

Annex A : Test Instruments

Equipment	Manufacturer	Model Name	Serial No.	Calibration Date	Calibration Period(MM)
REFERENCE TOOL FOR VPS	SATIMO	-	10/14 RT 49	N/A	N/A
KUKA ROBOT VPS	SATIMO	VPS	24/14 VPS 49	N/A	N/A
COMOSAR 450 MHz REFERENCE DIPOLE	SATIMO	SID450	24/14 DIP 0G450-310	June 20, 2014	24
COMOSAR ELLIPTIC PHANTOM	SATIMO	-	24/14 ELLI 35	N/A	N/A
PROBE HOLDER SECURITY	-	-	25/13 SUPR58	N/A	N/A
COMMUNICATION ANTENNA	SATIMO	COMMUNICATION ANTENNA	07/14 ANTA 53	N/A	N/A
COMOSAR IEEE SAM PHANTOM	SATIMO	-	24/14 SAM 113	N/A	N/A
DUMMY PROBE	SATIMO	-	03/14 DP 57	N/A	N/A
MULTIMETER	KEITHLEY	KEITHLEY 2000	4050396	April 21, 2015	12
LIMESAR DIELECTRIC PROBE	SATIMO	SCLMP	24/14 OCPG 65	N/A	N/A
LAPTOP POSITIONNING SYSTEM	SATIMO	-	24/14 LSH 27	N/A	N/A
MOBILE PHONE POSITIONNING SYSTEM	SATIMO	-	24/14 MSH 96	N/A	N/A
COMOSAR DOSIMETRIC E FIELD PROBE	SATIMO	SSE2	27/14 EPG 228	Nov. 25, 2014	12
KUKA ROBOT	KUKA	-	501820	N/A	N/A
KUKA ROBOT CONTROLLER	KUKA	-	23236	N/A	N/A
KUKA ROBOT CONTROLLER PAD	KUKA	-	235891	N/A	N/A
NETWORK ANALYZER	HP	8753D	3410A07297	Sept. 11, 2015	12
RF POWER AMPLIFIER	SUNGSAN	SSA024A	SSEC0003	Dec. 05, 2014	12
EPM SERIES POWER METER	HP	E4418A	GB38272621	Sept. 11, 2015	12
MXG VECTOR SIGNAL GENERATOR	Agilent	N5182A	MY46240037	Sept. 10, 2015	12
DUAL DIRECTIONAL COUPLER	HP	778D	1144A08477	Sept. 10, 2015	12
DUAL DIRECTIONAL COUPLER	HP	772D	2839A00395	Sept. 11, 2015	12
POWER SENSOR	Agilent	E9301A	MY41498589	June 24, 2015	12
POWER SENSOR	Agilent	E9301H	-	Sept. 10, 2015	12
POWER SENSOR	Agilent	8482B	3318A07045	June 24, 2015	12
ATTENUATOR	-	3db	-	Sept. 09, 2015	12
ATTENUATOR	-	3db	-	Sept. 09, 2015	12
ATTENUATOR	-	30db	13051601	Sept. 11, 2015	12
LOW PASS FILTER	MINI-CIRCUITS	VLF-1000	31433	Sept. 09, 2015	12
LOW PASS FILTER	MINI-CIRCUITS	VLF-2600	34129	Sept. 09, 2015	12
LOW PASS FILTER	MINI-CIRCUITS	VLF-6000	31429	Sept. 09, 2015	12
DIGITAL THERMO HYGROMETER	CAS	TE-201	-	Sept. 09, 2015	12
DIGITAL THERMO HYGROMETER	CAS	TE-201	-	Sept. 09, 2015	12
HYGRO-THERMOMETER	ACUBA	-	-	Sept. 09, 2015	12
EPM SERIES POWER METER	HP	E4419B	GB39290581	April 03, 2016	12
BODY / HEAD LIQUID 450	EMF SAFETY/HCT	-	-	-	-

Annex B : Calibration Reports of the Probe(S/N 27/14 EPG228)



COMOSAR E-Field Probe Calibration Report

Ref : ACR.330.2.14.SATU.A

BWS TECH INC.
#611-1, MESAN-RI, MOHYEN-MYEON, CHEOIN-GU,
YONGIN-CITY, GYEONGI-DO, SOUTH KOREA
SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 27/14 EPG228

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



11/25/2014

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.330.2.14.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	11/26/2014	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	11/26/2014	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	11/26/2014	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	BWS Tech Inc.

