

# **CALIBRATION REPORT**

F.1 E-Field Probe



# **COMOSAR E-Field Probe Calibration Report**

Ref: ACR.93.1.17.SATU.A

# SHENZHEN BALUN TECHNOLOGY CO.,LTD. BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD, NANSHAN DISTRICT, SHENZHEN, GUANGDONG

PROVINCE, P.R. CHINA 518055 MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 08/16 EPGO295

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





Calibration Date: 03/22/2017

# Summary:

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







Ref: ACR.93.1.17.SATU.A

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Issue	Date	Modifications	
A	4/3/2017	Initial release	
-			





Ref: ACR.93.1.17.SATU.A

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### 1 DEVICE UNDER TEST

Device Under Test			
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE		
Manufacturer	MVG		
Model	SSE2		
Serial Number	SN 08/16 EPGO295		
Product Condition (new / used)	New		
Frequency Range of Probe	0.3 GHz-6GHz		
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.212 MΩ		
Annual Control of the Control of	Dipole 2: R2=0.190 MΩ		
	Dipole 3: R3=0.189 MΩ		

A yearly calibration interval is recommended.

### 2 PRODUCT DESCRIPTION

### 2.1 GENERAL INFORMATION

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



Figure 1 – MVG 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.

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### 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  $15^{\circ}$  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 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	1	2.309%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	î	2.887%

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Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1,732%
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 %			

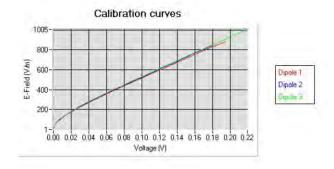
# 5.1 SENSITIVITY IN AIR

	Normy dipole		
$1 (\mu V/(V/m)^2)$	$2 (\mu V/(V/m)^2)$	$3 (\mu V/(V/m)^2)$	
0.78	0.69	0.96	

DCP dipole 1	DCP dipole 2	DCP dipole 3
(mV)	(mV)	(mV)
95	90	91

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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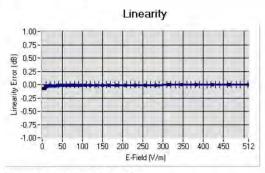
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# 5.2 LINEARITY



Linearity:[I+/-1.68% (+/-0.07dB)

# 5.3 SENSITIVITY IN LIQUID

Liquid	(MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL450	450	42.17	0.86	1.73
BL450	450	57.65	0.95	1.81
HL750	750	40.03	0.93	1.52
BL750	750	56.83	1.00	1.56
HL850	.835	42.19	0.90	1.78
BL850	835	54.67	1.01	1.85
HL900	900	42.08	1.01	1.62
BL900	900	55.25	1.08	1.68
HL1800	1800	41.68	1.46	1.88
BL1800	1800	53.86	1.46	1.94
HL1900	1900	38.45	1.45	2.19
BL1900	1900	53.32	1.56	2.24
HL2000	2000	38.26	1.38	1.97
BL2000	2000	52.70	1.51	2.03
HL2450	2450	37.50	1.80	2.21
BL2450	2450	53.22	1.89	2.30
HL2600	2600	39.80	1.99	2.20
BL2600	2600	52.52	2.23	2.27
HL5200	5200	35.64	4.67	1.32
BL5200	5200	48.64	5.51	1.36
HL5400	5400	36.44	4.87	1.88
BL5400	5400	46.52	5,77	1.92
HL5600	5600	36.66	5.17	1.94
BL5600	5600	46.79	5.77	2.00
HL5800	5800	35.31	5.31	1.76
BL5800	5800	47.04	6.10	1.82

LOWER DETECTION LIMIT: 9mW/kg

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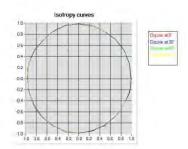


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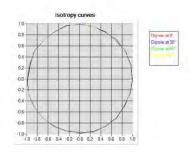
# 5.4 ISOTROPY

# HL900 MHz

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



HL1800 MHz
- Axial isotropy:
- Hemispherical isotropy:  $0.04~\mathrm{dB}$  $0.08~\mathrm{dB}$ 



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# Report No.: BL-SZ1760430-701

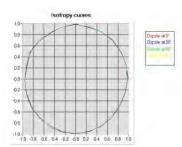


COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.93.1.17.SATU.A

# HL5600 MHz

- Axial isotropy: 0.06 dB - Hemispherical isotropy: 0.11 dB







Ref: ACR.93.1.17.SATU.A

# 6 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
Flat Phantom	MVG	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	02/2016	02/2019
Reference Probe	MVG	EP 94 SN 37/08	10/2016	10/2017
Multimeter	Keithley 2000	1188656	01/2017	01/2020
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	01/2017	01/2020
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020
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	150798832	10/2015	10/2017





# SAR Reference Dipole Calibration Report

Ref: ACR 75.7.15.SATU.A

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NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 750 MHZ

SERIAL NO.: SN 25/13 DIP 0G750-253

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





03/16/2015

Summers:

This document presents the method and results from an accredited SAR reference dipole cultivation performed in MVG USA using the COMOSAR test bench. All cultivation results are traceable to restional methology institutions.



# Report No.: BL-SZ1760430-701



# SAR REFERENCE DIPOLE CALIBRATION REPORT

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Insue	Dute	Modifications:
A	3/16/2015	Initial release

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Ref: AUR. 75.7.15.5A1T. A.

# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs 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

De	evice Under Test
Device Type	COMOSAR 750 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID750
Serial Number	SN 25/13 DIP 0G750-253
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

# 3 PRODUCT DESCRIPTION

# 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 - MVG COMOSAR Validation Dipole

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### 4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs 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 fiquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards.

### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEDIEC 62209 standards specify the mechanical components and dimensions of the validation dipotes, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipotes 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 Upcertainty.

# 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement

Frequency hand	Expanded Uncertainty on Return Loss			
400-6000MHz	D.I 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, FCC KDBs, CENELEC EN50361 and CEDIEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty		
1 g	20.3 %		

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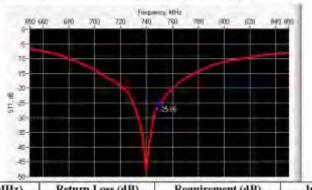


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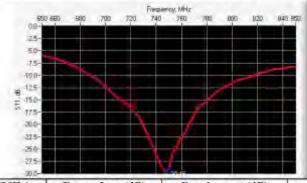
# 6 CALIBRATION MEASUREMENT RESULTS

# 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance | 750 | -25.86 | -20 | 54.5 Ω - 2.7 jΩ

# 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-29.45	-20	52.6 Ω + 2.3 jΩ

# 6.3 MECHANICAL DIMENSIONS

Frequency MH2	Lmm		h mm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1%		6.35 ±1 %.	

