATION REPORT

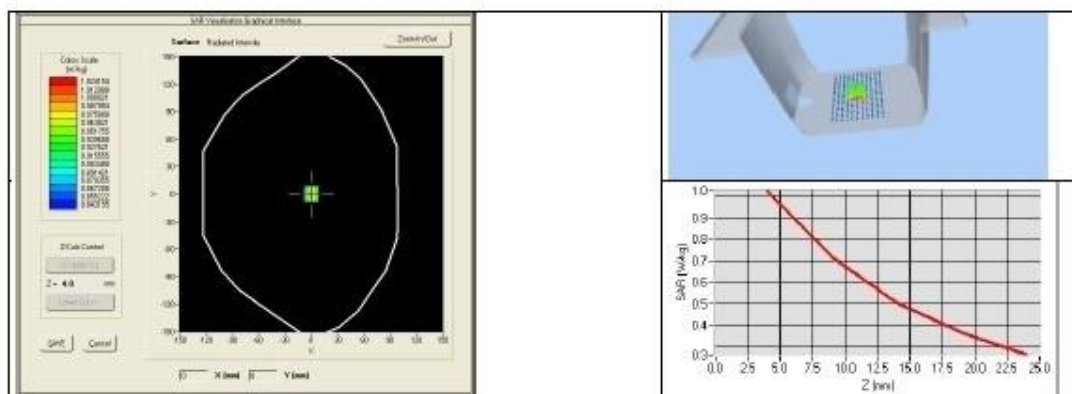
Ref: ACR.96.3.13.SATU.A



## 7.4 BODY MEASUREMENT RESULT

|                                           |                                                              |
|-------------------------------------------|--------------------------------------------------------------|
| Software                                  | OPENSAR V4                                                   |
| Phantom                                   | SN 20/09 SAM71                                               |
| Probe                                     | SN 18/11 EPG122                                              |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}^*$ : 55.3 $\sigma$ : 0.96 |
| 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              | 9.92 (0.99)      | 6.52 (0.65)       |



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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.3.13.SATU.A

## 8 LIST OF EQUIPMENT

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

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

Ref: ACR.96.5.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING  
(SHENZHEN) CO.,LTD  
ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI  
TOWN SHENZHEN,P.R.CHINA  
SATIMO COMOSAR REFERENCE DIPOLE  
FREQUENCY: 1800 MHZ**

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

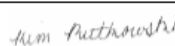
**04/05/13***Summary:*

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



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.96.5.13.SATU.A

|                      | <i>Name</i>   | <i>Function</i> | <i>Date</i> | <i>Signature</i>                                                                    |
|----------------------|---------------|-----------------|-------------|-------------------------------------------------------------------------------------|
| <i>Prepared by :</i> | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Checked by :</i>  | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 4/5/2013    |  |

|                       | <i>Customer Name</i>         |
|-----------------------|------------------------------|
| <i>Distribution :</i> | Shenzhen EMC-united Co., Ltd |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
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| A            | 4/5/2013    | Initial release      |
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|                      | <i>Name</i>   | <i>Function</i> | <i>Date</i> | <i>Signature</i>                                                                    |
|----------------------|---------------|-----------------|-------------|-------------------------------------------------------------------------------------|
| <i>Prepared by :</i> | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Checked by :</i>  | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 4/5/2013    |  |

|                       | <i>Customer Name</i>         |
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| <i>Distribution :</i> | Shenzhen EMC-united Co., Ltd |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A            | 4/5/2013    | 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 1800 MHz REFERENCE DIPOLE |
| Manufacturer                   | Satimo                            |
| Model                          | SID1800                           |
| Serial Number                  | SN 09/13 DIP1G800-216             |
| Product Condition (new / used) | new                               |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

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



Figure 1 – Satimo COMOSAR Validation Dipole

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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         | 16.19 %              |
| 10 g        | 15.86 %              |

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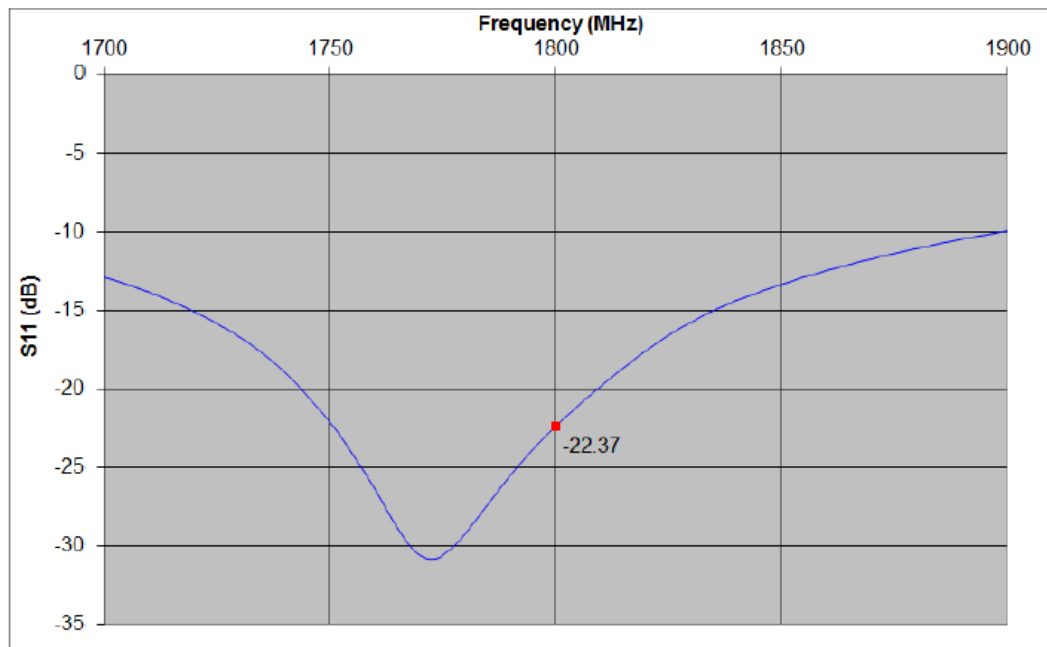


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.96.5.13.SATU.A

## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) |
|-----------------|------------------|------------------|
| 1800            | -22.37           | -20              |