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	11/26/2014	Initial release

Page: 2/10

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.330.2.14.SATU.A

TABLE OF CONTENTS

1	Device Under Test	4
2	Product Description	4
2.1	General Information	4
3	Measurement Method	4
3.1	Linearity	4
3.2	Sensitivity	5
3.3	Lower Detection Limit	5
3.4	Isotropy	5
3.5	Boundary Effect	5
4	Measurement Uncertainty	5
5	Calibration Measurement Results	6
5.1	Sensitivity in air	6
5.2	Linearity	7
5.3	Sensitivity in liquid	7
5.4	Isotropy	8
6	List of Equipment	10

Page: 3/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.330.2.14.SATU.A

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	Satimo
Model	SSE2
Serial Number	SN 27/14 EPG228
Product Condition (new / used)	New
Frequency Range of Probe	0.15 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.218 MΩ Dipole 2: R2=0.220 MΩ Dipole 3: R3=0.218 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	2 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.5 mm
Distance between dipoles / probe extremity	1 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.

Page: 4/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.330.2.14.SATU.A

3.2 SENSITIVITY

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

3.3 LOWER DETECTION LIMIT

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

3.4 ISOTROPY

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

3.5 BOUNDARY EFFECT

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

4 MEASUREMENT UNCERTAINTY

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

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

Page: 5/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.330.2.14.SATU.A

Combined standard uncertainty					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 %

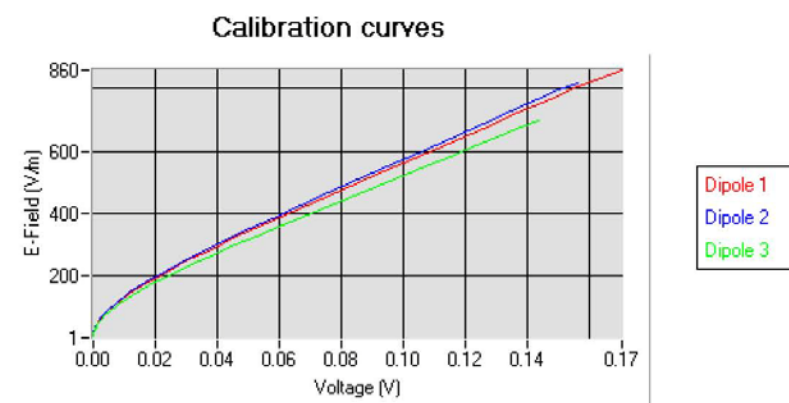
5.1 SENSITIVITY IN AIR

Normx dipole 1 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$)
0.74	0.64	0.56

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

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

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



Page: 6/10

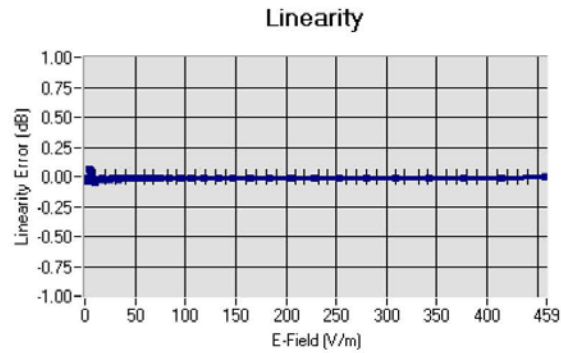
*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.330.2.14.SATU.A

5.2 LINEARITY



Linearity: $\pm 1.29\%$ ($\pm 0.06\text{dB}$)