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450	290.0 ±1 %		166.7 ±1 %.		5.35±1°N	
750	175.0 ±1 %	PASS	100,0 ±1 %	PASS	6.35 ±1%	PASS
835	161.0 ±1 %.		89.8±1%		3.6:1%	
900	1.49.6 ±1 %.		83.3 : 1.%		26:1%	
1450	89.1 ±1 %		51.7 t1 %		3.6:11%	
1500	80.5±1%		50.0±1%		3.621	
1640	79.0±1%.		45.7 ±1 %		16#IM	
1750	75.2 ±1 %.		42,9 ±2 %		3,6 21%	
1800	72.0±1%		417:1%		36:1%	
1900	68.0±1%.		39,5 ±1 %		3,6±1%	
1950	663±1%		38.5 ±1 %		3.6 ±1%	
2000	64.5 £1%		37.5 tl %		3.6 :1	
2100	61.0±1.W.		36.7±1 %		3.6±1 W.	
2300	55.5 ±1 W.		32.6 11.%		16:1%	
2450	51.5 ±1 W.		30,4 23 14		3,6:1%	
2600	485±1%		288:1%		36:1%	
3000	41.5±1%		25,0±1%		3,6:1%	
3500	37.0±1 H.		26.4±13/		3.6 ±1 %	
3700	34.7±1 %.		26.4 #1 %		3.6 ±1 %	

# 7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDEs 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	Relative per	Relative permittivity (s.')		lty (a) 5/m
	required	measured	required	measured
300	45.3.45 %		0.87 ±5%	
450	43.5 ±5 %		0.87 #5%	
750	41.9 25 %	PASS	0,89 ±5 1/4	PASS
R35	41.5 ±5.54		0.90 ±5 %	
900	V1,5 ±5 %		0.97 15 %	
1450	40,5 45 11		1.20±5 M	
1500	40.9 45 %		1.23.15%	
1540	40.2±5%		1,31.15%	
1750	40/1:45%		1.37 ±5 %	

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1800	40.0±5%	1.40 ±5%
3900	40.0 ±5 %	1,40 ±5 %
1950	40.0 45 %	1,40 ±5 Wi
2000	40.0 ±5 %	1.4015%
2100	39,8 ±5 %	1.49 15 %
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	47.9 45 %	2.91, e5 W

# 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	OFENSAR V4	
Phantam	SN 20/09 SAM7T	
Probe	SN 18/11 EPG122	
Liquid	Head Liquid Values, gps . 41.8 sigma : 0.00	
Distance between dipole center and liquid	15.0 mm	
Anai son resolution	ds=Kmm 'dy=Kmm	
Zoon Stan Resolution	dx Smm/dy Sm/dz 5mm	
Frequency	750 MHz	
Input power	20 @m	
Liquid Temperature	21 °C	
Lab Temperature	11 C	
Lab Buriday	45 %	

Frequency	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.54	-
450	4.58		3.06	
750	8,49	8.60 (0.86)	5.55	9.65 (0.96)
105	9,56		6.22	
900	10,9		6.99	
3450	29		16	
1500	30,5		16.8	
164D	34.2		18.4	
2750	36.4		19.3	
3.800	38,4		20.1	

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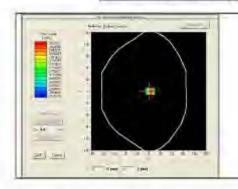
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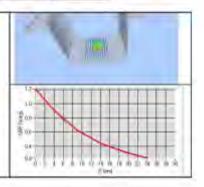




Ref: ACR. 75.7.15.SA(11). A.

1900	39.7	20.5
1900	-39.7	27.3
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





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (c.')	Conductiv	ity (a) S/m
	required	measured	required	measured
150	61.9 ±5.56		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %	PASS	0.96 ±5 %	PASS
835	55.2.±5 %		0.97±5%	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54,0±5%		1.30 ±5 %	-
1610	53.8 £5 %		1.40 ±5 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5 %		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	

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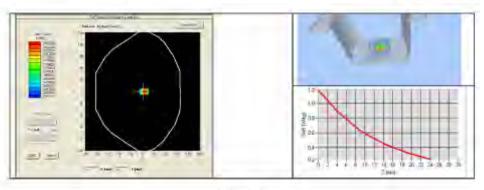
Ref: ACR.75.1 ES.SACO.A.

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±10.5V	5.51±10%
5500	48.6 ±10 %	5,65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2±10%	6.00±30%

# 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4	
Phantom	SN 20/09 SAM71	
Probe	SN 18/31 EPG322	
Laquid	Body Liquid Values, eps. 56.3 samma: 0.98	
Distance between dipole center and liquid	15.0 mm	
Area scan resolution	dx=8mm/dy=8mm	
Zoon Soan Resolution	dx=8mm/dy=8m/dz=5mm	
Frequency	750 MHz	
Input power	20 dBm	
Liquid Temperature	21 °C	
Lab Temperature:	21 °C	
Lab Humidity	45%	

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
750	8.91 (0.89)	5.91 (0.59)



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DREATH TELEVISION A

# 8 LIST OF EQUIPMENT

	Equ	pment Summary 3	sheet	
Equipment Description	Manufacturer/ Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	SN 20/09-SAM71	Validated No cal required.	Validated. No ca required.
COMOSAR Test Bench	Version 3	NA	Validated, No call required	Validated No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2018
Calipers	Carrera	CALIPER-01	12/2013	12/2016
Reference Probe	MVG	EPG122 SN 18/11	10/2014	10/2015
Mutimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aetheronmm	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	US37181480	12/2013	12/2016
Directional Couples	Marda 4216-20	Q1388	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.75.8.15.SATU.A.

# SHENZHEN BALUN TECHNOLOGY CO.,LTD.

BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,

NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ

SERIAL NO.: SN 25/13 DIP 0G835-246

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



03/16/2015

# Summary:

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







REC ACR. 75.8,15.8A(1) A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	3/16/2015	Je
Checked by :	Jérôme LUC	Product Manager	3/16/2015	JS
Approved by:	Kim RUTKOWSKI	Quality Manager	3/16/2015	Aim mother of

	Customer Name	
	SHENZHEN	
Provident on .	BALUN	
Distribution:	TECHNOLOGY	
	Co.,Ltd.	