### 6.2 MECHANICAL DIMENSIONS

| Frequency MHz | L mm        |          | h mm        |          | d mm       |          |
|---------------|-------------|----------|-------------|----------|------------|----------|
|               | required    | measured | required    | measured | required   | measured |
| 300           | 420.0 ±1 %. |          | 250.0 ±1 %. |          | 6.35 ±1 %. |          |
| 450           | 290.0 ±1 %. |          | 166.7 ±1 %. |          | 6.35 ±1 %. |          |
| 750           | 176.0 ±1 %. |          | 100.0 ±1 %. |          | 6.35 ±1 %. |          |
| 835           | 161.0 ±1 %. |          | 89.8 ±1 %.  |          | 3.6 ±1 %.  |          |
| 900           | 149.0 ±1 %. |          | 83.3 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1450          | 89.1 ±1 %.  |          | 51.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1500          | 80.5 ±1 %.  |          | 50.0 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1640          | 79.0 ±1 %.  |          | 45.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1750          | 75.2 ±1 %.  |          | 42.9 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1800          | 72.0 ±1 %.  | PASS     | 41.7 ±1 %.  | PASS     | 3.6 ±1 %.  | PASS     |
| 1900          | 68.0 ±1 %.  |          | 39.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1950          | 66.3 ±1 %.  |          | 38.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2000          | 64.5 ±1 %.  |          | 37.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2100          | 61.0 ±1 %.  |          | 35.7 ±1 %.  |          | 3.6 ±1 %.  |          |

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.96.5.13.SATU.A

|      |           |  |           |  |          |  |
|------|-----------|--|-----------|--|----------|--|
| 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 MEASUREMENT CONDITION

|                                           |                                                          |
|-------------------------------------------|----------------------------------------------------------|
| Software                                  | OPENSAR V4                                               |
| Phantom                                   | SN 20/09 SAM71                                           |
| Probe                                     | SN 18/11 EPG122                                          |
| Liquid                                    | Head Liquid Values: $\epsilon_p'$ : 40.2 $\sigma$ : 1.38 |
| Distance between dipole center and liquid | 10.0 mm                                                  |
| Area scan resolution                      | $dx=8mm/dy=8mm$                                          |
| Zoon Scan Resolution                      | $dx=8mm/dy=8m/dz=5mm$                                    |
| Frequency                                 | 1800 MHz                                                 |
| Input power                               | 20 dBm                                                   |
| Liquid Temperature                        | 21 °C                                                    |
| Lab Temperature                           | 21 °C                                                    |
| Lab Humidity                              | 45 %                                                     |

#### 7.2 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 %                               | PASS     | 1.40 ±5 %                     | PASS     |
| 1900             | 40.0 ±5 %                               |          | 1.40 ±5 %                     |          |
| 1950             | 40.0 ±5 %                               |          | 1.40 ±5 %                     |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.96.5.13.SATU.A

|      |           |  |           |  |
|------|-----------|--|-----------|--|
| 2000 | 40.0 ±5 % |  | 1.40 ±5 % |  |
| 2100 | 39.8 ±5 % |  | 1.49 ±5 % |  |
| 2300 | 39.5 ±5 % |  | 1.67 ±5 % |  |
| 2450 | 39.2 ±5 % |  | 1.80 ±5 % |  |
| 2600 | 39.0 ±5 % |  | 1.96 ±5 % |  |
| 3000 | 38.5 ±5 % |  | 2.40 ±5 % |  |
| 3500 | 37.9 ±5 % |  | 2.91 ±5 % |  |

## 7.3 MEASUREMENT RESULT

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

| Frequency<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             |              | 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             | 39.96 (4.00) | 20.1              | 20.98 (2.10) |
| 1900             | 39.7             |              | 20.5              |              |
| 1950             | 40.5             |              | 20.9              |              |
| 2000             | 41.1             |              | 21.1              |              |
| 2100             | 43.6             |              | 21.9              |              |
| 2300             | 48.7             |              | 23.3              |              |
| 2450             | 52.4             |              | 24                |              |
| 2600             | 55.3             |              | 24.6              |              |
| 3000             | 63.8             |              | 25.7              |              |
| 3500             | 67.1             |              | 25                |              |

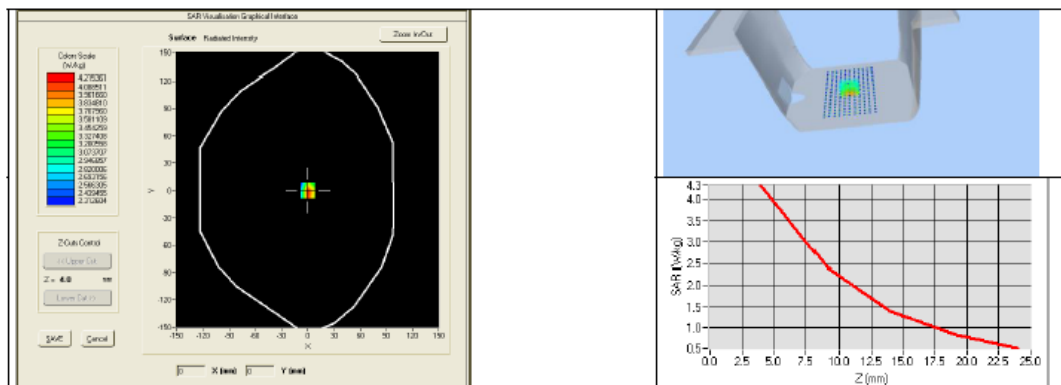
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# SAR REFERENCE DIPOLE CALIBRATION REPORT

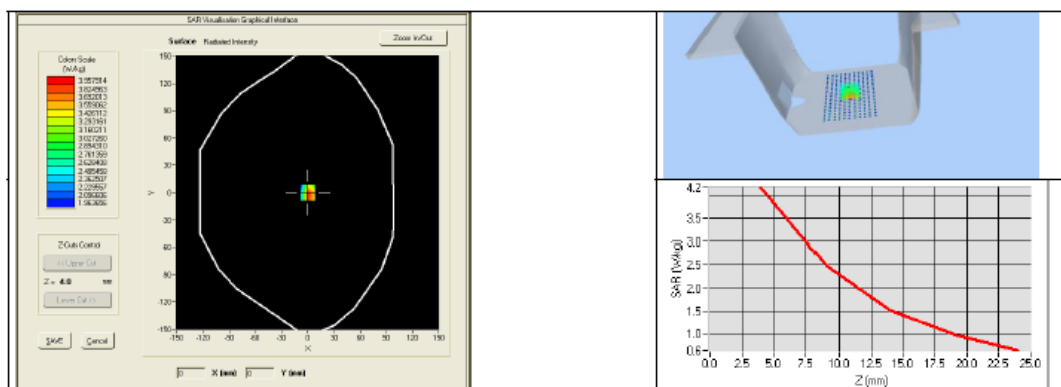
Ref ACR.96.5.13.SATU.A



## 7.4 BODY MEASUREMENT RESULT

|                                           |                                                        |
|-------------------------------------------|--------------------------------------------------------|
| Software                                  | OPENSAR V4                                             |
| Phantom                                   | SN 20/09 SAM71                                         |
| Probe                                     | SN 18/11 EPG122                                        |
| Liquid                                    | Head Liquid Values: $\epsilon_p^*$ : 52.1 sigma : 1.48 |
| 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                                 | 1800 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          |
| 1800             | 39.19 (3.92)     | 20.97 (2.10)      |



