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Appendix D. Probe Calibration Data



COMOSAR E-Field Probe Calibration Report

Ref: ACR.31.1.13.SATU.A

ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

1&2F, NO.2 BUILDING, HUAFENG NO.1 INDUSTRIAL PARK, GUSHU COMMUNITY XIXIANG STREET BAOAN DISTRICT, SHENZHEN, P.R. CHINA SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 04/13 EP165

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



01/31/13

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.

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.31.1.13.SATU.A

	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	1/31/2013	Jes
Checked by :	Jérôme LUC	Product Manager	1/31/2013	Jes
Approved by :	Kim RUTKOWSKI	Quality Manager	1/31/2013	frem Prethouski

0.	Customer Name
Distribution :	ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

Issue	Date	Modifications	
A	1/31/2013	Initial release	



Ref: ACR.31.1.13.SATU.A

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Ref: ACR.31.1.13.SATU.A

1 DEVICE UNDER TEST

Device Under Test				
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE			
Manufacturer	Satimo			
Model	SSE5			
Serial Number	SN 04/13 EP165			
Product Condition (new / used)	new			
Frequency Range of Probe	0.03 GHz-3GHz			
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.239 MΩ			
	Dipole 2: R2=0.224 MΩ			
	Dipole 3: R3=0.223 MΩ			

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

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



Figure 1 – Satimo COMOSAR Dosimetric E field Dipole

Probe Length	330 mm
Length of Individual Dipoles	4.5 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	5 mm
Distance between dipoles / probe extremity	2.7 mm

3 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

3.1 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.

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3.2 <u>SENSITIVITY</u>

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

3.3 LOWER DETECTION LIMIT

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

3.4 ISOTROPY

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

3.5 BOUNDARY EFFECT

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

4 MEASUREMENT UNCERTAINTY

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

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

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref. ACR.31.1.13.SATU.A

Combined standard uncertainty			5.831%
Expanded uncertainty 95 % confidence level k = 2			11.662%

5 CALIBRATION MEASUREMENT RESULTS

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

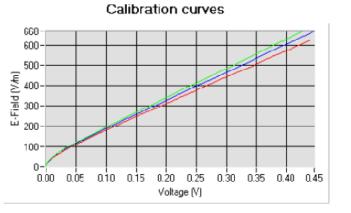
5.1 SENSITIVITY IN AIR

		Normy dipole	
	1 $(\mu V/(V/m)^2)$	$2 (\mu V/(V/m)^2)$	$3 (\mu V/(V/m)^2)$
Γ	5.66	5.98	5.64

DCP dipole 1	DCP dipole 2	DCP dipole 3
(mV)	(mV)	(mV)
94	90	90

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

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



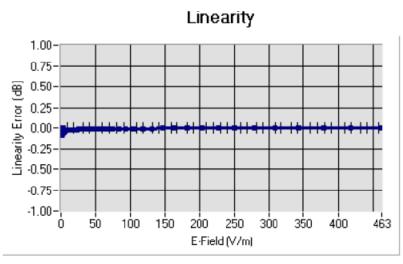
Dipole 1 Dipole 2 Dipole 3

Fage. 6/10



Ref. ACR.31.1.13 SATU.A

5.2 LINEARITY



Linearity: I+/-1.97% (+/-0.09dB)

5.3 <u>SENSITIVITY IN LIQUID</u>

Liquid	Frequency (MHz -/-	Permittivity	Epsilon (S/m)	ConvF
	100MHz)*			
HL150	150	50.12	0.77	4.36
BL150	150	60.56	0.79	4.56
HL300	300	44.75	0.84	4.58
BL300	300	57.99	0.93	4.70
HL450	450	42.08	0.90	4.75
BL450	450	57.63	0.96	4.89
HL850	835	40.96	0.90	5.30
BL850	835	54.22	0.98	5.46
HL900	900	39.90	0.97	5.16
BL900	900	55.99	1.06	5.29
HL1800	1750	38.96	1.37	4.54
BL1800	1750	52.34	1.51	4.66
HL1900	1880	38.67	1.40	4.72
BL1900	1880	52.12	1.52	4.84
HL2000	1950	38.97	1.43	4.24
BL2000	1950	54.01	1.54	4.39
HL2450	2450	37.97	1.83	4.19
BL2450	2450	53.04	1.96	4.32

^{*} MHz \pm 50MHz for frequency below 300MHz

LOWER DETECTION LIMIT: 9mW/kg

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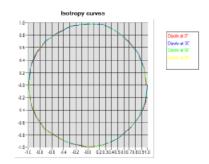