Institut	Date	Modifications
A	3/16/2015	Initial release





REC ACR. 75.8.15.SA(T) A

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Ref: ACR. 75.8.15.SATU A:

# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs 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 835 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID835
Serial Number	SN 25/13 DIP 0G835-246
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

# 3 PRODUCT DESCRIPTION

# 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 - MVG COMOSAR Validation Dipole

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Ref AIDL75.8.15.SATU A

### 4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs 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, FCC KDBs, CENELEC EN50361 and CELIEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

# Page: 5/11

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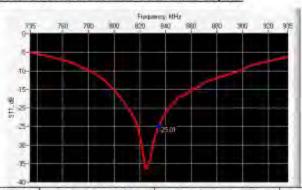


Ref: AUR. 75.8.15. SATU. A.

10 g	20.1 %
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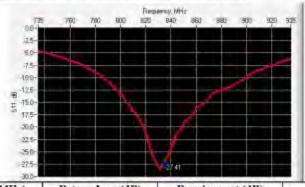
# 6 CALIBRATION MEASUREMENT RESULTS

# 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance | 835 | -25.01 | -20 | 55.9 Ω + 0.9 jΩ

# 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-27.41	-20	52.1 Ω + 3.8 iΩ

# 6.3 MECHANICAL DIMENSIONS

Frequency MH2	Lin	nm	hm	im	d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1%		6.35 ±1 %.	

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450	290.0 ±1 %		166.7±1%.		5.35±1%	
750	175.0 ±1 %		100,0±1 %		6.35 :1%	
835	161/0±1 %.	PASS	89.8 ±1 %	PASS	3.6±1%	PASS
900	IA9.0 ±1.56		83.3 :1.1%		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 ±2 %		3,6 ±1%	
1800	72.0±1%		417:1%		3.6 ±1%	
1900	68.0±1%		39,5 ±1 %		3,6±1%	
1950	66.3±1%		38.5 ±1.34		3.6±1%	
2000	64.5 £1 %		37.5 t3 %		3.6±1	
2100	61.0±1.W.		35.7 ±3 %		3.6±1 ₩	
2300	55.5 ±1 W.		32.6 11.%		16:1%	
2450	51.5±1%.		30,4 23 14		3,6 21 %	
2600	485±1%		288±1%		3.6 = 1 %	
3000	41.5±1%		25,0 ±1 %		3,6 ±1%	
3500	37.0±1 H.		26.4±13/		3.6 ±1 %	
3700	34.7±1 %.		26:4:1%		3.6 +1 %	

# 7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs 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	Relative per	mittivity (s.')	Conductiv	lty (a) 5/m
	required	measured	required	measured
300	45.3.45 %		0.87 ±5 %	
450	43.5 ±5 %		0.8715%	
750	41.9 ±5 %		0,89 ±5 %	
735	41.5.±5.56	PASS.	0.90±5%	PASS.
9000	V1,5 ±5 %		0.9715%	
1450	40,5 45 11		1.20 ±5 %	
1500	40.9 e5 %		1.23-15%	
1640	40.2.25%		1,31 ±5%	
1750	40.1 455		1.37 ±5 %	

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1800	40.045%	1.40 ±5 %
3900	40.0°±5 %	1,40 ±5 %
1950	40.0 45 %	1,40 ±5 %
2000	40.0 ±5 %	1.40.15%
2100	39,8 ±5 %	1.49 15 %
2300	39.5 ±5 %	1.67 15 %
2450	39.2 ±5 %	1,80±5%
2500	39.0 ±5 %	1.66±5%
3000	38,5 £5 %	2.40±5%
3500	37.9 ±5 %	2.91.45 W

# 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
Phantam	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values, eps. 42.1 sigma: 0.92
Distance between dipole center and liquid	15.0 mm
Area scan resolution	ds-Smm dy-Smm
Zoon Soan Resolution	dx 8mm/dy 8m/dz 5mm
Frequency	835 MHz
Input power	20 @m
Liquid Temperature	21 °C
Lab Temperature	10°C
Lab Buriday	45 %

Frequency	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	
135	9.56	9.81 (0.98)	6.22	6.34 (0.63)
900	10,9		6.99	
1450	29		16	
1500	30,5		16.8	
164D	34.2		18.4	
1750	36.4		19.3	
1800	38,4		20.0	

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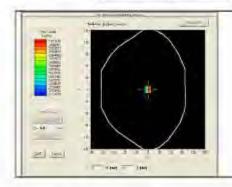
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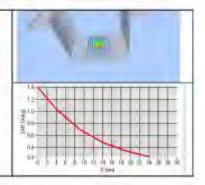




Ref: ACR. 75.8.15.SATU A.

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





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (c.')	Conductiv	ity (a) \$/m
	required	measured	required	measured
150	61.9 ±5.56		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5%	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5%	
835	55.2.±5 %	PASS	0.97±5%	PASS.
900	55.0 ±5 %		1.05 ±5 %	
915	55,0 ±5 %		1.06 ±5%	
1450	54.0 ±5.56		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5%		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	

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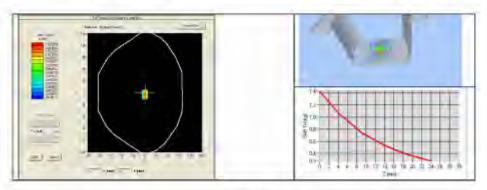
Ref: ACR-75.8.(5.SA)(U.A)

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%	5.51±10%
5500	48.6±10%	:5.65±10%
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2±10%	6.00±10%

# 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps 53.8 sagma: 0.98
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 Hemidity	43 %.
and advantaged,	1

Frequency	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
835	10.53 (1.05)	6.89 (0.69)



Page: 10/11

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REC ACR. 75 8.15 SATU A:

# 8 LIST OF EQUIPMENT

Equipment Summary Sheet					
Equipment Description	Manufacturer/ Model	Identification No.	Current Calibration Date	Next Calibration Date	
SAM Phantom	MVG	SN-20/09-SAM71	Validated No cal required.	Validated. No ca required.	
COMOSAR Test Bench	Version 3	NA	Validated, No-cal required	Validated No cal required	
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2018	
Calipers	Carrera	CALIPER-01	12/2013	12/2016	
Reference Probe	MVG	EPG122 SN 18/11	10/2014	10/2015	
Mutimeter	Keithley 2000	1188656	12/2013	12/2016	
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016	
Amplifier	Aetherdomm	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	01986	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.75.10.15.SATU.A

# SHENZHEN BALUN TECHNOLOGY CO.,LTD.

BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,

NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1800 MHZ

SERIAL NO.: SN 25/13 DIP 1G800-248

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





03/16/2015

Summary:

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



# Report No.: BL-SZ1760430-701



# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.75.10.15.SATU.A

	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	3/16/2015	Jes
Checked by :	Jérôme LUC	Product Manager	3/16/2015	JES
Approved by :	Kim RUTKOWSKI	Quality Manager	3/16/2015	non Pathons 187

	Customer Name
	SHENZHEN
Distribution :	BALUN
	TECHNOLOGY
	Co.,Ltd.

