



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.3.14.SATU.A

## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity ( $\epsilon_r'$ )		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 %	PASS	0.89 ± 5 %	PASS
835	41.5 ± 5 %		0.90 ± 5 %	
900	41.5 ± 5 %		0.97 ± 5 %	
1450	40.5 ± 5 %		1.20 ± 5 %	
1500	40.4 ± 5 %		1.23 ± 5 %	
1640	40.2 ± 5 %		1.31 ± 5 %	
1750	40.1 ± 5 %		1.37 ± 5 %	
1800	40.0 ± 5 %		1.40 ± 5 %	
1900	40.0 ± 5 %		1.40 ± 5 %	
1950	40.0 ± 5 %		1.40 ± 5 %	
2000	40.0 ± 5 %		1.40 ± 5 %	
2100	39.8 ± 5 %		1.49 ± 5 %	
2300	39.5 ± 5 %		1.67 ± 5 %	
2450	39.2 ± 5 %		1.80 ± 5 %	
2600	39.0 ± 5 %		1.96 ± 5 %	
3000	38.5 ± 5 %		2.40 ± 5 %	
3500	37.9 ± 5 %		2.91 ± 5 %	

### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: $\epsilon_r'$ : 42.1 sigma : 0.89
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm

Page: 7/11

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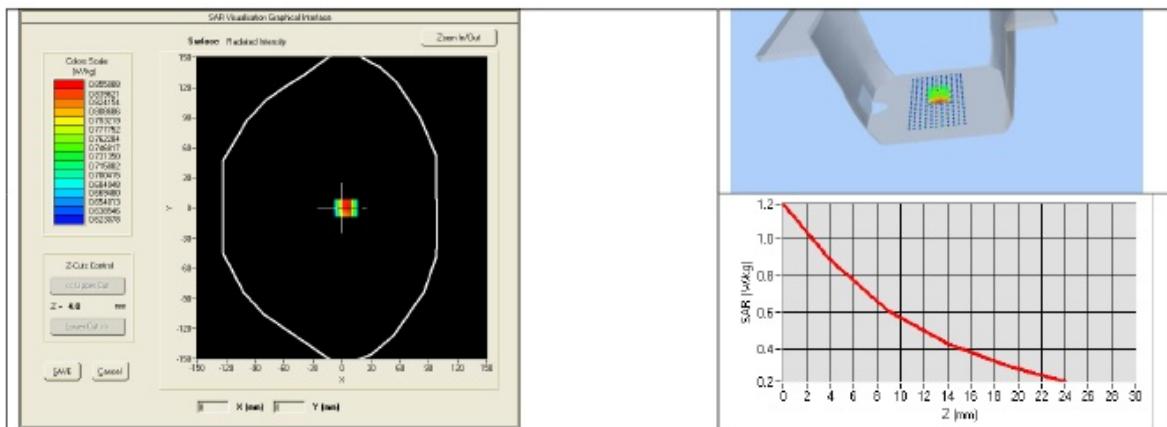


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.3.14.SATU.A

Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49	8.38 (0.84)	5.55	5.53 (0.55)
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		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	



Page: 8/11

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.3.14.SATU.A

7.3 BODY LIQUID MEASUREMENT

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

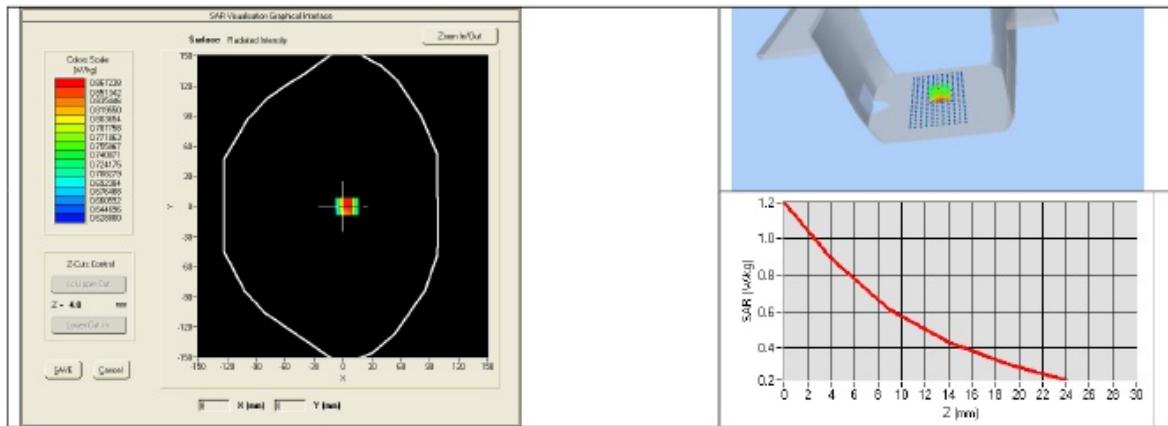
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: $\epsilon_r'$ : 56.6 sigma : 0.99
Distance between dipole center and liquid	15.0 mm
Area scan resolution	$dx=8mm/dy=8mm$
Zoon Scan Resolution	$dx=8mm/dy=8m/dz=5mm$
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.3.14.SATU.A