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz $\pm 100\text{MHz}$)	Permittivity	Epsilon (S/m)	ConvF
HL150	150	54.54	0.73	21.86
BL150	150	59.03	0.82	22.49
HL300	300	45.03	0.84	19.10
BL300	300	60.12	0.92	19.82
HL450	450	43.68	0.87	20.22
BL450	450	58.34	0.99	21.00
HL600	600	41.38	0.89	14.00
BL600	600	56.05	0.95	14.45
HL850	835	42.59	0.90	15.28
BL850	835	53.19	0.97	15.60
HL900	900	42.25	0.97	15.13
BL900	900	56.41	1.08	15.56
HL1800	1800	41.10	1.39	15.67
BL1800	1800	53.00	1.52	16.29
HL1900	1900	40.88	1.43	18.32
BL1900	1900	53.93	1.55	18.93
HL2000	2000	39.52	1.44	17.26
BL2000	2000	53.65	1.54	17.74
HL2450	2450	38.85	1.79	17.34
BL2450	2450	52.70	1.94	17.74
HL5200	5200	36.44	4.79	13.08
BL5200	5200	50.70	5.11	13.51
HL5400	5400	35.99	4.91	14.15
BL5400	5400	50.01	5.64	14.63
HL5600	5600	35.22	5.18	14.50
BL5600	5600	49.34	5.85	14.89
HL5800	5800	34.95	5.42	14.04
BL5800	5800	48.54	6.22	14.39

LOWER DETECTION LIMIT: 9mW/kg

Page: 7/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*



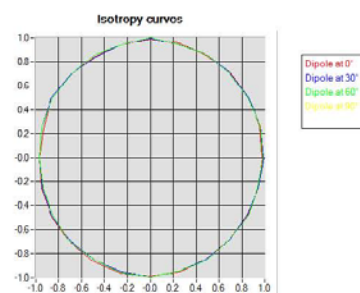
COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.330.2.14.SATU.A

5.4 ISOTROPY

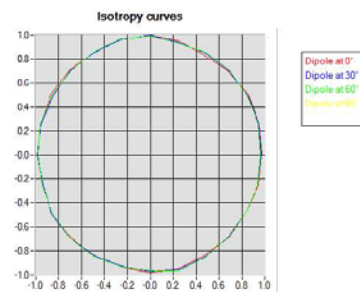
HL900 MHz

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.06 dB



HL1800 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.08 dB



Page: 8/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

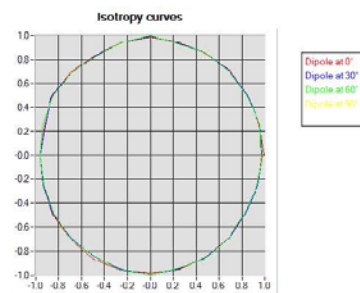


COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.330.2.14.SATU.A

HL5600 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.10 dB



Page: 9/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.330.2.14.SATU.A

6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
Flat Phantom	Satimo	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2016
Reference Probe	Satimo	EP 94 SN 37/08	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.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	11-661-9	8/2012	8/2015

Page: 10/10

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.

Annex C : Calibration Reports of Dipole 450 MHz(S/N:24/14 DIP 0G 450-310)



SAR Reference Dipole Calibration Report

Ref : ACR.183.3.14.SATU.A

BWS TECH INC.

**#611-1, MESAN-RI, MOHYEN-MYEON, CHEOIN-GU,
YONGIN-CITY, GYEONGI-DO, SOUTH KOREA**

SATIMO COMOSAR REFERENCE DIPOLE

FREQUENCY: 450 MHZ

SERIAL NO.: SN 24/14 DIP 0G450-310

Calibrated at SATIMO US

2105 Barrett Park Dr. - Kennesaw, GA 30144



06/20/2014




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.183.3.14.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	7/2/2014	
<i>Checked by :</i>	Jérôme LUC	Product Manager	7/2/2014	
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	7/2/2014	

	<i>Customer Name</i>
<i>Distribution :</i>	BWS Tech Inc.