Issue	Date	Modifications
A	3/16/2015	Initial release





Ref: ACR.75.10.15.SATU.A

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Ref: ACR.75.10.15.SATU.A

# 1 INTRODUCTION

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

# 2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR 1800 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID1800
Serial Number	SN 25/13 DIP 1G800-248
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

# 3 PRODUCT DESCRIPTION

# 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 – MVG COMOSAR Validation Dipole

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Ref: ACR.75.10.15.SATU.A

#### 4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs 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 <u>RETURN LOSS REQUIREMENTS</u>

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, FCC KDBs, 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 %

Page: 5/11



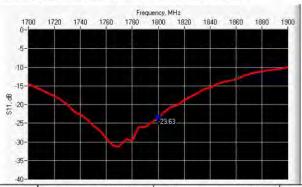


Ref: ACR.75.10.15.SATU.A

10 -	20.1.0/
10 2	20.1 %

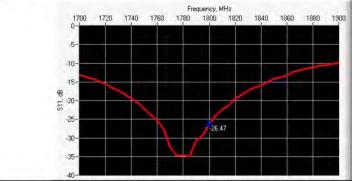
#### 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz) Return Loss (dB) Requirement (dB) Impedance 1800 -23.63 -20  $45.1 \Omega + 4.0 \text{ j}\Omega$ 

#### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1800	-26.47	-20	45.5 Ω - 0.3 iΩ

#### 6.3 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h m	nm	d r	nm
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %.	

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Ref: ACR.75.10.15.SATU.A

450	290.0 ±1 %.		166,7 ±1 %,		6,35 ±1 %.	
750	176.0 ±1 %.		100.0 ±1 %.		6.35 ±1 %.	
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0 ±1 %.		83.3 ±1 %,		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
1800	72.0 ±1 %.	PASS	41.7 ±1 %.	PASS	3.6 ±1 %.	PASS
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	-
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.	
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.	

#### 7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs 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 (s <sub>r</sub> ')		Conductivity (a) S/r	
	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 %	7
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 %	

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Ref: ACR.75.10.15.SATU.A

1800	40.0 ±5 %	PASS	1,40 ±5 %	PASS
1900	40.0 ±5 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	-
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2,40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps': 41.1 sigma: 1.39
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	1800 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9,56		6.22	
900	10,9		6.99	
1450	29		16	
1500	30,5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38,4	38.72 (3.87)	20.1	20.37 (2.04

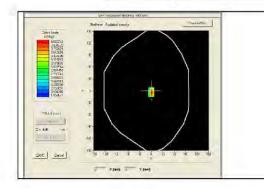
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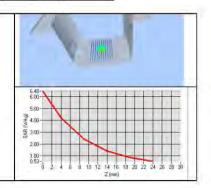




Ref: ACR.75.10.15.SATU.A

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





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity $(\epsilon_r')$		Conductivity (σ) S/m	
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %	PASS	1.52 ±5 %	PASS
1900	53.3 ±5 %		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	

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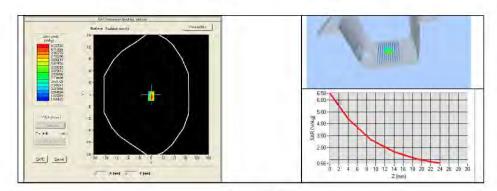
Ref: ACR.75.10.15.SATU.A

2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5 %	3.31 ±5 %
5200	49.0 ±10 %	5.30 ±10 %
5300	48.9 ±10 %	5.42 ±10 %
5400	48.7 ±10 %	5.53 ±10 %
5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2 ±10 %	6.00 ±10 %

# 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps': 53.0 sigma: 1.52
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	1800 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
1800	40.42 (4.04)	21.53 (2.15)



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Ref: ACR.75.10.15.SATU.A

## 8 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date	
SAM Phantom	MVG	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	Carrera	CALIPER-01	12/2013	12/2016	
Reference Probe	MVG	EPG122 SN 18/11	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.	
Temperature and Humidity Sensor	Control Company	11-661-9	8/2012	8/2015	





# **SAR Reference Dipole Calibration Report**

Ref: ACR.75.11.15.SATU.A

# SHENZHEN BALUN TECHNOLOGY CO.,LTD.

BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,

NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1900 MHZ

SERIAL NO.: SN 25/13 DIP 1G900-249

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





03/16/2015

Summary:

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







Ref: ACR.75.11.15.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	3/16/2015	Jes
Checked by :	Jérôme LUC	Product Manager	3/16/2015	Jes
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	TECHNOLOGY
	Co.,Ltd.

Issue	Date	Modifications
A	3/16/2015	Initial release





Ref: ACR.75.11.15.SATU.A

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#### 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs 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	MVG	
Model	SID1900	
Serial Number	SN 25/13 DIP 1G900-249	
Product Condition (new / used)	Used	

A yearly calibration interval is recommended.

#### 3 PRODUCT DESCRIPTION

# 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 – MVG COMOSAR Validation Dipole

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#### 4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs 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		
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, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Expanded Uncertainty
20.3 %

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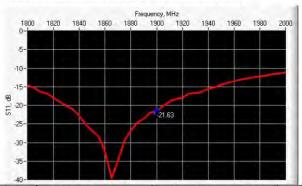


Ref: ACR.75.11.15.SATU.A

10 σ	20.1 %
10 8	20.1

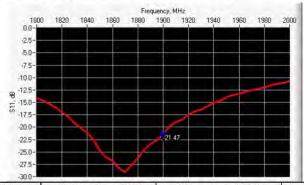
## 6 CALIBRATION MEASUREMENT RESULTS

#### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)Return Loss (dB)Requirement (dB)Impedance1900-21.63-20 $53.9 \Omega + 7.7 j\Omega$ 

#### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-21.47	-20	$48.9 \Omega + 8.4 j\Omega$

## 6.3 MECHANICAL DIMENSIONS

Frequency MHz L mr		nm	h mm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %.	