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

Ref: ACR.96.6.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING  
(SHENZHEN) CO.,LTD  
ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI  
TOWN SHENZHEN,P.R.CHINA  
SATIMO COMOSAR REFERENCE DIPOLE  
FREQUENCY: 1900 MHZ**

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

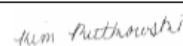
**04/05/13***Summary:*

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



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.6.13.SATU.A

|                      | <i>Name</i>   | <i>Function</i> | <i>Date</i> | <i>Signature</i>                                                                    |
|----------------------|---------------|-----------------|-------------|-------------------------------------------------------------------------------------|
| <i>Prepared by :</i> | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Checked by :</i>  | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 4/5/2013    |  |

|                       | <i>Customer Name</i>         |
|-----------------------|------------------------------|
| <i>Distribution :</i> | Shenzhen EMC-united Co., Ltd |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A            | 4/5/2013    | Initial release      |
|              |             |                      |
|              |             |                      |
|              |             |                      |

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| 5.3 | Validation Measurement.....           | 5  |
| 6   | Calibration Measurement Results ..... | 6  |
| 6.1 | Return Loss .....                     | 6  |
| 6.2 | Mechanical Dimensions .....           | 6  |
| 7   | Validation measurement.....           | 7  |
| 7.1 | Measurement Condition .....           | 7  |
| 7.2 | Head Liquid Measurement .....         | 7  |
| 7.3 | Measurement Result .....              | 8  |
| 7.4 | Body Measurement Result .....         | 9  |
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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 1900 MHz REFERENCE DIPOLE |
| Manufacturer                   | Satimo                            |
| Model                          | SID1900                           |
| Serial Number                  | SN 09/13 DIP1G900-218             |
| Product Condition (new / used) | new                               |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

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



Figure 1 – Satimo COMOSAR Validation Dipole

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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         | 16.19 %              |
| 10 g        | 15.86 %              |

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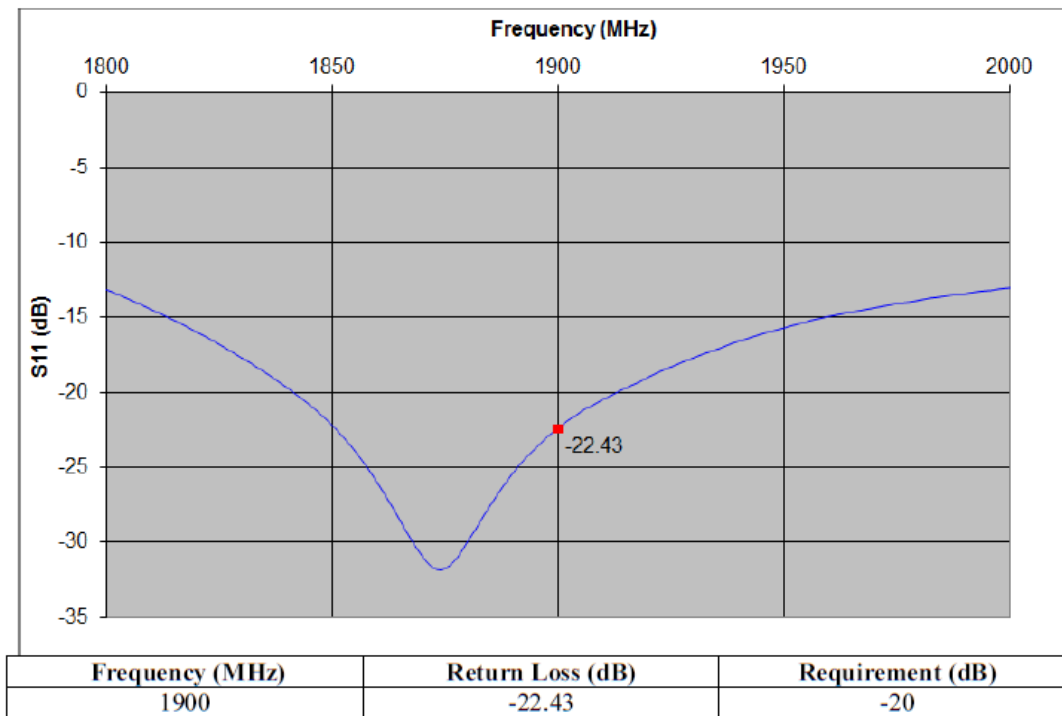


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.96.6.13.SATU.A

### 6 CALIBRATION MEASUREMENT RESULTS

#### 6.1 RETURN LOSS



#### 6.2 MECHANICAL DIMENSIONS

| Frequency MHz | L mm        |          | h mm        |          | d mm       |          |
|---------------|-------------|----------|-------------|----------|------------|----------|
|               | required    | measured | required    | measured | required   | measured |
| 300           | 420.0 ±1 %. |          | 250.0 ±1 %. |          | 6.35 ±1 %. |          |
| 450           | 290.0 ±1 %. |          | 166.7 ±1 %. |          | 6.35 ±1 %. |          |
| 750           | 176.0 ±1 %. |          | 100.0 ±1 %. |          | 6.35 ±1 %. |          |
| 835           | 161.0 ±1 %. |          | 89.8 ±1 %.  |          | 3.6 ±1 %.  |          |
| 900           | 149.0 ±1 %. |          | 83.3 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1450          | 89.1 ±1 %.  |          | 51.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1500          | 80.5 ±1 %.  |          | 50.0 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1640          | 79.0 ±1 %.  |          | 45.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1750          | 75.2 ±1 %.  |          | 42.9 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1800          | 72.0 ±1 %.  |          | 41.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1900          | 68.0 ±1 %.  | PASS     | 39.5 ±1 %.  | PASS     | 3.6 ±1 %.  | PASS     |
| 1950          | 66.3 ±1 %.  |          | 38.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2000          | 64.5 ±1 %.  |          | 37.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2100          | 61.0 ±1 %.  |          | 35.7 ±1 %.  |          | 3.6 ±1 %.  |          |

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|      |            |  |            |  |           |  |
|------|------------|--|------------|--|-----------|--|
| 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 MEASUREMENT CONDITION

|                                           |                                                         |
|-------------------------------------------|---------------------------------------------------------|
| Software                                  | OPENSAR V4                                              |
| Phantom                                   | SN 20/09 SAM71                                          |
| Probe                                     | SN 18/11 EPG122                                         |
| Liquid                                    | Head Liquid Values: $\epsilon_p$ : 39.8 $\sigma$ : 1.43 |
| Distance between dipole center and liquid | 10.0 mm                                                 |
| Area scan resolution                      | $dx=8mm/dy=8mm$                                         |
| Zoon Scan Resolution                      | $dx=8mm/dy=8m/dz=5mm$                                   |
| Frequency                                 | 1900 MHz                                                |
| Input power                               | 20 dBm                                                  |
| Liquid Temperature                        | 21 °C                                                   |
| Lab Temperature                           | 21 °C                                                   |
| Lab Humidity                              | 45 %                                                    |

