Probe Calibration Certificate



COMOSAR E-Field Probe Calibration Report

Ref: ACR.227.15.14.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI TOWN

SHENZHEN, P.R. CHINA (POST CODE:518055)
SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 04/13 EP166

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



08/10/2015

Summary:

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

	Nam e	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	8/11/2015	JE
Checked by :	Jérôme LUC	Product Manager	8/11/2015	JE
Approved by :	Kim RUTKOWSKI	Quality Manager	8/11/2015	tum Puthowski

Custom er Name		
CCIC SOUTHERN		
ELECTRONIC		
PRODUCT		
TESTING		
(SHENZHEN) Co.,		
Ltd		

Issue	Date	Modifications	
A	8/11/2015	Initial release	

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1 DEVICE UNDER TEST

Device	e Under Test
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	Satimo
Model	SSE5
Serial Number	SN 04/13 EP166
Product Condition (new / used)	Used
Frequency Range of Probe	0.7 GHz-3 GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.231 MΩ
	Dipole 2: R2=0.225 MΩ
	Dipole 3: R3=0.228 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 0.01 W/kg to 100 W/kg.

3.2 SENSITIVITY

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

3.3 LOWER DETECTION LIMIT

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

3.4 ISOTROPY

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

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 CEL/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 wave	guide			
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
Incident or forward power	3.00%	Rectangular	√3	1	1.732%
Reflected power	3.00%	Rectangular	$\sqrt{3}$	ī	1.732%
Liquid conductivity	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Liquid permittivity	4.00%	Rectangular	$\sqrt{3}$	1	2.309%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%

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Combined standard uncertainty	9		5.831%
Expanded uncertainty 95 % confidence level k = 2			12.0%

5 CALIBRATION MEASUREMENT RESULTS

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

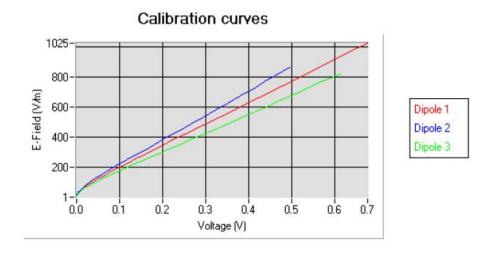
5.1 <u>SENSITIVITY IN AIR</u>

Normx dipole 1 (μV/(V/m) ²)	Normy dipole 2 (μV/(V/m) ²)	Normz dip ole 3 (μV/(V/m) ²)
8.57	4.83	7.15

DCP dipole 1	DCP dipole 2	DCP dipole 3
(mV)	(mV)	(mV)
92	90	95

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

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

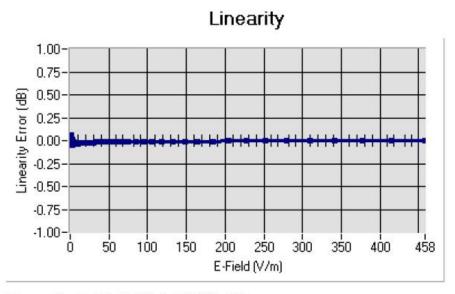


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5.2 LINEARITY



Linearity: I+/-1.55% (+/-0.07dB)

5.3 SENSITIVITY IN LIQUID

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

LOWER DETECTION LIMIT: 7mW/kg

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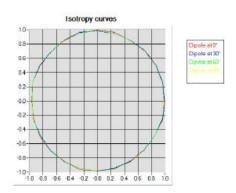
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5.4 ISOTROPY

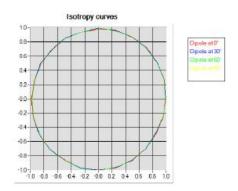
HL900 MHz

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



HL1800 MHz

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



6 LIST OF EQUIPMENT

	Equipment Summary Sheet							
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date				
Flat Phantom	Satimo	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.				
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.				
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2016				
Reference Probe	Satimo	EP 94 SN 37/08	10/2014	10/2015				
Multimeter	Keithley 2000	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.				
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.				
Wa∨eguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated, No cal required.				
Temperature / Humidity Sensor	Control Company	11-661-9	8/2013	8/2016				