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
750	8.77 (0.88)	5.78 (0.58)



Page: 10/11

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.3.14.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	12/2013	12/2016
Reference Probe	Satimo	EPG122 SN 18/11	10/2015	10/2016
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2013	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature and Humidity Sensor	Control Company	11-661-9	8/2013	8/2016

Page: 11/11

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## 5.5 SID835Dipole Calibration Ceriticate



### SAR Reference Dipole Calibration Report

Ref : ACR.287.4.14.SATU.A

#### SHENZHEN LCS COMPLIANCE TESTING LABORATORY LTD.

1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD,  
BAO'AN BLVD  
BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA  
SATIMO COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ

SERIAL NO.: SN 07/14 DIP 0G835-303

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



10/01/2015

#### 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.287.4.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	10/14/2015	
Checked by :	Jérôme LUC	Product Manager	10/14/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	10/14/2015	

	Customer Name
	Shenzhen LCS
Distribution :	Compliance Testing Laboratory Ltd.

Issue	Date	Modifications
A	10/14/2015	Initial release

Page: 2/11

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

## TABLE OF CONTENTS

1	Introduction.....	4
2	Device Under Test .....	4
3	Product Description .....	4
3.1	General Information .....	4
4	Measurement Method .....	5
4.1	Return Loss Requirements .....	5
4.2	Mechanical Requirements .....	5
5	Measurement Uncertainty.....	5
5.1	Return Loss .....	5
5.2	Dimension Measurement .....	5
5.3	Validation Measurement .....	5
6	Calibration Measurement Results.....	6
6.1	Return Loss and Impedance .....	6
6.2	Mechanical Dimensions .....	6
7	Validation measurement .....	7
7.1	Head Liquid Measurement .....	7
7.2	SAR Measurement Result With Head Liquid.....	7
7.3	Body Liquid Measurement .....	9
7.4	SAR Measurement Result With Body Liquid .....	9
8	List of Equipment .....	11

Page: 3/11

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

## 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 07/14 DIP 0G835-303
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**



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

**4 MEASUREMENT METHOD**

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

**4.1 RETURN LOSS REQUIREMENTS**

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

**4.2 MECHANICAL REQUIREMENTS**

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

**5 MEASUREMENT UNCERTAINTY**

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

**5.1 RETURN LOSS**

The following uncertainties apply to the return loss measurement:

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

**5.2 DIMENSION MEASUREMENT**

The following uncertainties apply to the dimension measurements:

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

**5.3 VALIDATION MEASUREMENT**

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

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

Page: 5/11

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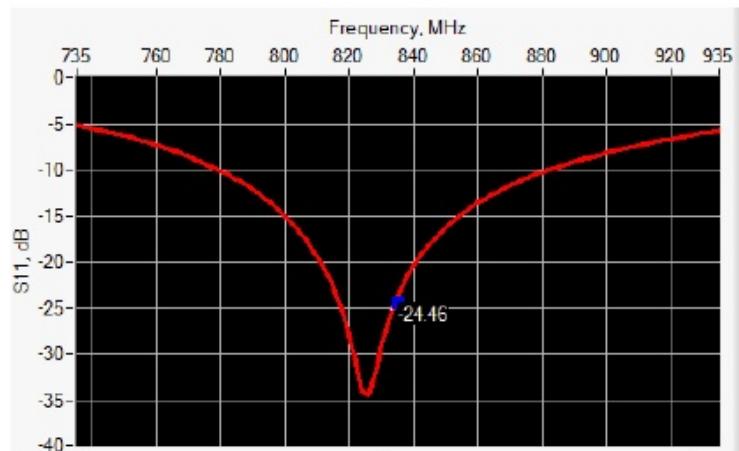