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	7/2/2014	Initial release

Page: 2/10

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.183.3.14.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	Measurement Condition	7
7.2	Head Liquid Measurement	7
7.3	Measurement Result	8
7.4	Body Measurement Result	9
8	List of Equipment	10

Page: 3/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.183.3.14.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 450 MHz REFERENCE DIPOLE
Manufacturer	Satimo
Model	SID450
Serial Number	SN 24/14 DIP 0G450-310
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

Page: 4/10

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.183.3.14.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: 5/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*

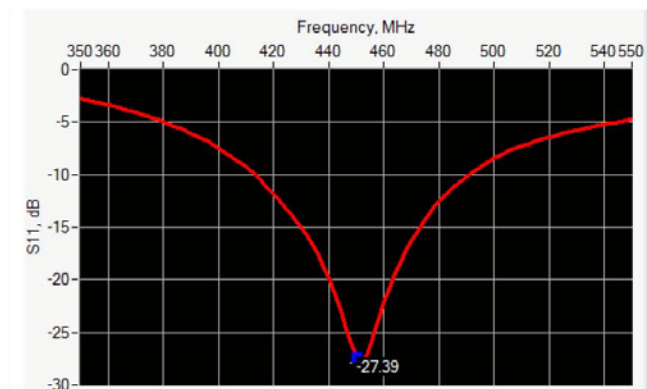


SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.183.3.14.SATU.A

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
450	-27.39	-20	46.0 Ω - 1.4 j Ω

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 %	PASS	166.7 \pm 1 %	PASS	6.35 \pm 1 %	PASS
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 %		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: 6/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.183.3.14.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 MEASUREMENT CONDITION

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: $\epsilon_r' : 43.0$ $\sigma : 0.85$
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	450 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')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 \pm 5 %		0.87 \pm 5 %	
450	43.5 \pm 5 %	PASS	0.87 \pm 5 %	PASS
750	41.9 \pm 5 %		0.89 \pm 5 %	
835	41.5 \pm 5 %		0.90 \pm 5 %	
900	41.5 \pm 5 %		0.97 \pm 5 %	
1450	40.5 \pm 5 %		1.20 \pm 5 %	
1500	40.4 \pm 5 %		1.23 \pm 5 %	
1640	40.2 \pm 5 %		1.31 \pm 5 %	
1750	40.1 \pm 5 %		1.37 \pm 5 %	
1800	40.0 \pm 5 %		1.40 \pm 5 %	
1900	40.0 \pm 5 %		1.40 \pm 5 %	
1950	40.0 \pm 5 %		1.40 \pm 5 %	
2000	40.0 \pm 5 %		1.40 \pm 5 %	
2100	39.8 \pm 5 %		1.49 \pm 5 %	
2300	39.5 \pm 5 %		1.67 \pm 5 %	
2450	39.2 \pm 5 %		1.80 \pm 5 %	
2600	39.0 \pm 5 %		1.96 \pm 5 %	
3000	38.5 \pm 5 %		2.40 \pm 5 %	
3500	37.9 \pm 5 %		2.91 \pm 5 %	

Page: 7/10

*This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.*



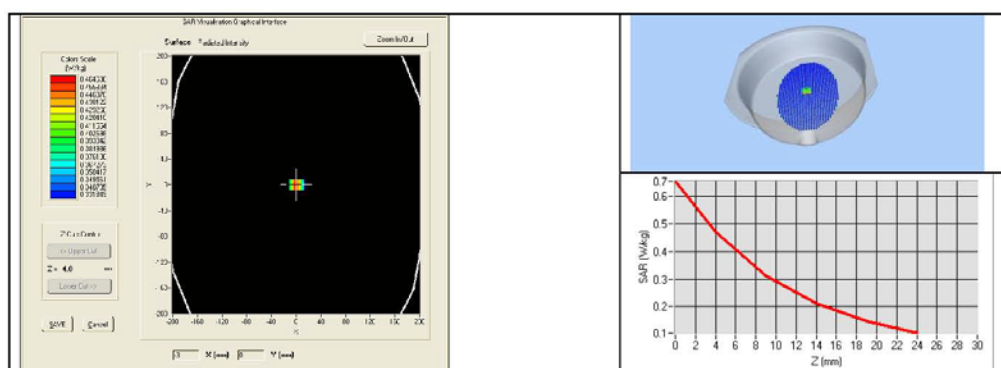
SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.183.3.14.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	4.83 (0.48)	3.06	3.09 (0.31)
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	