SID835 Dipole Calibration Certificate



SAR Reference Dipole Calibration Report

Ref: ACR.240.1.14.SATU.A

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

ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI TOWN

SHENZHEN, P.R. CHINA (POST CODE:518055) SATIMO COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ

SERIAL NO.: SN 09/13 DIP0G835-217

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





08/28/14

Summary

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



	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	8/29/2014	25
Checked by :	Jérôme LUC	Product Manager	8/29/2014	23
Approved by :	Kim RUTKOWSKI	Quality Manager	8/29/2014	Again Phothau Ni

	Customer Name		
Distribution:	CCIC SOUTHERN		
	PRODUCT		
	TESTING		
	(SHENZHEN) Co.,		
	1.1d		

Issue	Date	Modifications
A	8/29/2014	Initial release



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1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test				
Device Type	COMOSAR 835 MHz REFERENCE DIPOLE			
Manufacturer	Satimo			
Model	SID835			
Serial Number	SN 09/13 DIP0G835-217			
Product Condition (new / used)	used			

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

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



Figure 1 - Satimo COMOSAR Validation Dipole



4 MEASUREMENT METHOD

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

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom 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 Los 0.1 dB		
400-6000MHz			

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

5.3 VALIDATION MEASUREMENT

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

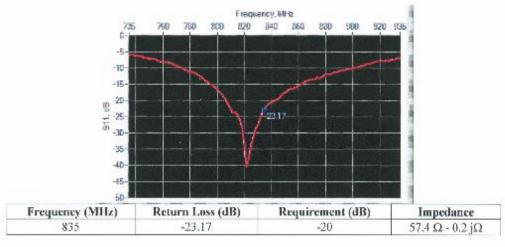
Scan Volume	Expanded Uncertainty
1 g	20.3 %
10 g	20.1 %

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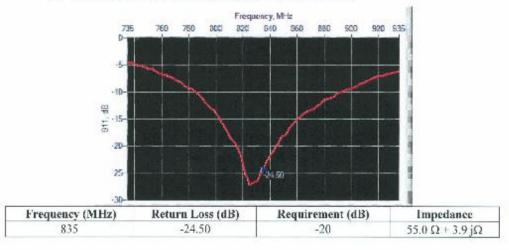


6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



6.3 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h m	h mm		d mm	
	required	measured	required	measured	required	measured	
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %.		
450	290.0 ±1 %.		156.7 ±1 %,		6.35 ±1 %.		
750	176.0 ±1 %.		100.0 ±1 %.		6.35 ±1 %.		
835	161.0 ±1 %.	PASS	89.8 ±1 %.	PASS	3.6 ±1 %.	PASS	

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900	149.0±1%.	83.3 ±1 %.	3.6 ±1 %.
1450	89 1 ±1 %.	\$1.7 ±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 %.	3.5 ±1 %.
1900	68.0 ±1 %.	39.5 ±1 %.	3.6 ±1 %.
1950	66.3 ±1.%.	38.5 ±1 %.	3.5 ±1 %.
2000	64.5 ±1 %.	37.5 ±1 %.	3.5 ±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 %.	3.5 ±1 %.
2600	48.5 ±1 %.	28.8 ±1 %.	3.6 ±1 %.
3000	41.5 ±1.%.	25.0 ±1 %.	3.5 ±1 %.
3500	37.0±1 %.	26.4 ±1 %.	3.5 ±1 %.
3700	34.7±1 %.	26.4 ±1 %.	3.6 ±1 %.

7 VALIDATION MEASUREMENT

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

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (Conductiv	ity (a) S/m
	required	measured	required	measured
3CO	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %		0.89 ±5 %	
835	41.5 ±5 %	PASS	0.90 ±5 %	PASS
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	
1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	

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	T	Francisco I
2100	39.8 ±5 %	1.49 ±5 %
2300	39.5 ±5 % 1.67 ±5 %	
2450	39.2 ±5 %	1,80 ±5 %
2500	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.