Ref. ACR.31.1.13.SATU.A

5.4 ISOTROPY

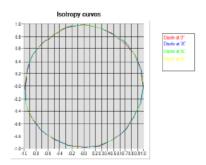
HL900 MHz

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



HL1800 MHz

- Axial isotropy: 0.08 dB - Hemispherical isotropy: 0.11 dB



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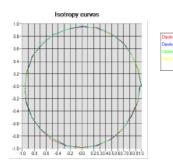


COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref. ACR.31.1.13.SATU.A

HL2450 MHz

- Axial isotropy: 0.09 dB - Hemispherical isotropy: 0.13 dB





Ref: ACR.31.1.13.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-SAM/1	Validated. No cal required.	Validated. No cal required.	
COMOSAR Test Bench	Version 3	NΛ	Validated. No cal required.	Validated. No cal required.	
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2010	02/2013	
Reference Probe	Satimo	EP 94 SN 37/08	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Multimeter	Keithley 2000	1188656	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	US37131460	11/2010	11/2013	
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	3/2012	3/2014	

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Appendix E. Dipole Calibration Data



SAR Reference Dipole Calibration Report

Ref: ACR.343.5.11.SATU.A

ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

1&2F, NO.2 BUILDING, HUAFENG NO.1 INDUSTRIAL PARK, GUSHU COMMUNITY XIXIANG STREET BAOAN DISTRICT, SHENZHEN, P.R. CHINA SATIMO COMOSAR REFERENCE DIPOLE

FREQUENCY: 900 MHZ SERIAL NO.: SN 46/11 DIP 0G900-185

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



12/09/11

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.

Report No.: AGC00417130601FH01 Page 100 of 116



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.343.5.11.SATU.A

-	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	12/9/2011	JS
Checked by :	Jérôme LUC	Product Manager	12/9/2011	JES
Approved by :	Kim RUTKOWSKI	Quality Manager	12/9/2011	frim Prothoustri

	Customer Name
Distribution :	ATTESTATION
	OF GLOBAL COMPLIANCE
	CO. LTD.

Issue	Date	Modifications
A	12/9/2011	Initial release



Ref: ACR.343.5.11.SATU.A

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Ref: ACR.343.5.11.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	SID900		
Serial Number	SN 46/11 DIP 0G900-185		
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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Ref: ACR.343.5.11.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 constucted as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

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

5 MEASUREMENT UNCERTAINTY

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

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

5.2 <u>DIMENSION MEASUREMENT</u>

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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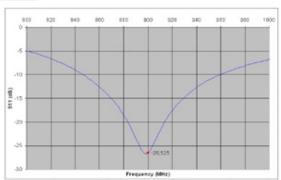


SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.343.5.11.SATU.A

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS



Frequency (MHz)	Return Loss (dB)	Requirement (dB)
900	-26.52	-20

6.2 MECHANICAL DIMENSIONS

Frequency MHz L mm		nm	n h mm		d r	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 %.	PASS	83.3 ±1 %.	PASS	3.6 ±1 %.	PASS
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 %.	1	3.6 ±1 %.	
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 ±1 %.		35.7 ±1 %.	()	3.6 ±1 %.	
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.	
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0±1%.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.	

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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 MEASUREMENT CONDITION

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps': 41.5 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	900 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

7.2 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ϵ_{r}')		Conductiv	ity (a) 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 %	PASS	0.97 ±5 %	PASS
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 %	

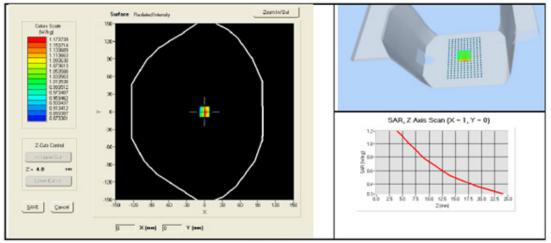
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Ref: ACR.343.5.11.SATU.A

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 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	11.20 (1.12)	6.99	7.04 (0.70
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	9
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	1
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	



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Ref: ACR.343.5.11.SATU.A

8 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	02/2010	02/2013	
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	3/2010	3/2012	

Report No.: AGC00417130601FH01

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SAR Reference Dipole Calibration Report

Ref: ACR.343.7.11.SATU.A

ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

 $1\&2F, \, \text{NO.2 BUILDING}, \, \text{HUAFENG NO.1 INDUSTRIAL PARK}, \, \text{GUSHU} \\ \text{COMMUNITY XIXIANG STREET}$

BAOAN DISTRICT, SHENZHEN, P.R. CHINA

SATIMO COMOSAR REFERENCE DIPOLE

FRE QUENCY: 1900 MHZ SERIAL NO.: SN 46/11 DIP 1G900-187

Calibrated at SATIMO US

2105 Barrett Park Dr. - Kennesaw, GA 30144



12/09/11

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.