Page: 8/10

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.



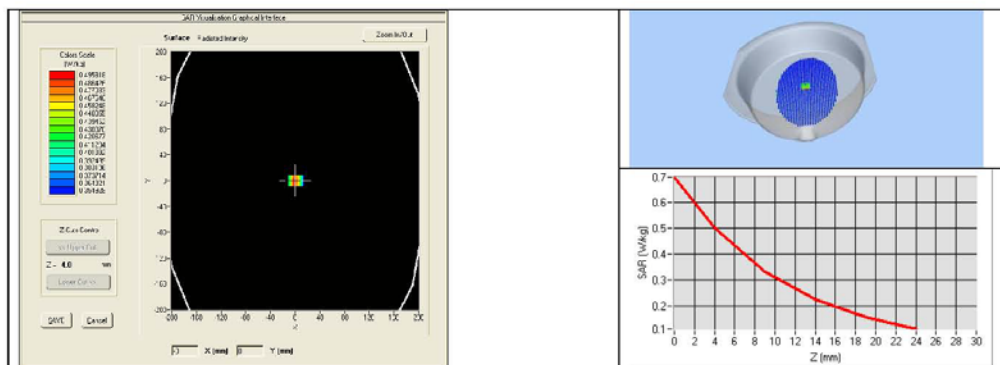
SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.183.3.14.SATU.A

7.4 BODY MEASUREMENT RESULT

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: $\epsilon_p' : 57.5$ $\sigma : 0.96$
Distance between dipole center and liquid	15.0 mm
Area scan resolution	$dx=8mm/dy=8mm$
Zoon Scan Resolution	$dx=8mm/dy=8m/dz=5mm$
Frequency	450 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)
	measured	measured
450	5.05 (0.50)	3.24 (0.32)



Page: 9/10

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.183.3.14.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	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
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

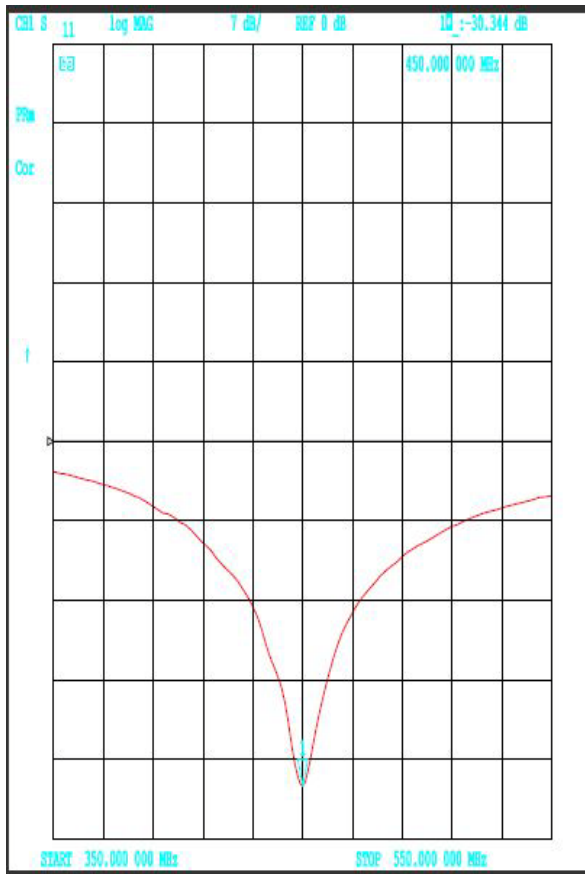
Page: 10/10

This document shall not be reproduced, except in full or in part, without the written approval of SATIMO.
The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of SATIMO.