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Ref: ACR.75.11.15.SATU.A

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 %.	1 0
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 %,	

#### 7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs 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 (ε,')	Conductiv	ity (σ) 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 %	1	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 %	

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Ref: ACR.75.11.15.SATU.A

1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %	PASS	1.40 ±5 %	PASS
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1,40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1,96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

Software	OPENSAR V4		
Phantom	SN 20/09 SAM71		
Probe	SN 18/11 EPG122		
Liquid	Head Liquid Values: eps': 40.9 sigma: 1.43		
Distance between dipole center and liquid	10.0 mm		
Area scan resolution	dx=8mm/dy=8mm		
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm		
Frequency	1900 MHz		
Input power	20 dBm		
Liquid Temperature	21 °C		
Lab Temperature	21 °C		
Lab Humidity	45 %		

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	1	16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	

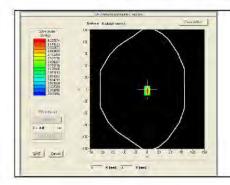
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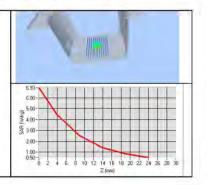




Ref: ACR.75.11.15.SATU.A

1900	39.7	40.75 (4.08)	20.5	20.82 (2.08)
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	





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (ε,′)	Conductiv	ity (σ) S/m
	required	measured	required	measured
150	61,9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %		1.30 ±5 %	
1610	53.8 ±5 %		1.40 ±5 %	
1800	53.3 ±5 %		1,52 ±5 %	
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 %	

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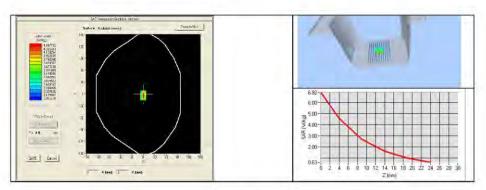
Ref: ACR.75.11.15.SATU.A

2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5 %	3.31 ±5 %
5200	49.0 ±10 %	5.30 ±10 %
5300	48.9 ±10 %	5.42 ±10 %
5400	48.7 ±10 %	5.53 ±10 %
5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5,77 ±10 %
5800	48.2 ±10 %	6.00 ±10 %

# 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

SN 20/09 SAM71 SN 18/11 EPG122
GNI 19/11 EDG100
DIN 16/11 EFG122
Body Liquid Values: eps': 53.9 sigma: 1.55
10.0 mm
dx=8mm/dy=8mm
dx=8mm/dy=8m/dz=5mm
1900 MHz
20 dBm
21 °C
21 °C
45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
1900	42.06 (4.21)	21.87 (2.19)



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Ref: ACR.75.11.15.SATU.A

## 8 LIST OF EQUIPMENT

Equipment	Manufacturer /	Identification No.	Current	Next Calibration
Description	Model		Calibration Date	Date
SAM Phantom	MVG	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	Carrera	CALIPER-01	12/2013	12/2016
Reference Probe	MVG	EPG122 SN 18/11	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.
Temperature and Humidity Sensor	Control Company	11-661-9	8/2012	8/2015





# **SAR Reference Dipole Calibration Report**

Ref: ACR.75.13.15,SATU.A

# SHENZHEN BALUN TECHNOLOGY CO.,LTD.

BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,

NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ

SERIAL NO.: SN 25/13 DIP 2G450-251

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





03/16/2015

### Summary:

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







Ref: ACR.75.13.15.SATU A

	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	3/16/2015	25
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Approved by:	Kim RUTKOWSKI	Quality Manager	3/16/2015	them that homes hi

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Co.,Ltd.

Issue	Date	Modifications
A	3/16/2015	Initial release





Ref: ACR.75.13.15.SATU.A

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#### 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs 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	MVG
Model	SID2450
Serial Number	SN 25/13 DIP 2G450-251
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

# 3 PRODUCT DESCRIPTION

# 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 – MVG COMOSAR Validation Dipole

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#### 4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs 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, FCC KDBs, 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 %

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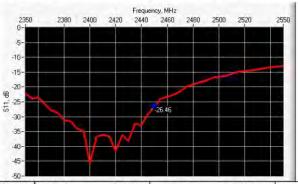


Ref: ACR.75.13.15.SATU.A

10 ~	20.1 %
10 g	20.1 70

# 6 CALIBRATION MEASUREMENT RESULTS

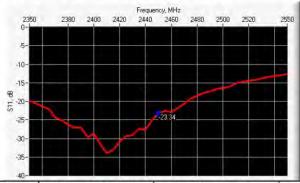
# 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



 Frequency (MHz)
 Return Loss (dB)
 Requirement (dB)
 Impedance

 2450
 -26.46
 -20
 49.3 Ω - 4.7 jΩ

## 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-23.34	-20	53.4 Ω - 6.2 iΩ

# 6.3 MECHANICAL DIMENSIONS

Frequency MHz	Ln	nm	,h m	m	d r	nm
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %	

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450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.		100.0 ±1 %		6.35±1 %	
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
1800	72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.	-
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.	PASS	30.4 ±1 %.	PASS	3.6 ±1 %.	PASS
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.	

#### 7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs 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 (s <sub>r</sub> ')		Conductivity (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 %		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	1.37 ±5 %	

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	1.40 ±5 %		40.0 ±5 %	1800
	1.40 ±5 %		40.0 ±5 %	1900
	1.40 ±5 %		40.0 ±5 %	1950
	1.40 ±5 %		40.0 ±5 %	2000
	1.49 ±5 %		39.8 ±5 %	2100
	1.67 ±5 %		39.5 ±5 %	2300
PASS	1.80 ±5 %	PASS	39.2 ±5 %	2450
	1.96 ±5 %		39.0 ±5 %	2600
	2.40 ±5 %		38.5 ±5 %	3000
	2.91 ±5 %		37.9 ±5 %	3500

## 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': 38.9 sigma: 1.79	
Distance between dipole center and liquid	10.0 mm	
Area scan resolution	dx=8mm/dy=8mm	
Zoon Scan Resolution	dx=5mm/dy=5m/dz=5mm	
Frequency	2450 MHz	
Input power	20 dBm	
Liquid Temperature	21 °C	
Lab Temperature	21 °C	
Lab Humidity	45 %	