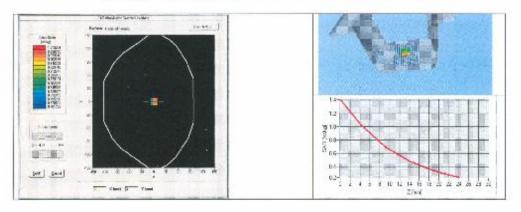
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Prope	SN 18/11 EPG122
Liquid	Head Liquid Values: eps': 42.3 sigma: 0.92
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution dx=8mm/dy=8m/dz=5mm	
Frequency 835 MHz	
Input power	20 dBm
Liquid Temperature	21 °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		5.94		
490	4.58		3.06		
750	8.49		5.55		
835	9.56	9.77 (0.98)	6.22	6.30 (0.63	
900	10.9	0.50	6.99		
1450	29		16		
1500	30.5	30.5			
1640	34.2		18.4		
1750	36.4		19.3		
1800	38.4	38.4 20.1			
1900	39.7		20.5		
1950	40.5		20.9		
2000	41.1		21.1		
2100	43.6	43.6 21.			
2300	48.7		23.3		

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2452		7.4
2450	52.4	24
2600	55.3	24.6
-	55.0	80.0
3000	63.8	25.7
3500	57.1	25



7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (ε, ')	Conductiv	ity (a) 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 %	55.5 ±5 % 0.96				
835	55.2 ±5 %	FASS	0.97 ±5 %	PASS		
900	55.0 ±5 % 1		1.05 ±5 %			
915	55.0 ±5 %		1.06 ±5 %			
1450	54.0 ±5 56		1.30 ±5 %			
1610	53.8 ±5 %		1.40 ±5 %			
1800	53.3 ±5 %		1.52 ±5.%			
1900	53.3 ±5 56		1.52 £5 %			
2000	53.3 ±5.56		1.52 ±5 %			
2100	53,2 ±5 %	53.2 ±5 % 1.62 ±5				
2450	52.7 ±5 %	52.7 ±5 % 1.95 ±				
2600	52.5 ±5 %		2600 52.5 ±5 % 2.16 ±5 5		2.16 ±5 %	
3000	52.0 ±5 %		52.0 ±5 % 2.73 ±5 %			
3500	51.3 ±5 %		3.31 ±5 %			
5200	49.0 ±10 %		5.30 ±10 %			
5300	48.9 ±10 %	48.9 ±10 %				
5400	48.7±10%		5.53 ±10 %			

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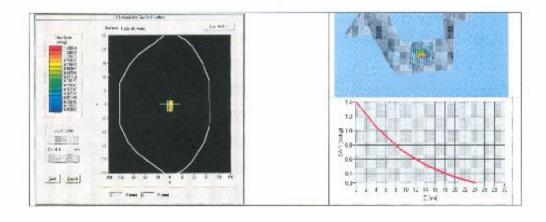


5500	48.5 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2 ±10 %	6.00 ±10 %

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

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

Frequency MHz	1 g 5AR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
835	10.31 (1.03)	6.74 (0.67)





8 LIST OF EQUIPMENT

	Equipment Summary Sheet			
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	Satimo	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2016
Calipers	Carrera	CALIPER-01	12/2013	12/2016
Reference Probe	Satimo	EPG122 SN 18/11	10/2013	10/2014
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2013	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature and Humidity Sensor	Control Company	11-661-9	8/2012	8/2015



SAR Reference Dipole Calibration Report

Ref: ACR.240.4.14.SATU.A

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

ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI TOWN

SHENZHEN, P.R. CHINA (POST CODE:518055) SATIMO COMOSAR REFERENCE DIPOLE

> FREQUENCY: 1900 MHZ SERIAL NO.: SN 09/13 DIP1G900-218

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





08/28/14

Summary:

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



	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	8/29/2014	25
Checked by :	Jérôme LUC	Product Manager	8/29/2014	J35
Approved by :	Kim RUTKOWSKI	Quality Manager	8/29/2014	dien furthmodisi

Distribution : CCIC SOUTHERN ELECTRONIC PRODUCT TESTING		Customer Name		
Distribution : PRODUCT TESTING				
TESTING	Distribution :	PRODUCT		
		TESTING (SHENZHEN) Co.,		