#### 7.2 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 %                              | PASS     | 1.40 ±5 %                     | PASS     |
| 1950             | 40.0 ±5 %                              |          | 1.40 ±5 %                     |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.6.13.SATU.A

|      |            |  |            |  |
|------|------------|--|------------|--|
| 2000 | 40.0 ± 5 % |  | 1.40 ± 5 % |  |
| 2100 | 39.8 ± 5 % |  | 1.49 ± 5 % |  |
| 2300 | 39.5 ± 5 % |  | 1.67 ± 5 % |  |
| 2450 | 39.2 ± 5 % |  | 1.80 ± 5 % |  |
| 2600 | 39.0 ± 5 % |  | 1.96 ± 5 % |  |
| 3000 | 38.5 ± 5 % |  | 2.40 ± 5 % |  |
| 3500 | 37.9 ± 5 % |  | 2.91 ± 5 % |  |

## 7.3 MEASUREMENT RESULT

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

| Frequency<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             |              | 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             | 40.95 (4.10) | 20.5              | 20.93 (2.09) |
| 1950             | 40.5             |              | 20.9              |              |
| 2000             | 41.1             |              | 21.1              |              |
| 2100             | 43.6             |              | 21.9              |              |
| 2300             | 48.7             |              | 23.3              |              |
| 2450             | 52.4             |              | 24                |              |
| 2600             | 55.3             |              | 24.6              |              |
| 3000             | 63.8             |              | 25.7              |              |
| 3500             | 67.1             |              | 25                |              |

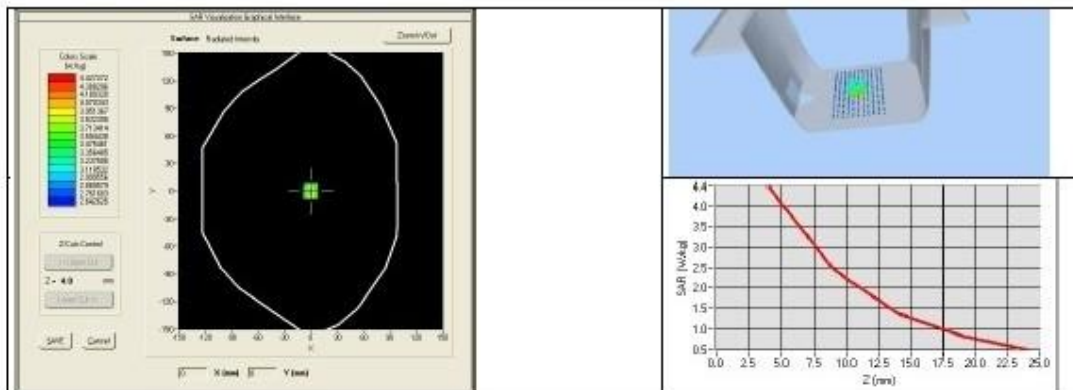
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# SAR REFERENCE DIPOLE CALIBRATION REPORT

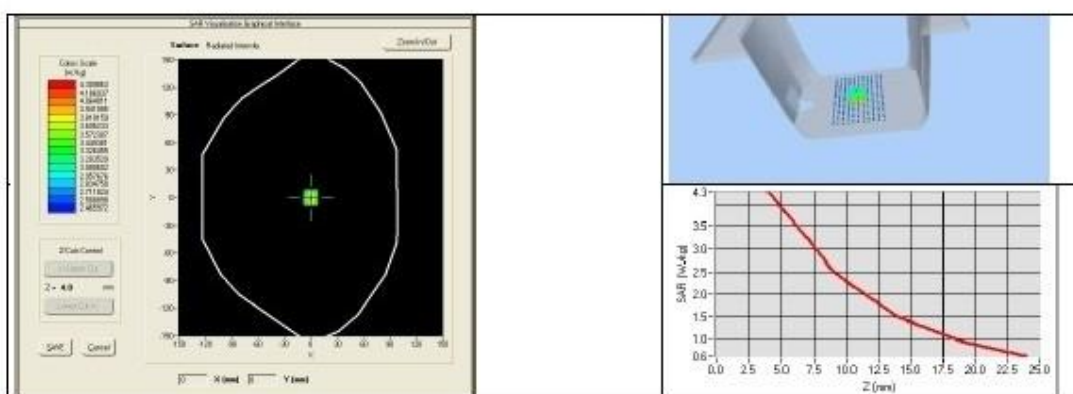
Ref: ACR-96.6.13.SATU.A



## 7.4 BODY MEASUREMENT RESULT

|                                           |                                                            |
|-------------------------------------------|------------------------------------------------------------|
| Software                                  | OPENSAR V4                                                 |
| Phantom                                   | SN 20/09 SAM71                                             |
| Probe                                     | SN 18/11 EPG122                                            |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}$ : 52.5 $\sigma$ : 1.50 |
| 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                                 | 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) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 1900             | 40.29 (4.03)     | 21.10 (2.11)      |



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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.6.13.SATU.A

## 8 LIST OF EQUIPMENT

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

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

Ref : ACR.96.8.13.SATU.A

**CCIC SOUTHERN ELECTRONIC PRODUCT TESTING  
(SHENZHEN) CO.,LTD**

**ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI  
TOWN SHENZHEN,P.R.CHINA**

**SATIMO COMOSAR REFERENCE DIPOLE  
FREQUENCY: 2450 MHZ**

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

**04/05/13***Summary:*

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



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.96.8.13.SATU.A

|                      | <i>Name</i>   | <i>Function</i> | <i>Date</i> | <i>Signature</i>                                                                    |
|----------------------|---------------|-----------------|-------------|-------------------------------------------------------------------------------------|
| <i>Prepared by :</i> | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Checked by :</i>  | Jérôme LUC    | Product Manager | 4/5/2013    |  |
| <i>Approved by :</i> | Kim RUTKOWSKI | Quality Manager | 4/5/2013    |  |

|                       | <i>Customer Name</i>         |
|-----------------------|------------------------------|
| <i>Distribution :</i> | Shenzhen EMC-united Co., Ltd |

| <i>Issue</i> | <i>Date</i> | <i>Modifications</i> |
|--------------|-------------|----------------------|
| A            | 4/5/2013    | 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 2450 MHz REFERENCE DIPOLE |
| Manufacturer                   | Satimo                            |
| Model                          | SID2450                           |
| Serial Number                  | SN 09/13 DIP2G450-220             |
| Product Condition (new / used) | new                               |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

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



Figure 1 – Satimo COMOSAR Validation Dipole

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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         | 16.19 %              |
| 10 g        | 15.86 %              |