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5,55	
835	9.56	1	6.22	
900	10.9		6,99	
1450	29	1 1	16	
1500	30.5	1 11	16.8	
1640	34.2		18.4	
1750	36.4	]	19.3	-
1800	38.4		20.1	

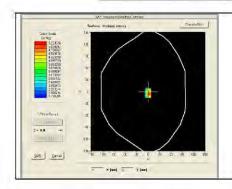
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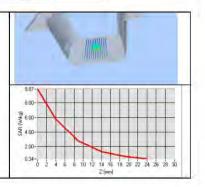




Ref: ACR.75.13.15.SATU.A

1900	39.7	1	20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21,9	
2300	48.7	1	23.3	
2450	52.4	54.29 (5.43)	24	24.20 (2.42)
2600	55.3	11	24.6	
3000	63.8		25.7	
3500	67.1		25	





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (ε,′)	Conductiv	ity (o) S/m
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 ±5 %		0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %	1	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

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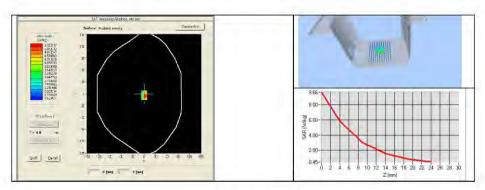
Ref: ACR.75.13.15.SATU.A

2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5 %	3.31 ±5 %
5200	49.0 ±10 %	5.30 ±10 %
5300	48.9 ±10 %	5.42 ±10 %
5400	48.7 ±10 %	5.53 ±10 %
5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2 ±10 %	6.00 ±10 %

# 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4		
Phantom	SN 20/09 SAM71		
Probe	SN 18/11 EPG122		
Liquid	Body Liquid Values: eps': 52.7 sigma: 1.94		
Distance between dipole center and liquid	10.0 mm		
Area scan resolution	dx=8mm/dy=8mm		
Zoon Scan Resolution	dx=5mm/dy=5m/dz=5mm		
Frequency	2450 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
2450	54.70 (5.47)	24.86 (2.49)



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Ref: ACR.75.13.15.SATU A

## 8 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	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	Carrera	CALIPER-01	12/2013	12/2016
Reference Probe	MVG	EPG122 SN 18/11	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.
Temperature and Humidity Sensor	Control Company	11-661-9	8/2012	8/2015





# SAR Reference Dipole Calibration Report

Ref: ACR.75.14.15.SATU.A

# SHENZHEN BALUN TECHNOLOGY CO.,LTD.

BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,

NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2600 MHZ

SERIAL NO.: SN 25/13 DIP 2G600-254

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





03/16/2015

Summers:

This document presents the method and results from an accredited SAR reference dipole cultivation performed in MVG USA using the COMOSAR test bench. All calibration results are traceable to restional methology institutions.







RECEIVED INSTITUTE

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	3/16/2015	Je
Checked by:	Jérôme LUC	Product Manager	3/16/2015	75
Approved by:	Kim RUTKOWSKI	Quality Manager	3/16/2015	him waterally

	Customer Name		
Distribution:	SHENZHEN		
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Res: ACR.7514.15.SATU A.

#### 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs 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 2600 MHz REFERENCE DIPOLE		
Manufacturer	MVG		
Model	SID2600		
Serial Number	SN 25/13 DIP 2G600-254		
Product Condition (new / used)	Used		

A yearly calibration interval is recommended.

#### 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 - MVG COMOSAR Validation Dipole

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#### 4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs 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 jeturn loss of -20 dB or better. The return loss measurement shall be performed against a liquid tilled 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	Espanded Uncertainty on Return Los		
400-6000MHz	D.I 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, FCC KDBs, CENELEC EN50361 and CEDIEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

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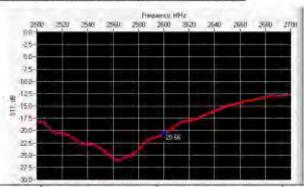


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10 g	20.1 %	

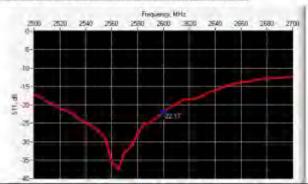
#### 6 CALIBRATION MEASUREMENT RESULTS

#### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance | 2600 | -20.66 | -20 | 51.0 Ω + 9.4 jΩ

# 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2600	-22.17	-20	$47.9 \Omega + 7.5 j\Omega$

# 6.3 MECHANICAL DIMENSIONS

Frequency MH2	equency MH2 1 mm		h mm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1%.		6.35 ±1 %.	

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450	290.6 ±1 %		166.7±1%.		5.35±1°N		
750	176.0 ±1 %		100,0±1%		6.35 ±1%		
835	161/0±1 %.	161.0 ±1 %.		89.8±1%		3.6±1%	
900	149.6 ±1 %.		83.1:1% 3.6:1%				
1450	89.1 ±1 %		51.7 t1 %		3.6:1%		
1500	80.5±1%		50.0 t1 %		3.621		
1640	79.0±1%.		45.7±1%	45.7±1% ±6±1%			
1750	75.2 ±1%.		42,9 12 %	19:2 % 3,6:1%.			
1800	72.0±1%		41.7:1%		36:1%		
1900	68.0±1%.		39,5 ±2 %	-	3,6±1%		
1950	663±1%		38.5 £1.3		3.6 ±1%		
2000	645 £1%		37.5 t1 %		3.6 :1		
2100	61.0±1.W.		36.7 ±3 %	3.6±1 W.			
2300	55.3 td W.		32.6 11.96		16:1%		
2450	\$1.5 ±1 W.		30,4 ±2 1/4		3.621%		
2600	485±1%	PASS	288±1%	PASS	3.6=1%	PASS	
3000	41.5±1%		25,0 ±1 %		3,6:1%		
3500	37.0±1 H.		26.4±1%		3.6 ±1%		
3700	34.7±1 %.		26.4 #1 %		3.6 ±1 %		

## 7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDEs 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	Relative per	mittivity (s.')	Conductivity (a) 5/m		
	required	measured	required	measured	
300	45.3.45 %		0.87 ±5%		
450	43.5 ±5 %		0.87 #5%		
750	41.9 25 %		0,89 ±5 1/4		
R35	41.5.±5.5W		0.90 ±5 %		
900	V1,5 ±5 %		0.97 15 %		
3450	40.5 45 11		1.20±5 M		
1500	40.0 45 %		1.23.15%		
1540	40.2±5%		1,31.15%		
1750	40/1.45%		1.37 ±5 %		