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

## 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-24.46	-20	$55.4 \Omega + 2.4 j\Omega$

## 6.2 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	$161.0 \pm 1\%$ .	PASS	$89.8 \pm 1\%$ .	PASS	$3.6 \pm 1\%$ .	PASS
900	$149.0 \pm 1\%$ .		$83.3 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1450	$89.1 \pm 1\%$ .		$51.7 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1500	$80.5 \pm 1\%$ .		$50.0 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1640	$79.0 \pm 1\%$ .		$45.7 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1750	$75.2 \pm 1\%$ .		$42.9 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1800	$72.0 \pm 1\%$ .		$41.7 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1900	$68.0 \pm 1\%$ .		$39.5 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1950	$66.3 \pm 1\%$ .		$38.5 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2000	$64.5 \pm 1\%$ .		$37.5 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2100	$61.0 \pm 1\%$ .		$35.7 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2300	$55.5 \pm 1\%$ .		$32.6 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2450	$51.5 \pm 1\%$ .		$30.4 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2600	$48.5 \pm 1\%$ .		$28.8 \pm 1\%$ .		$3.6 \pm 1\%$ .	
3000	$41.5 \pm 1\%$ .		$25.0 \pm 1\%$ .		$3.6 \pm 1\%$ .	
3500	$37.0 \pm 1\%$ .		$26.4 \pm 1\%$ .		$3.6 \pm 1\%$ .	
3700	$34.7 \pm 1\%$ .		$26.4 \pm 1\%$ .		$3.6 \pm 1\%$ .	

Page: 6/11

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## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity ( $\epsilon_r'$ )		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 %	
2100	39.8 ± 5 %		1.49 ± 5 %	
2300	39.5 ± 5 %		1.67 ± 5 %	
2450	39.2 ± 5 %		1.80 ± 5 %	
2600	39.0 ± 5 %		1.96 ± 5 %	
3000	38.5 ± 5 %		2.40 ± 5 %	
3500	37.9 ± 5 %		2.91 ± 5 %	

### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: $\epsilon_r'$ : 42.3 sigma : 0.92
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm

Page: 7/11

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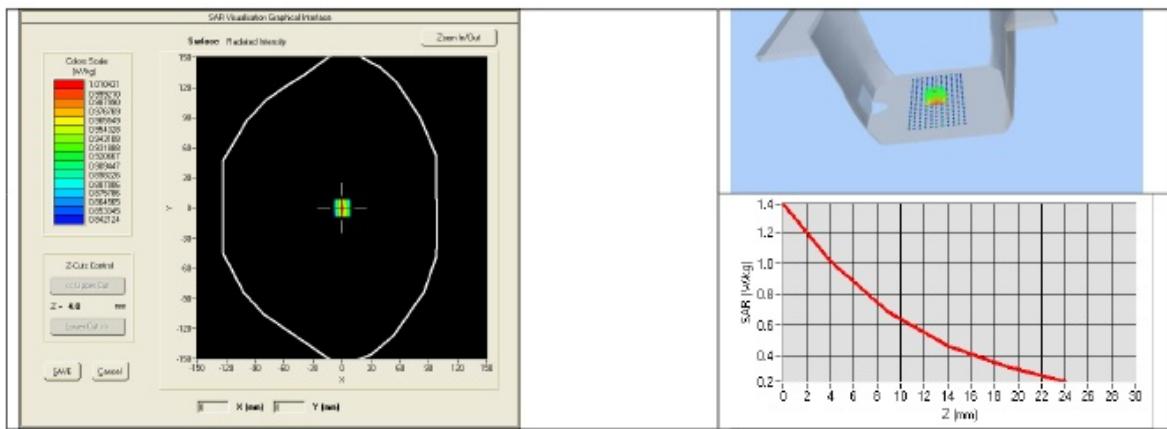


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	835 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56	9.60 (0.96)	6.22	6.20 (0.62)
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	