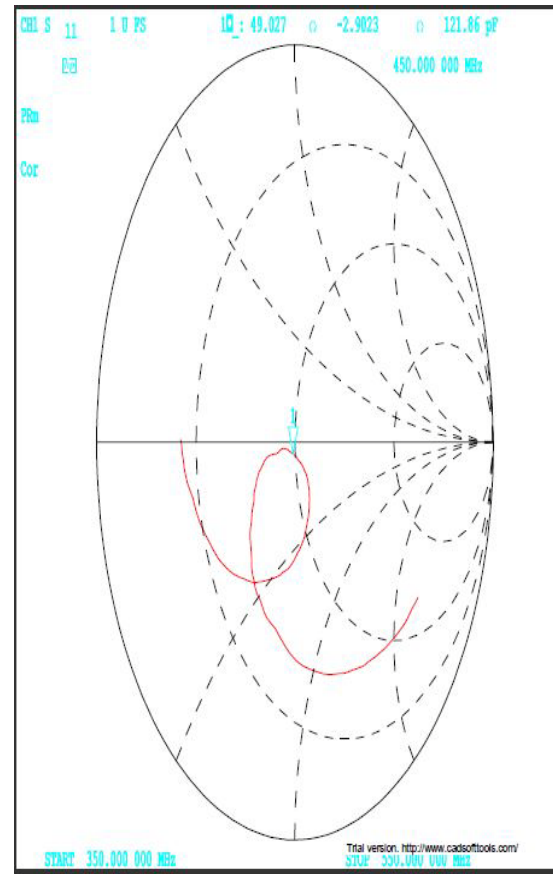
Annex D : DIPOLE EXTENDED MEASUREMENT RESULTS FOR 450MHz

- The return-loss and impedance of Head tissue.

Return-loss: -30.344 dB

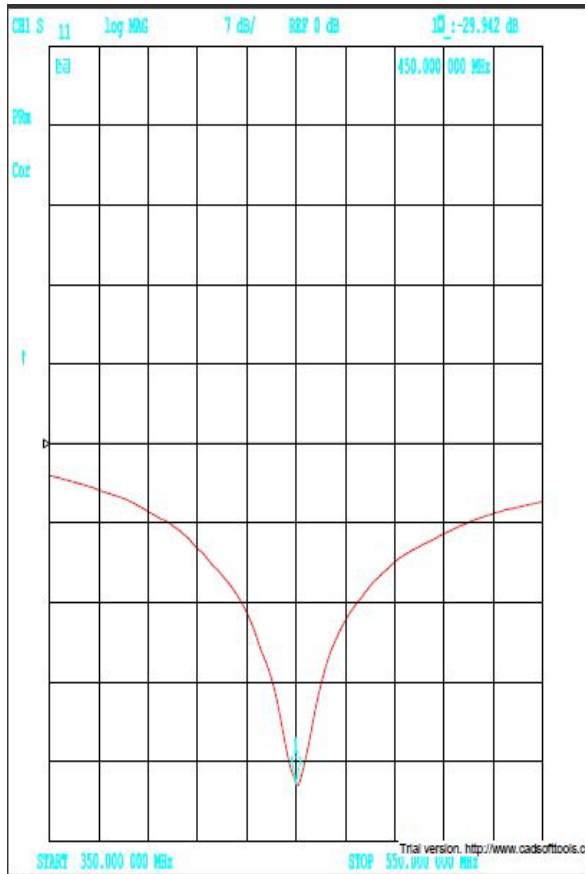


Impedance: 49.0-2.9 jΩ



- The return-loss and impedance of Body tissue.

Return-loss: -29.9 dB



Impedance: 48.27-2.6 jΩ