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1800	40.0°±5 %		1.40 ±5 %	
3900	40.0 ±5 %	40.0±5% 1,40±5%		
1950	40.0 45 %		1,40 ±5 %	
2000	40.0±5%		L40.15%	
2100	39,8 ±5 %		1,49 15%	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2500	39.0 ±5 %	PASS	1.66 ±5 %	PASS
3000	38,5 £5 %		2.40 ±5 %	
3500	37.9 ±5.%		2.91.45 W	

### 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	OFENSAR V4	
Phantam	SN 20/09 SAM7T	
Probe	SN 18/11 EPG122	
Liquid	Head Liquid Values, eps. 38.2 sigmu : 193	
Distance between dipole center and liquid	10.0'mmy	
Apai scan resolution	ds=8mm dy=8mm	
Zoon Scan Resolution	dx 5mm dy 5mm da 5mm	
Frequency	2600 MHz	
Input power	20 @m	
Liquid Temperature	21 10	
Lab Temperature	10°C	
Lab Hisniday	45 4	

Frequency	1 g SAR	1 g SAR (W/kg/W)		(W/kg/W)
	required	measured	required	measured
300	2.85		1.54	-
450	4.58		3.06	
750	8.49		5.55	
105	9,56		6.22	
900	10,9		6.99	
3450	29		16	
1500	30,5		16.8	
164D	34.2		18.4	
2750	36.4		19.3	
3.800	38,4		20.1	

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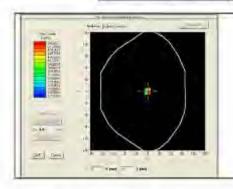
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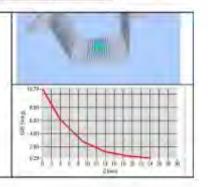




Res: ACR-75-14-15-SATT/ A

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	57 37 (5.74)	24.6	24 68 [2,47]
3000	63.8		25.7	
3500	67,1		25	





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (c.')	Conductivity (a) S/n	
	required	measured	required	measured
150	61.9 ±5.56		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5%	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2.±5 %		0.97±5%	
900	55.0 ±5 %		1.05 15 %	
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 %	53.3 ±5 % 1.52 ±5 %		
1900	53.3 ±5%		1.52 ±5 %	
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	

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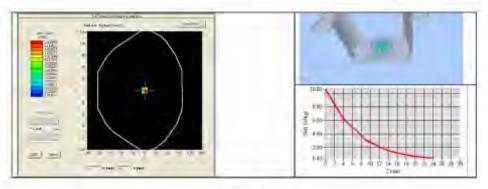
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2600	52.5.±5%	PASS	2.16 ±5 %	PASS
3000	52,0±5%	52,0 ±5 % 2,73 ±5 %		
3500	51.3 ±5 %	51.3 ±5 % 3.31 ±5 %		
5200	49.0 ±10 %	49.0 ±10 % 5.30 ±10 %		
5300	48.9 ±10 % 5.42 ±20 %			
5400	48.7±10.5V	48.7±10% 5.51±10%		
5500	48.6 ±10 %	48.6 ±10 % 5.65 ±10 %		
5600	48.5±10% 5.77±10%			
5800	48.2±10% 6.00±10%			

# 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

OPENSAR V4
SN 20/09 SAM71
SN 18/11 EPG122
Body Liquid Values: eps   51.6 samma   2.21
10.0 mm
dx=8mm/dy=8mm
dx-5mm/dy-5mm/dz-5mm
2600 MHz
20 dBm
ži C
2I *C
45 %.

Frequency	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
2500	57.62 (5.76)	25.39 (2.54)



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# 8 LIST OF EQUIPMENT

	Equi	pment Summary 3	offeet.	
Equipment Description	Manufacturer/ Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	SN 20/09-SAM71	Validated No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated, No call required	Validated No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2013	02/2018
Calipers	Carrera	CALIPER-01	12/2013	12/2016
Reference Probe.	MVG	EPG122 SN 18/11	10/2014	10/2015
Mutimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aetherdomm	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	US37181480	12/2013	12/2016
Directional Couples	Marda 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 Waveguide Calibration Report**

Ref: ACR.75.15.15.SATU.A

# SHENZHEN BALUN TECHNOLOGY CO.,LTD.

BLOCK B, FL 1, BAISHA SCIENCE AND TECHNOLOGY PARK, SHAHE XI ROAD,

NANSHAN DISTRICT, SHENZHEN, GUANGDONG PROVINCE, P.R. CHINA 518055

# MVG COMOSAR REFERENCE WAVEGUIDE

FREQUENCY: 5000-6000 MHZ SERIAL NO.: SN 30/13 WGA24

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





03/16/2015

### Summary:

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







Ref: ACR.75.15.14.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	3/16/2015	JE
Checked by :	Jérôme LUC	Product Manager	3/16/2015	JES
Approved by :	Kim RUTKOWSKI	Quality Manager	3/16/2015	pum Putthonnia

	Customer Name
Distribution :	SHENZHEN
	BALUN
	TECHNOLOGY
	Co.,Ltd.

Date	Modifications
3/16/2015	Initial release
	40.4116





the design of

### SAR REFERENCE WAVEGUIDE CALIBRATION REPORT

Ret. ACR: 75.15,14.5ATU A

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#### 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528 and CEI/IEC 62209 standards for reference waveguides 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 5000-6000 MHz REFERENCE WAVEGUIDE		
Manufacturer	MVG		
Model	SWG5500		
Serial Number	SN 30/13 WGA24		
Product Condition (new / used)	Used		

A yearly calibration interval is recommended.

#### 3 PRODUCT DESCRIPTION

#### 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Waveguides are built in accordance to the IEEE 1528 and CEI/IEC 62209 standards.

#### 4 MEASUREMENT METHOD

The IEEE 1528 and CEI/IEC 62209 standards provide requirements for reference waveguides 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 waveguide used for SAR system validation measurements and checks must have a return loss of -8 dB or better. The return loss measurement shall be performed with matching layer placed in the open end of the waveguide, with the waveguide and matching layer in direct contact with the phantom shell as outlined in the fore mentioned standards.

#### 4.2 MECHANICAL REQUIREMENTS

The IEEE 1528 and CEI/IEC 62209 standards specify the mechanical dimensions of the validation waveguide, the specified dimensions are as shown in Section 6.2. Figure 1 shows how the dimensions relate to the physical construction of the waveguide:





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### 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.