Issue	Date	Modifications
A	8/29/2014	Initial release



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1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test				
Device Type	COMOSAR 1900 MHz REFERENCE DIPOLE			
Manufacturer	Satimo			
Model	SID1900			
Serial Number	SN 09/13 DIP1G900-218			
Product Condition (new / used)	Used			

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

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



Figure 1 - Satimo COMOSAR Validation Dipole



4 MEASUREMENT METHOD

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

4.1 RETURN LOSS REQUIREMENTS

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

4.2 MECHANICAL REQUIREMENTS

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

5 MEASUREMENT UNCERTAINTY

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

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

5.3 VALIDATION MEASUREMENT

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

Scan Volume	Expanded Uncertainty
1 g	20,3 %
10 g	20.1 %

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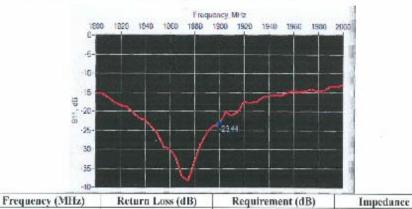
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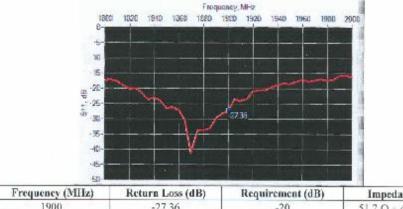
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



1900 -23.44 $55.4 \Omega + 5.2 j\Omega$

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Impedance 1900 -27.36 -20 $51.7 \Omega = 4.4 \text{ j}\Omega$

6.3 MECHANICAL DIMENSIONS

Frequency MHz	Lm	m	h m	m	d r	nm
	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 11 %.	
835	161.0 :1 %.		89.8±1 %.		3.5 ±1 %.	

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900	149.3 ±1 %.		83.3 ±1 %.		3.6 ±1.%.	
1450	89.1 ±1 54.		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 %.	FASS	39.5 ±1 %.	PASS	3.5±1 %,	PAS
1950	66.3 ±1 %.		38.5 ±1 %.		3.5 11 %.	
2000	64.5 ±1 %.		37.5 +1.%.		3.6 ±1 %.	
2100	61.0 11 %.		35.7 11 %.		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 %.		36±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 CEF/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

Prequency MHz	Relative per	mittivity (c,')	Conductiv	ity (a) S/m
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 15 %		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 15 %	
1540	40.2 ±5 %		1 31 ±5 %	
1750	40.1 ±5 %		1.37 15 %	
1900	40.0 ±5 %		1.40 ±5 %	
1900	40.0 15 %	PASS	1,40 ±5 %	PASS
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.015%		1.40 ±5 %	

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2100	39.8 ±5 %	1,49 ±5 %
2300	39.5 ±5 %	1.67 ±5 %
2450	39.2 ±5 %	1.80 ±5 %
2500	39.0 15 %	1.96 ±5 %
300C	38.5 ±5 %	2.40 ±5 %
3500	37.9 15 %	2.51 ±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; eps'; 41,1 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
Lub Humidity	45.%

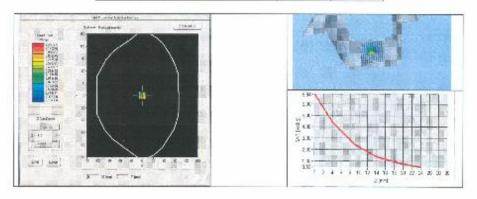
Frequency MHz	1 g SAR	(W/kg/W)	10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.26	
750	8.49		5.55	
835	9.56		5.27	
900	10.9		5.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.2	
1800	38.4		20.1	
1900	39.7	40.37 (4.04)	20.5	20.62 (2.06)
1950	40.5		20.9	
2000	41.1		25.1	
2100	43.6		21.9	
2300	48.7		23.3	