Page: 8/11

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7.3 BODY LIQUID MEASUREMENT

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

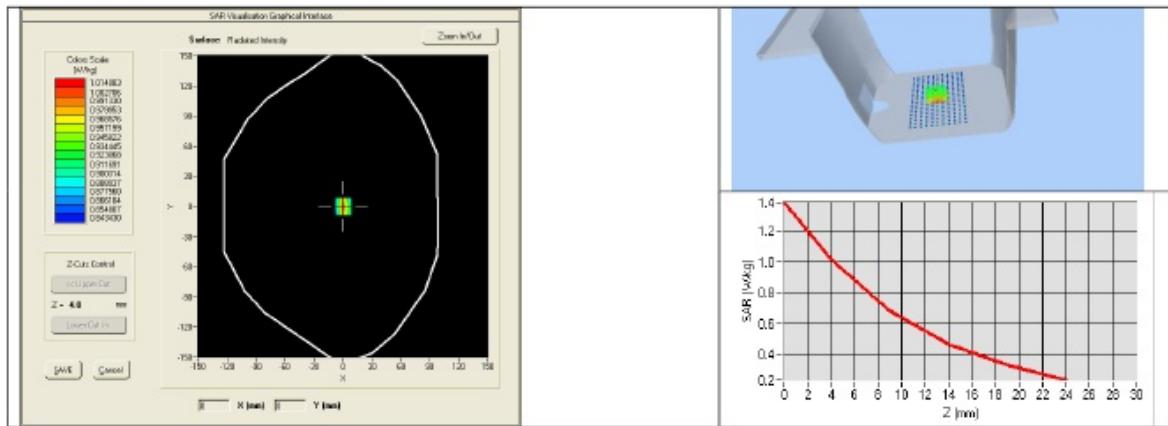
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: $\epsilon_r'$ : 54.1 sigma : 0.97
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	835 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.4.14.SATU.A

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
835	9.90 (0.99)	6.39 (0.64)



Page: 10/11

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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	12/2013	12/2016
Reference Probe	Satimo	EPG122 SN 18/11	10/2015	10/2016
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2013	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature and Humidity Sensor	Control Company	11-661-9	8/2013	8/2016

Page: 11/11

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## 5.6 SID1800 Dipole Calibration Certificate



### SAR Reference Dipole Calibration Report

Ref : ACR.287.6.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING  
LABORATORY LTD.**  
**1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD,  
BAO'AN BLVD**  
**BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA**  
**SATIMO COMOSAR REFERENCE DIPOLE**  
**FREQUENCY: 1800 MHZ**  
**SERIAL NO.: SN 07/14 DIP 1G800-301**

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



**10/01/2015**

#### 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.287.6.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	10/14/2015	
Checked by :	Jérôme LUC	Product Manager	10/14/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	10/14/2015	

	Customer Name
Distribution :	Shenzhen LCS Compliance Testing Laboratory Ltd.

Issue	Date	Modifications
A	10/14/2015	Initial release

Page: 2/11

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.6.14.SATU.A

## TABLE OF CONTENTS

1	Introduction.....	4
2	Device Under Test .....	4
3	Product Description .....	4
3.1	General Information .....	4
4	Measurement Method .....	5
4.1	Return Loss Requirements .....	5
4.2	Mechanical Requirements .....	5
5	Measurement Uncertainty.....	5
5.1	Return Loss .....	5
5.2	Dimension Measurement .....	5
5.3	Validation Measurement .....	5
6	Calibration Measurement Results.....	6
6.1	Return Loss and Impedance .....	6
6.2	Mechanical Dimensions .....	6
7	Validation measurement .....	7
7.1	Head Liquid Measurement .....	7
7.2	SAR Measurement Result With Head Liquid.....	7
7.3	Body Liquid Measurement .....	9
7.4	SAR Measurement Result With Body Liquid .....	9
8	List of Equipment .....	11

Page: 3/11

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.6.14.SATU.A

## 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 07/14 DIP 1G800-301
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**



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR-287.6.14.SATU.A

**4 MEASUREMENT METHOD**

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

**4.1 RETURN LOSS REQUIREMENTS**

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

**4.2 MECHANICAL REQUIREMENTS**

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

**5 MEASUREMENT UNCERTAINTY**

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

**5.1 RETURN LOSS**

The following uncertainties apply to the return loss measurement:

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

**5.2 DIMENSION MEASUREMENT**

The following uncertainties apply to the dimension measurements:

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

**5.3 VALIDATION MEASUREMENT**

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

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

Page: 5/11

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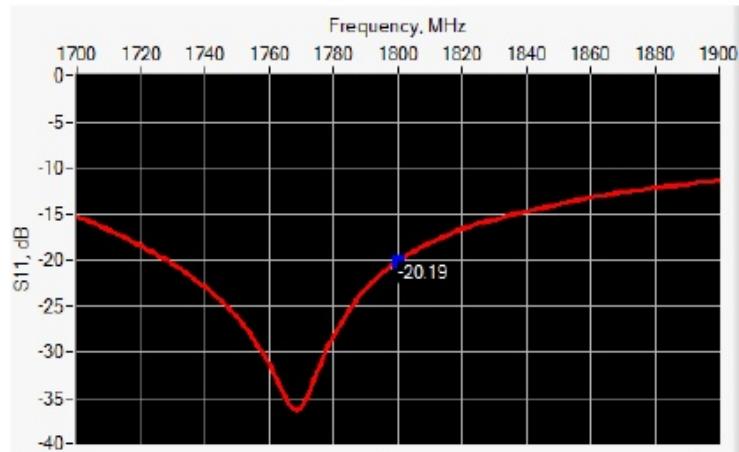


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.6.14.SATU.A

## 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1800	-20.19	-20	$43.4 \Omega + 7.2 j\Omega$

## 6.2 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	$161.0 \pm 1\%$ .		$89.8 \pm 1\%$ .		$3.6 \pm 1\%$ .	
900	$149.0 \pm 1\%$ .		$83.3 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1450	$89.1 \pm 1\%$ .		$51.7 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1500	$80.5 \pm 1\%$ .		$50.0 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1640	$79.0 \pm 1\%$ .		$45.7 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1750	$75.2 \pm 1\%$ .		$42.9 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1800	$72.0 \pm 1\%$ .	PASS	$41.7 \pm 1\%$ .	PASS	$3.6 \pm 1\%$ .	PASS
1900	$68.0 \pm 1\%$ .		$39.5 \pm 1\%$ .		$3.6 \pm 1\%$ .	
1950	$66.3 \pm 1\%$ .		$38.5 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2000	$64.5 \pm 1\%$ .		$37.5 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2100	$61.0 \pm 1\%$ .		$35.7 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2300	$55.5 \pm 1\%$ .		$32.6 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2450	$51.5 \pm 1\%$ .		$30.4 \pm 1\%$ .		$3.6 \pm 1\%$ .	
2600	$48.5 \pm 1\%$ .		$28.8 \pm 1\%$ .		$3.6 \pm 1\%$ .	
3000	$41.5 \pm 1\%$ .		$25.0 \pm 1\%$ .		$3.6 \pm 1\%$ .	
3500	$37.0 \pm 1\%$ .		$26.4 \pm 1\%$ .		$3.6 \pm 1\%$ .	
3700	$34.7 \pm 1\%$ .		$26.4 \pm 1\%$ .		$3.6 \pm 1\%$ .	

Page: 6/11

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.6.14.SATU.A

## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity ( $\epsilon_r'$ )		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 %	
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 %	

### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: $\epsilon_r'$ : 41.3 sigma : 1.38
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm

Page: 7/11

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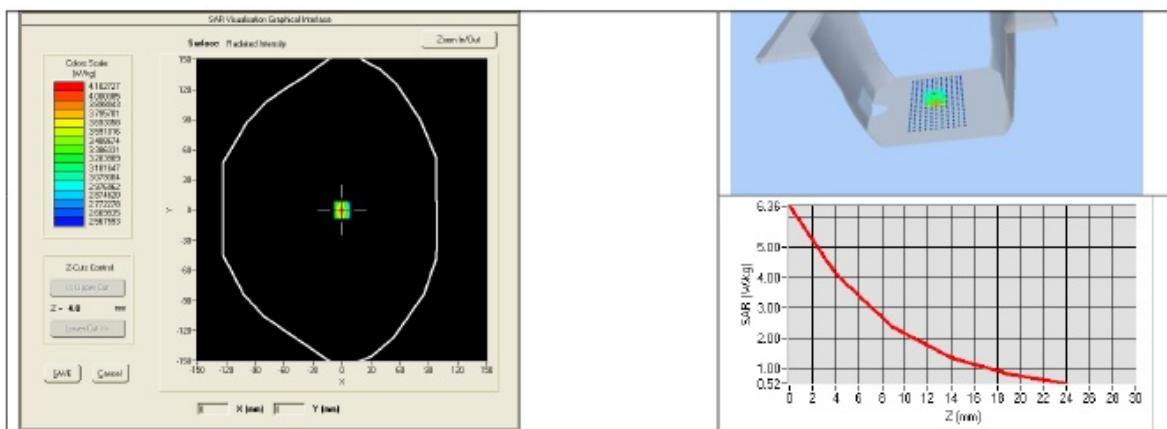


## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.6.14.SATU.A

Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	1800 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4	38.13 (3.81)	20.1	20.20 (2.02)
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	



Page: 8/11

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.6.14.SATU.A

7.3 BODY LIQUID MEASUREMENT

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

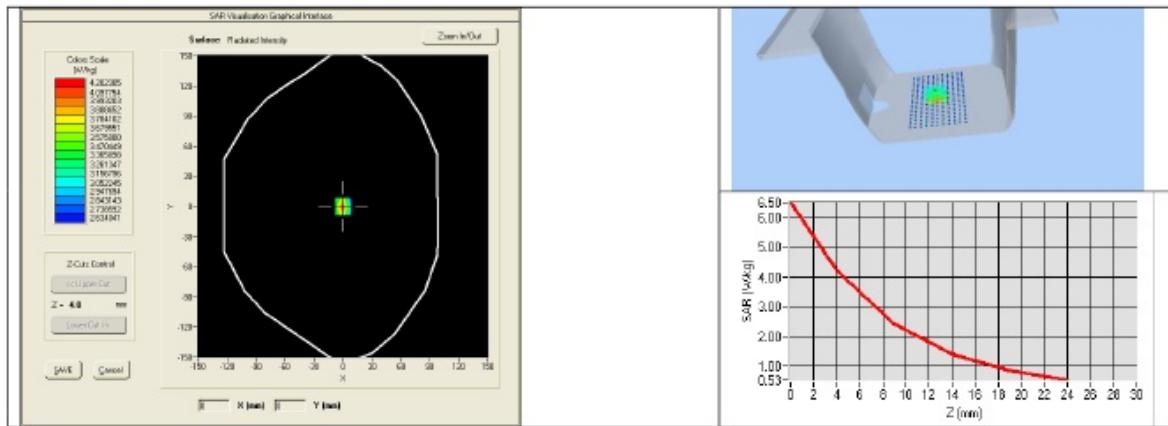
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: $\epsilon_r'$ : 53.3 sigma : 1.51
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	1800 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.6.14.SATU.A

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
1800	39.03 (3.90)	20.65 (2.07)



Page: 10/11

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.287.6.14.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	12/2013	12/2016
Reference Probe	Satimo	EPG122 SN 18/11	10/2015	10/2016
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2013	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature and Humidity Sensor	Control Company	11-661-9	8/2013	8/2016

Page: 11/11

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## 5.7 SID1900 Dipole Calibration Certificate



### COMOSAR E-Field Probe Calibration Report

Ref : ACR.262.8.14.SATU.A

**SHENZHEN LCS COMPLIANCE TESTING  
LABORATORY LTD.  
1F., XINGYUAN INDUSTRIAL PARK, TONGDA ROAD,  
BAO'AN BLVD  
BAO'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA  
SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE  
FREQUENCY: 1900MHz  
SERIAL NO.: SN 30/14 DIP1G900-333**

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



10/01/2015

#### 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.



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.262.8.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	10/14/2015	
Checked by :	Jérôme LUC	Product Manager	10/14/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	10/14/2015	Kim Rutkowska

	Customer Name
Distribution :	Shenzhen LCS Compliance Testing Laboratory Ltd.

Issue	Date	Modifications
A	10/14/2015	Initial release

Page: 2/9

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR-262.8.14.SATU.A

## TABLE OF CONTENTS

1	Introduction.....	4
2	Device Under Test .....	4
3	Product Description .....	4
3.1	General Information .....	4
4	Measurement Method .....	5
4.1	Return Loss Requirements .....	5
4.2	Mechanical Requirements .....	5
5	Measurement Uncertainty.....	5
5.1	Return Loss .....	5
5.2	Dimension Measurement .....	5
5.3	Validation Measurement .....	5
6	Calibration Measurement Results.....	6
6.1	Return Loss and Impedance In Head Liquid .....	6
6.2	Return Loss and Impedance In Body Liquid .....	6
6.3	Mechanical Dimensions .....	6
7	Validation measurement .....	7
7.1	Head Liquid Measurement .....	7
7.2	SAR Measurement Result With Head Liquid .....	8
7.3	Body Liquid Measurement .....	9
7.4	SAR Measurement Result With Body Liquid .....	10
8	List of Equipment .....	11