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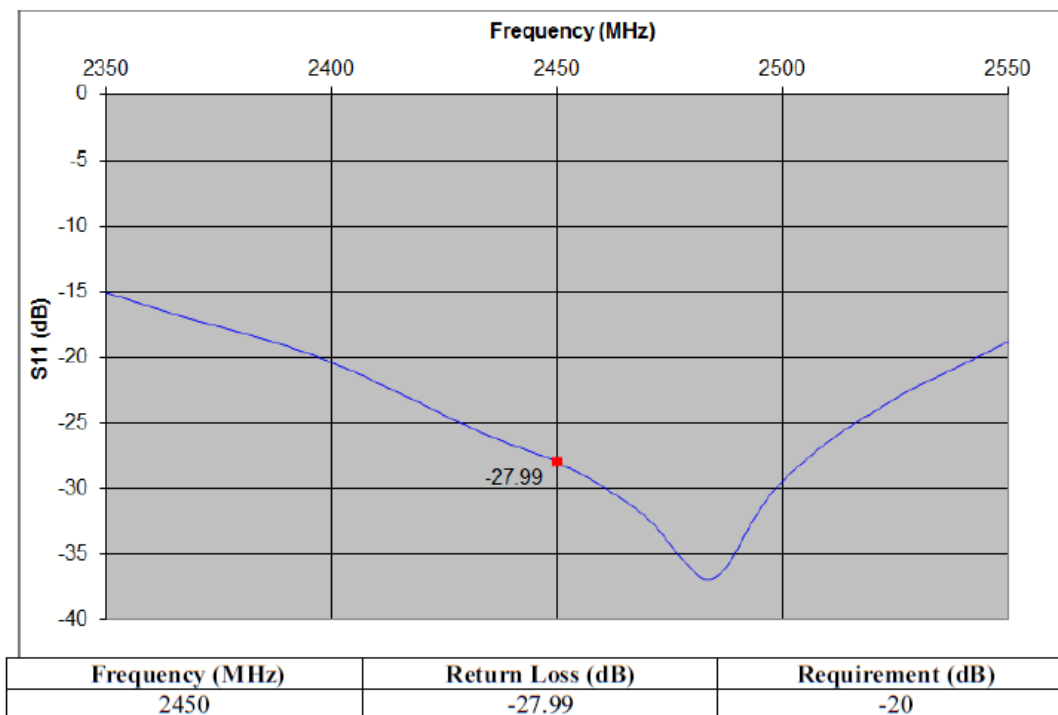


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.8.13.SATU.A

### 6 CALIBRATION MEASUREMENT RESULTS

#### 6.1 RETURN LOSS



#### 6.2 MECHANICAL DIMENSIONS

| Frequency MHz | L mm        |          | h mm        |          | d mm       |          |
|---------------|-------------|----------|-------------|----------|------------|----------|
|               | required    | measured | required    | measured | required   | measured |
| 300           | 420.0 ±1 %. |          | 250.0 ±1 %. |          | 6.35 ±1 %. |          |
| 450           | 290.0 ±1 %. |          | 166.7 ±1 %. |          | 6.35 ±1 %. |          |
| 750           | 176.0 ±1 %. |          | 100.0 ±1 %. |          | 6.35 ±1 %. |          |
| 835           | 161.0 ±1 %. |          | 89.8 ±1 %.  |          | 3.6 ±1 %.  |          |
| 900           | 149.0 ±1 %. |          | 83.3 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1450          | 89.1 ±1 %.  |          | 51.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1500          | 80.5 ±1 %.  |          | 50.0 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1640          | 79.0 ±1 %.  |          | 45.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1750          | 75.2 ±1 %.  |          | 42.9 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1800          | 72.0 ±1 %.  |          | 41.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1900          | 68.0 ±1 %.  |          | 39.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1950          | 66.3 ±1 %.  |          | 38.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2000          | 64.5 ±1 %.  |          | 37.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2100          | 61.0 ±1 %.  |          | 35.7 ±1 %.  |          | 3.6 ±1 %.  |          |

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|      |            |      |            |      |           |      |
|------|------------|------|------------|------|-----------|------|
| 2300 | 55.5 ±1 %. |      | 32.6 ±1 %. |      | 3.6 ±1 %. |      |
| 2450 | 51.5 ±1 %. | PASS | 30.4 ±1 %. | PASS | 3.6 ±1 %. | PASS |
| 2600 | 48.5 ±1 %. |      | 28.8 ±1 %. |      | 3.6 ±1 %. |      |
| 3000 | 41.5 ±1 %. |      | 25.0 ±1 %. |      | 3.6 ±1 %. |      |
| 3500 | 37.0±1 %.  |      | 26.4 ±1 %. |      | 3.6 ±1 %. |      |
| 3700 | 34.7±1 %.  |      | 26.4 ±1 %. |      | 3.6 ±1 %. |      |

### 7 VALIDATION MEASUREMENT

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

#### 7.1 MEASUREMENT CONDITION

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

#### 7.2 HEAD LIQUID MEASUREMENT

| Frequency<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 %                     |          |

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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref ACR.96.8.13.SATU.A

|      |            |      |            |      |
|------|------------|------|------------|------|
| 2000 | 40.0 ± 5 % |      | 1.40 ± 5 % |      |
| 2100 | 39.8 ± 5 % |      | 1.49 ± 5 % |      |
| 2300 | 39.5 ± 5 % |      | 1.67 ± 5 % |      |
| 2450 | 39.2 ± 5 % | PASS | 1.80 ± 5 % | PASS |
| 2600 | 39.0 ± 5 % |      | 1.96 ± 5 % |      |
| 3000 | 38.5 ± 5 % |      | 2.40 ± 5 % |      |
| 3500 | 37.9 ± 5 % |      | 2.91 ± 5 % |      |

## 7.3 MEASUREMENT RESULT

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

| Frequency<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             |              | 6.22              |              |
| 900              | 10.9             |              | 6.99              |              |
| 1450             | 29               |              | 16                |              |
| 1500             | 30.5             |              | 16.8              |              |
| 1640             | 34.2             |              | 18.4              |              |
| 1750             | 36.4             |              | 19.3              |              |
| 1800             | 38.4             |              | 20.1              |              |
| 1900             | 39.7             |              | 20.5              |              |
| 1950             | 40.5             |              | 20.9              |              |
| 2000             | 41.1             |              | 21.1              |              |
| 2100             | 43.6             |              | 21.9              |              |
| 2300             | 48.7             |              | 23.3              |              |
| 2450             | 52.4             | 53.33 (5.33) | 24                | 24.23 (2.42) |
| 2600             | 55.3             |              | 24.6              |              |
| 3000             | 63.8             |              | 25.7              |              |
| 3500             | 67.1             |              | 25                |              |