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.343.7.11.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	12/9/2011	JES
Checked by:	Jérôme LUC	Product Manager	12/9/2011	JE
Approved by:	Kim RUTKOWSKI	Quality Manager	12/9/2011	sum Pritthowski

	Customer Name
	ATTESTATION
Distribution:	OF GLOBAL
Distribution:	COMPLIANCE
	CO. LTD.

Issue	Date	Modifications
A	12/9/2011	Initial release



Ref: ACR.343.7.11.SATU.A

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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 CEVIEC 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 SID 1900			
Serial Number SN 46/11 DIP 1G900-187			
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 constucted as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

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

5 MEASUREMENT UNCERTAINTY

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

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Fr equency 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 %

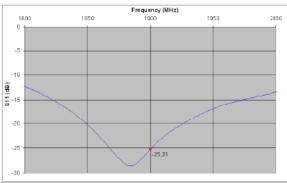
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6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS



Frequency (MHz)	Return Loss (dB)	Requirement (dB)
1900	-25.23	-20

6.2 <u>MECHANICAL DIMENSIONS</u>

Frequency MHz	L mm		hmm		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%.	
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%.	

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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 MEASUREMENT CONDITION

Software	OPENSAR V 4		
Phantom	SN 20/09 SAM71		
Probe	SN 18/11 EPG122		
Liquid	Head Liquid Values: eps': 39.4 sigma: 1.42		
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 MHz	Relative permittivity (s,')		Conductivity (c) S/m		
	required	measured	required	measured	
300	45.3 ±5%		0.87 ±5 %	20	
450	43.5 ±5%		0.87 ±5 %		
750	41.9 ±5%		0.89 ±5 %	100	
835	41.5 ±5%		0.90 ±5 %		
900	41.5 ±5%		0.97 ±5 %	2	
1450	40.5 ±5%		1.20 ±5 %		
1500	40.4 ±5 %		1.23 ±5 %	%, 100	
1640	40.2 ±5%		1.31 ±5 %		
1750	40.1 ±5%		1.37 ±5 %	26	
1800	40.0 ±5 %		1.40 ±5 %	%, ==:	
1900	40.0 ±5 %	PASS	1.40 ±5 %	PASS	
1950	40.0 ±5%		1.40 ±5 %	30	
2000	40.0 ±5 %		1.40 ±5 %	16, 111	
2100	39.8±5%		1.49 ±5 %		
2300	39.5 ±5%		1.67 ±5 %	30	
2450	39.2 ±5%		1.80 ±5 %	%. 	
2600	39.0 ±5%		1.96 ±5 %		
3000	38.5 ±5%		2.40 ±5 %	35	
3500	37.9 ±5%		2.91 ±5 %	×	

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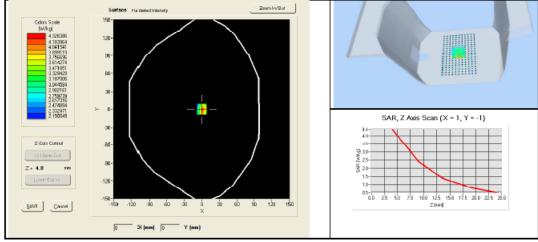


Ref: ACR.343.7.11.SATU.A

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 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	40.44 (4.04)	20.5	20.60 (2.06)	
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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8 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. Nocal required.	√alidated. No cal required.		
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.		
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2010	02/2013		
Calipers	Carrera	CALIPER-01	12/2010	12/2013		
Reference Probe	Satimo	EPG122 SN 18/11	Characterized pricr to test. No cal required.	Characterized prior to test. No cal required.		
Multimeter	Keith ey 2000	1188656	1 1/20 10	11/2013		
Signal Generator	Agilent E4438C	MY49070581	12/2010	12/2013		
Amplifier	Aethercomm	SN 046	Characterized pricr to test. No cal required.	Characterized prior to test. No cal required.		
Power Meter	HP E4418A	US38261498	11/2010	11/2013		
Pcwer Sensor	HP ECP-E26A	US37181460	11/2010	11/2013		
Directional Coupler	Narda 4216-20	01386	Characterized pricr to test. No cal required.	Characterized prior to test. No cal required.		
Temperature and Humidity Sensor	Control Company	11-661-9	3/2010	3/2012		