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



7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (r,')		Conductivity (a) S/m	
	required	measured	required	measured
150	\$1.9 ±5 %		0.80 ±5 %	
300	58.2 +5 %		0.92 ±5 %	
450	56.7 15 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 ±5 %		0.97 ±5 %	
900	55.0±5 %		1.05 15 %	
915	55.0 ±5 %		1.06 ±5.%	
1450	54.0 ±5 %		130 t5 %	
1610	53.8 +5 %		1.40 ±5 %	
1800	53.3±5%		1.52.15 %	
1900	53.3 ±5 %	PASS	1.52 ±5 %	PASS
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5.%		1.62±5 %	
2450	52.7±5%		1.95 ±5 %	
2600	52.5 ±5 %		2.16 ± 5 %	
3000	52.0 ±5 %		2.73 = 5 %	
3500	51.3 15 %		3.31 ±5 %	
5200	49.0±10%		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10%		5.53 ±10 %	

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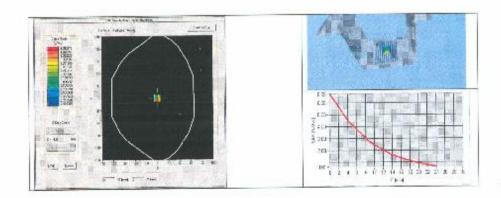
SAR REFERENCE DIPOLE CALIBRATION REPORT

5500	48.5 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2 ±10 %	6.00 110 %

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phanton	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps' : 54.2 sigma : 1.54
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	1900 MHz
looot power	20 dBm
Liquid Temperature	21 °C
Lab Temperaturu	21 °C
Lab Humidity	45 %

Frequency IVHz	1 g SAR (W/kg/W)	10 g 5AR (W/kg/W)
	measured	measured
1900	40.81 (4.08)	21.21 (2.12)



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8 LIST OF EQUIPMENT

OF REAL PROPERTY.	PART OF THE PART O	Man water transport	THE RESERVE OF THE PARTY OF THE	DATE OF THE OWNER, WHEN	
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 ca required.	
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No ca required.	
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2016	
Calipers	Саптега	CALIPER-01	12/2013	12/2016	
Reference Probe	Satimo	EPG122 SN 18/11	10/2013	10/2014	
Multimeter	Keithley 2000	1188656	12/2013	12/2016	
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016	
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required	
Power Meter	HP E4418A	US38261498	12/2013	12/2016	
Power Sensor	HP ECP-E28A	US37181460	12/2013	12/2016	
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required	
Temperature and Humidity Sensor	Control Company	11 661-9	8/2012	8/2015	



SAR Reference Dipole Calibration Report

Ref: ACR.240.6.14.SATU.A

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

ELECTRONIC TESTING BUILDING, SHAHE ROAD, XILI TOWN

SHENZHEN, P.R. CHINA (POST CODE:518055) SATIMO COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ

SERIAL NO.: SN 09/13 DIP2G450-220

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





08/28/14

Summary:

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



	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	8/29/2014	JEST
Checked by :	Jérôme LUC	Product Manager	8/29/2014	235
Approved by :	Kim RUTKOWSKI	Quality Manager	8/29/2014	As in that though

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING		Customer Name
Distribution : PRODUCT TESTING		
Distribution : TESTING		
TESTING	Distribution :	
		(SHENZHEN) Co.,
		Ltd

Issue	Date	Modifications
A	8/29/2014	Initial release



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1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

D	evice Under Test
Device Type	COMOSAR 2450 MHz REFERENCE DIPOLE
Manufacturer	Satimo
Model	SID2450
Serial Number	SN 09/13 DIP2G450-220
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

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



Figure 1 - Satimo COMOSAR Validation Dipole



4 MEASUREMENT METHOD

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

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom 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 Lo		
400-6000MHz	0.1 dB		

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements.