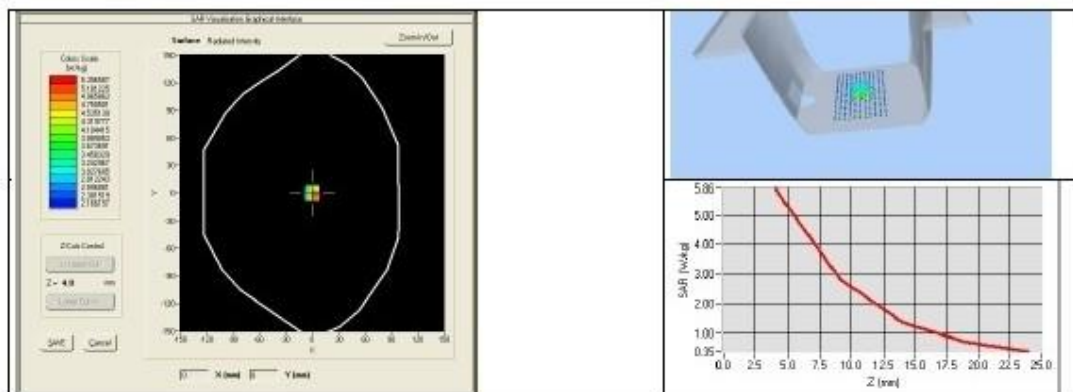
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# SAR REFERENCE DIPOLE CALIBRATION REPORT

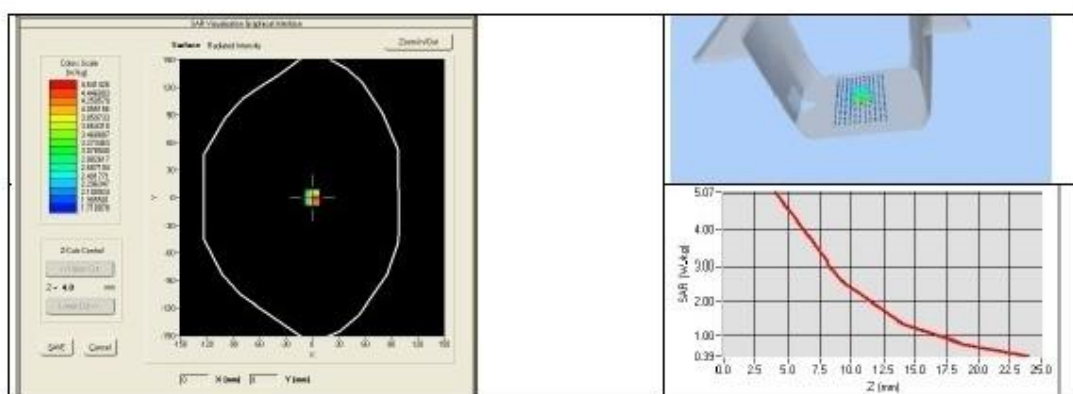
Ref: ACR.96.8.13.SATU.A



## 7.4 BODY MEASUREMENT RESULT

|                                           |                                                             |
|-------------------------------------------|-------------------------------------------------------------|
| Software                                  | OPENSAR V4                                                  |
| Phantom                                   | SN 20/09 SAM71                                              |
| Probe                                     | SN 18/11 EPG122                                             |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}' : 52.0$ $\sigma : 1.94$ |
| Distance between dipole center and liquid | 10.0 mm                                                     |
| Area scan resolution                      | $dx=8mm/dy=8mm$                                             |
| Zoon Scan Resolution                      | $dx=8mm/dy=8mm/dz=5mm$                                      |
| 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             | 51.99 (5.20)     | 23.96 (2.40)      |



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## SAR REFERENCE DIPOLE CALIBRATION REPORT

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

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### <Justification of the extended calibration>

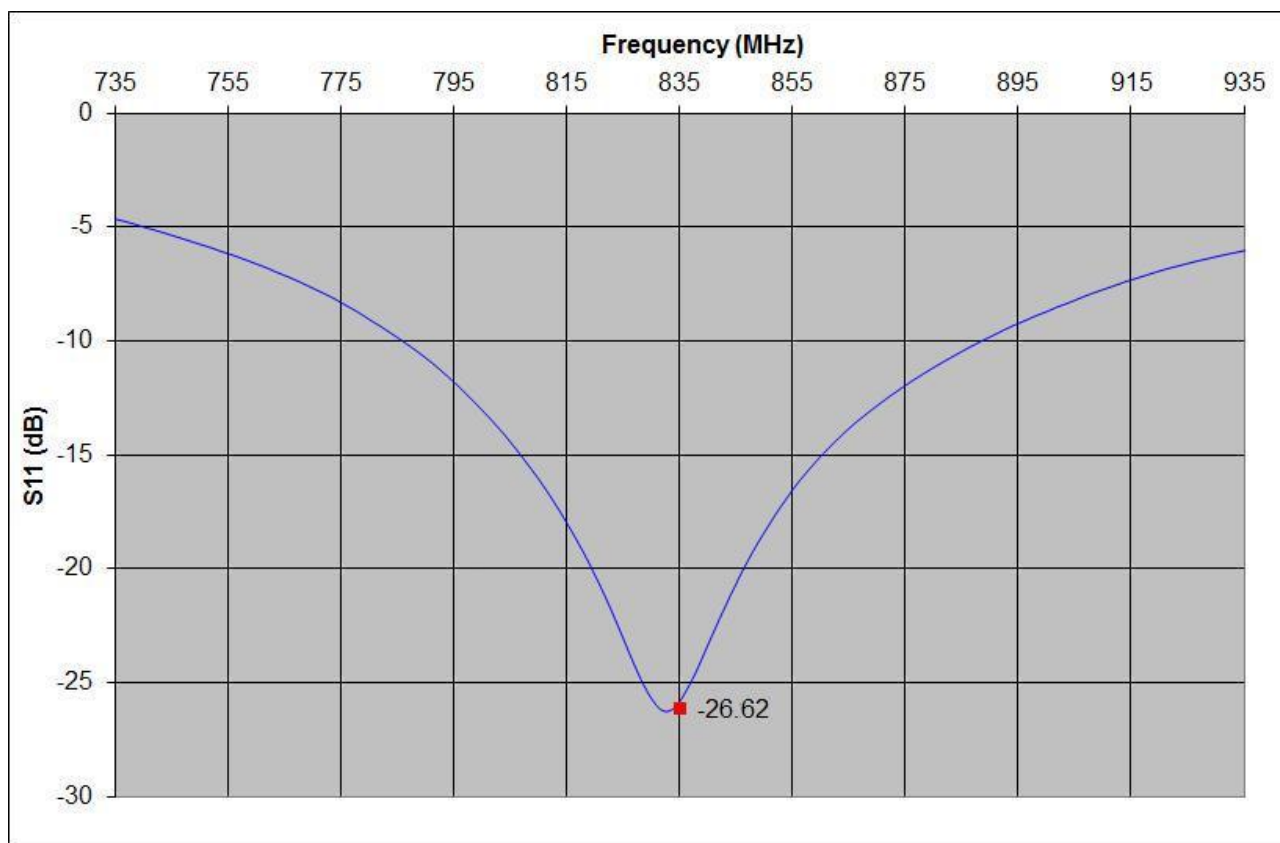
Referring to KDB 450824, if dipoles are verified in return loss(<-20dB, within 20% of prior calibration),and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

| 835MHz              |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2013.04.05          | -26.15           | -         | 49.25     | -          |
| 2014.04.02          | -26.62           | 1.8       | 48.37     | 0.88       |

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>

#### 835MHz

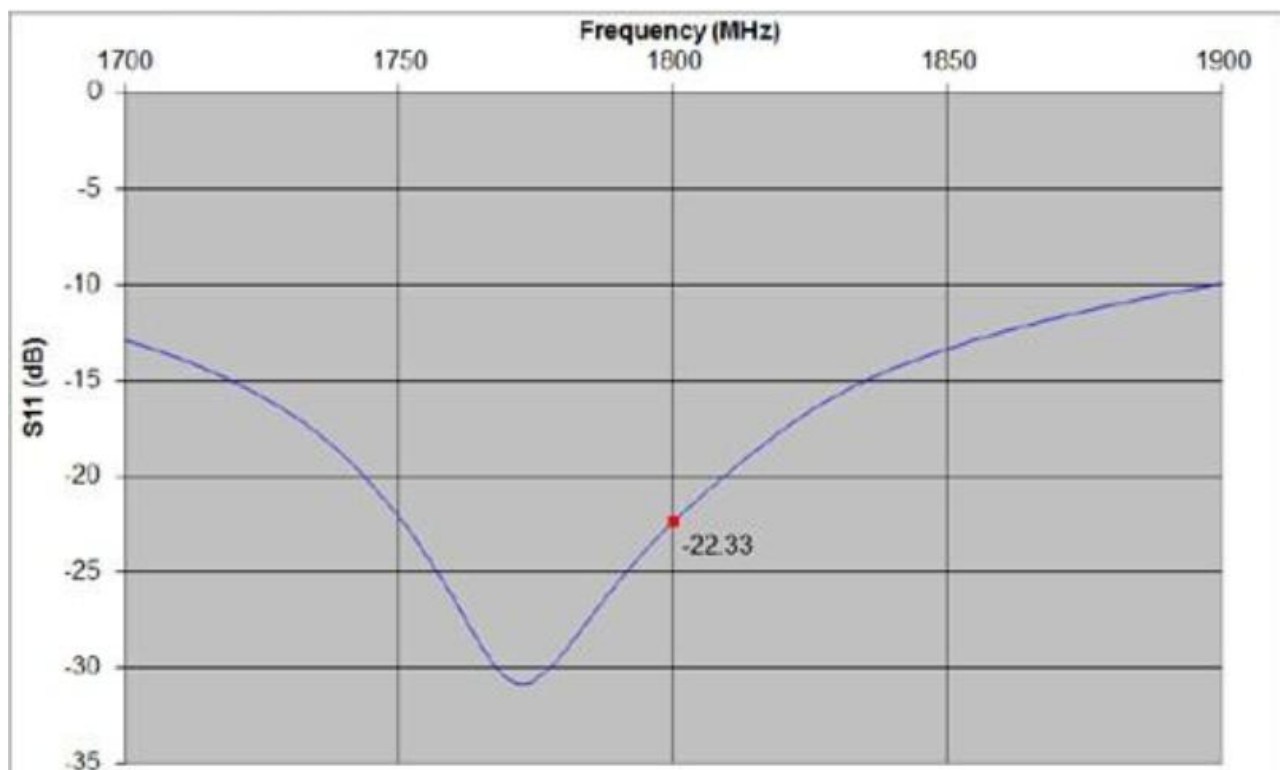


| 1800MHz             |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2013.04.05          | -23.37           | -         | 50.48     | -          |
| 2014.04.02          | -23.33           | -0.17     | 51.32     | -0.84      |

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>

##### 1800MHz

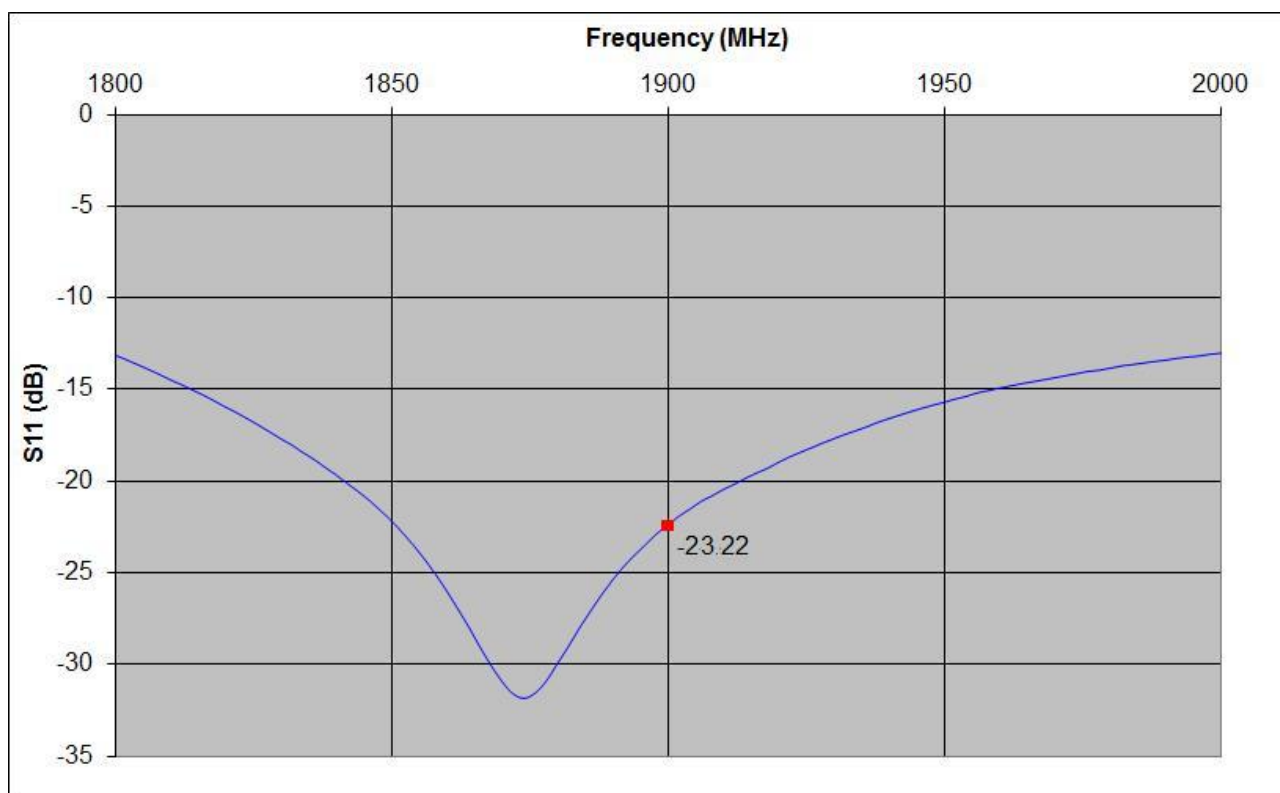


| 1900MHz             |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2013.04.05          | -22.43           | -         | 50.21     | -          |
| 2014.04.02          | -23.22           | 3.5       | 51.08     | -0.87      |