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

5.3 VALIDATION MEASUREMENT

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

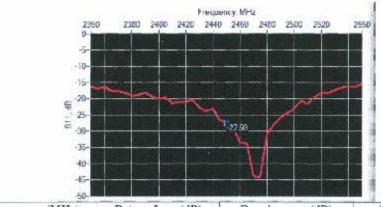
Scan Volume	Expanded Uncertainty
1 g	20.3 %
10 g	20.1 %

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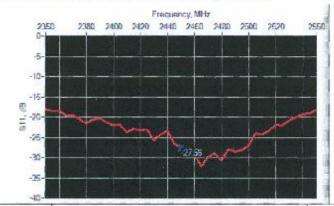
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



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

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



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

6.3 MECHANICAL DIMENSIONS

Frequency MHz	Ln	ım.	hm	h mm		d mm	
	required	measured	required	measured	required	measured	
300	420.0 ±1 %.		250.0 ±1 %.		6.35 11 %.		
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 11 %		3.6 ±1 %.		

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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 1.1 %.	
1800	72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.	
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 :1 %.		35.7 ±1 %.		3.6 ±1 %.	
2300	55.5 ±1 %.		32.5 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.	PASS	30.4±1%.	PAS5	3.6 ±1 %.	PAS
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3,G 11 %.	
3500	37.0±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7±1 %.		26.4 ±1 %.		3.6 11 %.	

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 per	mittivity (s _r ')	Conductiv	ity (a) S/m
	required	measured	required	measured
300	45.3 15 %		0.87 15 %	
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 15 %	
1640	40.2 15 %		1.31 15 %	
1750	40.1 ±5 %		1.37 ±5 %	
1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 15 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	

Page: 7/11



2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67±5%	
2450	39.2 -5 %	PASS	1.80 ±5 %	PASS
2600	39.0 ±5 %		1,96 ±5 %	
3000	38-5 =5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

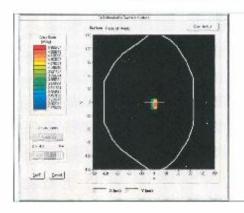
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Prohe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps': 39.0 sigma: 1.77
Distance between dipole center and liquid 10.0 mm	
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	2450 MHz
Input power	20 dBm
Liquid Temperature	21 ℃
Lab Temperature	21 °C
Lab Humidity	45 %

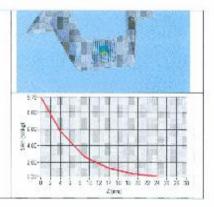
Frequency MHz	1 g SAR (W/kg/W)	10 g SAR	(W/kg/W)
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	

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2450	52.4	53.60 (5.36)	24	23.77 (2.38)
2430	32.4	25.60 (5.30)	24	23.77 [2.30]
2600	55.3		24.6	
3000	53.8		25.7	
3500	57.1		25	





7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (s,')	Conductiv	ity (o) S/m
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 15 %		0.92 15 %	
450	56.7 ±5 %		0.94 15 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 15 %		0.97 15 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5 %		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	
2450	52.7 ±5 %	PASS	1.95 ±5 %	PASS
2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	

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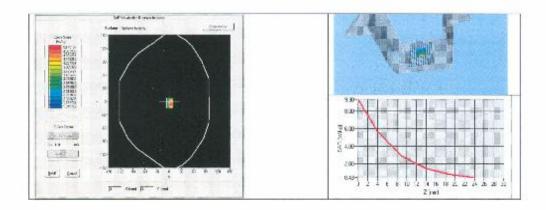


5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2 ±10 %	6.00 ±10 %

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values; eps'; 53.0 sigma: 1.93
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8nun
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 Hamidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
2450	52.66 (5.27)	23.73 (2.37)



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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	10/2013	10/2014	
Mult meter	Keithley 2000	1188656	12/2013	12/2016	
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016	
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Power Meter	HP E4418A	US38261498	12/2013	12/2016	
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016	
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Temperature and Humidity Sensor	Control Company	11-661-9	8/2012	8/2015	

<Justification of the extended calibration>

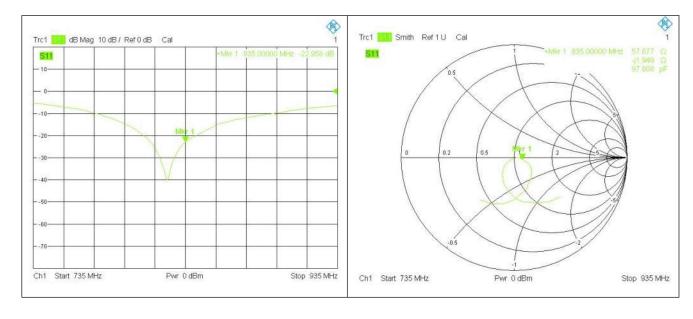
Referring to KDB 865664 D01v01r03, if dipoles are verified in return loss(<-20dB, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