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>

#### 1900MHz

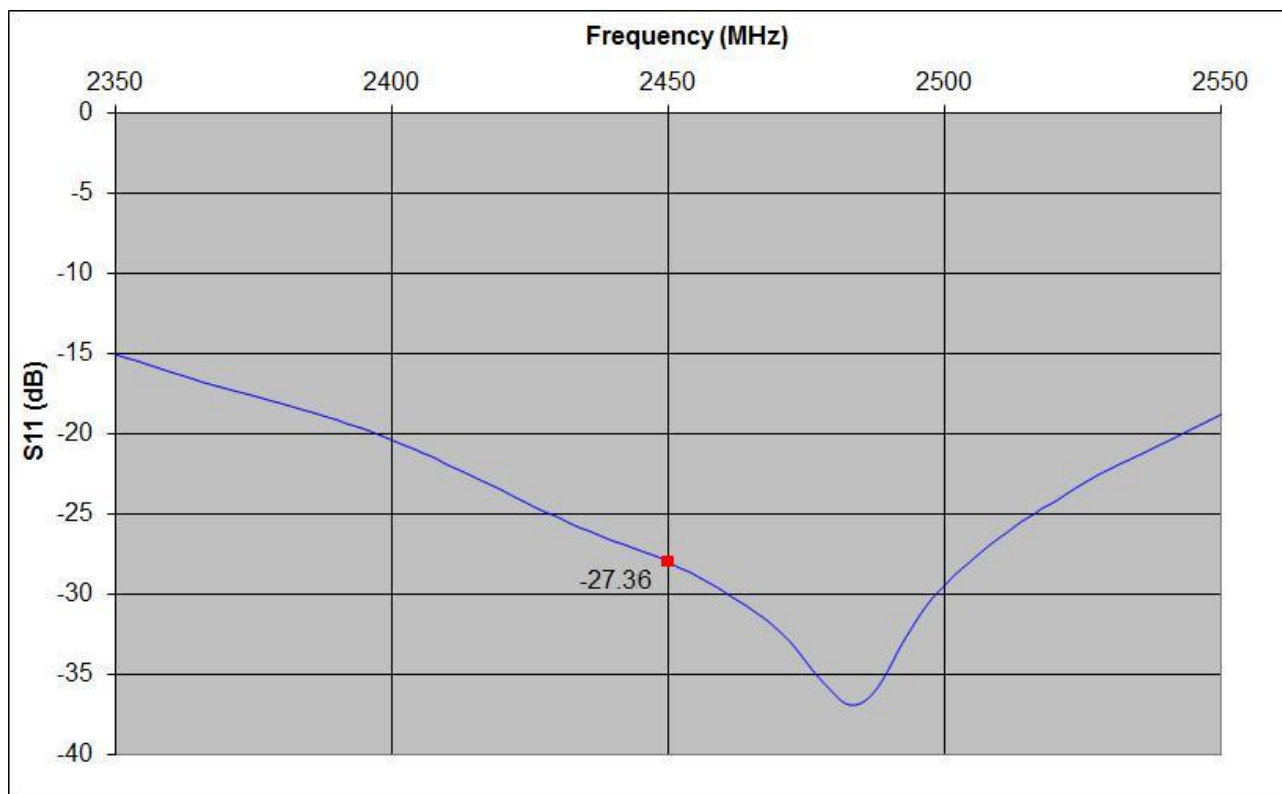


| 2450MHz             |                  |           |           |            |
|---------------------|------------------|-----------|-----------|------------|
| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
| 2013.04.05          | -27.99           | -         | 51.37     | -          |
| 2014.04.02          | -27.36           | 2.3       | 50.46     | 0.91       |

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>

#### 2450MHz



**Calibration Certificate of Keithley 2000 Multimeter****KEITHLEY**

A Tektronix Company

A Greater Measure of Confidence

## TRACEABLE CALIBRATION

2000, 4014020  
Cal Date: 30-JAN-2013  
Cal Due: Lab: Kel**KEITHLEY**

KEITHLEY INSTRUMENTS, INC. • 28775 AUBORA RD, CLEVELAND, OHIO - USA • 419-248-0400 • Fax: 419-248-6168 • 1-888-KEITHLEY • www.keithley.com

Calibration Facility: This product was calibrated for Keithley Instruments by  
Tektronix (China) Co. Ltd., 1227 Chuan Qiao Road, Pudong New District, Shanghai, China 201206**Calibration Certificate**Certificate No: PCXPTG6FZX  
Manufacturer: Keithley  
Description: Multimeter, 6 1/2 digit  
Calibration Date: 30-JAN-2013Revision: 00  
Model: 2000  
Temperature: 23.0 °C  
Date Placed In Service: \_\_\_\_\_  
Serial No: 4014020  
Humidity: 46 %  
Due Date: \_\_\_\_\_

\* Optional customer entry fields: The due date may be established by adding the Keithley recommended cal interval stated in the product manual to the "Date placed in service"

**Initial Condition:** Not applicable, new product**Final Condition:** In Tolerance

- Keithley Instruments, Inc. certifies that the above instrument meets its published measurement specifications.
- This instrument has been calibrated using measurement standards traceable to the International System of Units (SI) through the PRC National Institute of Metrology (NIM), or other National Metrology Institutes (such as NIST, NPL, PTB, etc.).
- The policies and procedures used for the calibration of this product are based upon ANSI/NCSL Z540.1-1994 (R2002).
- The quality system used by the calibration facility is ISO 9001 registered.
- This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.
- This calibration certificate shall not be reproduced, except in full, without the written approval of Keithley Instruments, Inc.

**Calibration Procedure Used:** MANIFEST:Product\_Dmm\_KeithleyDMM\_Full VERSION:107**Calibration Standards Used:**

| <u>Manufacturer/Model</u> | <u>Model Description</u>        | <u>ID Number</u> | <u>Due Date</u> |
|---------------------------|---------------------------------|------------------|-----------------|
| Fluke 5720A               | Calibrator                      | KI10138          | 18-Nov-2013     |
| Fluke 5725A               | Power Amplifier                 | KI5554           | 09-Jan-2014     |
| Keithley 3390             | Function/Arbitrary Waveform Gen | KI10261          | 16-Nov-2013     |

**Issued By:****Quality Director:**

Cui, Hu Wa

**Certified By:** Lin Qing Zhu**Date Issued:** 30-JAN-2013

2000 4014020



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PA-1061A



—End of the Report—