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

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

<Dipole Verification Data>

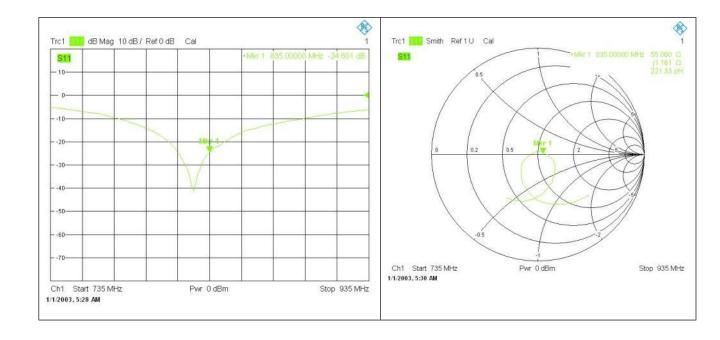
Head 835MHz



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

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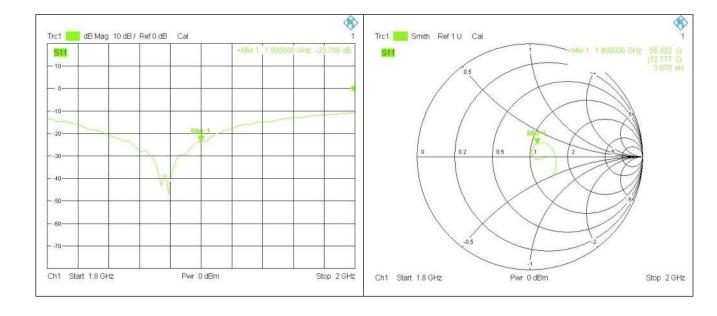
Body 835MHz



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

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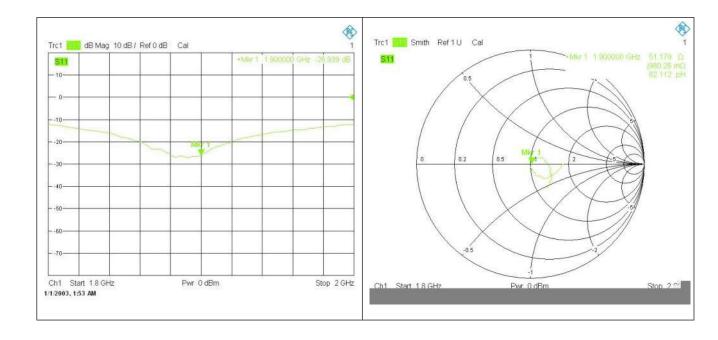
Head 1900MHz



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

<Dipole Verification Data>

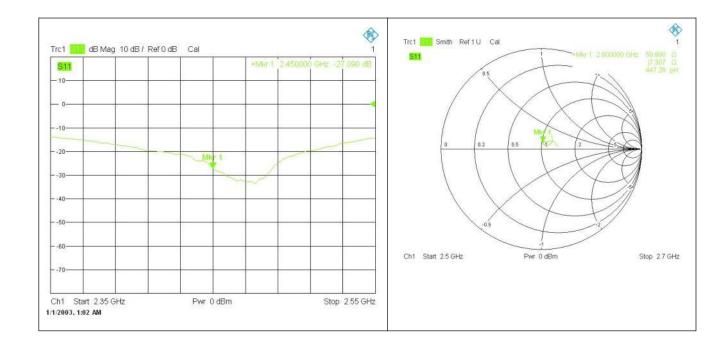
Body 1900MHz



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

<Dipole Verification Data>

Head 2450MHz



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

<Dipole Verification Data>

Body 2450MHz