### 53 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 Lengt		
3 - 300	0.05 nun		

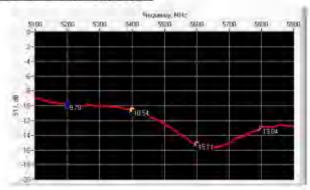
# 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528 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 %

# 6 CALIBRATION MEASUREMENT RESULTS

# 6.1 RETURN LOSS IN HEAD LIQUID



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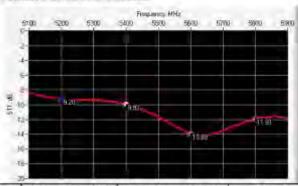




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Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
5200	-9.78	-8	26.6 Ω ÷ 9.1 jΩ
5400	-10:54	-8	89.7 Ω + 12.3 jΩ
5600	-15.11	-8	38.1 Ω - 9.8 jΩ
5800	-13.04	-8	54.0 Ω = 23.4 jΩ

### 6.2 RETURN LOSS IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
5200	-9.20	-8	$25.7 \Omega = 10.6 j\Omega$
5400	-9.92	-8	95.8 Ω + 8.8 jΩ
5600	-13.89	-8	35,3 Ω - 9,2 jΩ
5800	-11.91	-8	56,0 \(\Omega + 27.2 \)

# 6.3 MECHANICAL DIMENSIONS

Description	L (mm) W (mm		mm)	Lc(mm)		Wr (mm)		I (mm)		
y (MHz)	Require	Measure	Require	Measure d	Require	Measure	Require	Measure	Roquie	Mossur
5500	40,39 = 0.13	PASS	7019± 0.13	PASS	81.03± 11.13	PASS	61.88 ± 0.13	PASS	5.3*	PASS
5800	40.39± 0.13	PASS	20.19± 0.13	PASS	81.03± 0.13	PASS	61.98 ± 0.13	PASS	43*	PASS

<sup>\*</sup> The tolerance for the matching layer is included in the return loss measurement.

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Figure 1: Validation Waveguide Dimensions

### 7 VALIDATION MEASUREMENT

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference waveguide meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed with the matching layer placed in the open end of the waveguide, with the waveguide and matching layer in direct contact with the phantom shell.

### 7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (s/)	Conductivity (a) 5/m		
	required	measured	required	measured	
5000	36,2 ±10 %		4.45 ±10 %		
5100	35.1 ±10 %		4.56 ±10.%		
5200	36.0±10%	PASS	4,66±10%	PASS	
5300	35.9 ±10%		4.76±10%		
5400	35.8±10%	PASS	4.85 ±10 %	PAS5	
5500	35.6 :10 %		4.97 ±10%		
5600	35.5 ±10 %	PASS	5.07 ±10 %	PASS	
5700	35,4±10%		5.17±10%		
5800	35.3 ±10 %	PASS	5.27 ±10.%	PASS	
5900	35.2 110%		5.38 £10%		
9000	.35.1 ±10.%		5.48 ±10 %		

#### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

At those frequencies, the target SAR value can not be generic. Hereunder is the target SAR value defined by MVG, within the uncertainty for the system validation. All SAR values are normalized to 1 W net power. In bracket, the measured SAR is given with the used input power.

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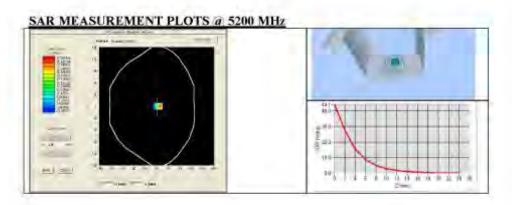




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Software	OPENSAR V4		
Phantom	SN 20/09 SAM71		
Probe	SN 18/11 EPG122		
Lïquid	Head Liquid Values 5200 MHz eps' 36.44 sigma 4.70 Head Liquid Values 5400 MHz eps' 35.99 sigma 4.91 Head Liquid Values 5600 MHz eps' 35.22 sigma 5.18 Head Liquid Values 5800 MHz eps' 34.95 sigma 5.42		
Distance between dipole waveguide and liquid	0 mm		
Area scan resolution	dx-8mm/dy-8mm		
Zoon Scan Resolution	dx-4mm/dy-4m/dz-2mm		
Frequency	5200 MHz 5400 MHz 5600 MHz 5800 MHz		
Input power	20 dBar		
Liquid Temperature	21 °C		
Lab Temperature	21 °C		
Lab Humidity	45 %		

Frequency (MHz)	1 g SA	R (W/kg)	10 g SAR (W/kg)	
	required	measured	required	measured
5200	159.00	157.80 (15.78)	56.90	55.01 (5.50)
5400	166.40	162.69 (16.27)	58.43	56.17 (5.62)
5600	173.80	171.22 (17.12)	59.97	58.57 (5.86)
5800	181.20	179,53 (17.95)	61.50	60.55 (6.05)



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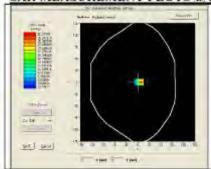
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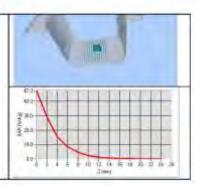




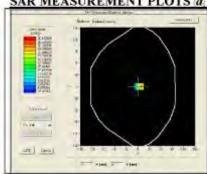
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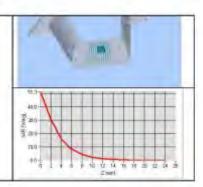




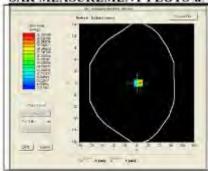


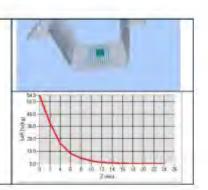
# SAR MEASUREMENT PLOTS @ 5600 MHz





# SAR MEASUREMENT PLOTS @ 5800 MHz





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# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	minthely (c.')	Conductivity (a) 5/m		
	required	measured	required	measured	
5200	49.0±10.%	PASS	530110%	PASS	
5300	48.9 ±10 %		5.42±10%		
5400	48.7 ±10%	PASS	5.53.±10 W	PASS.	
5500	48.6±10%		5.65 +30%		
5600	48.5 ±10 %	PASS	5.77±10W	PASS	
5800	48.2 ± 10 %	PASS	6.00.130%	PASS	
	-				

# 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4		
Phantom	SN 2009 SAM71		
Probe	SN 18/11 BPG122		
Liquid	Body Liquid Values \$200 MHz; eps. 50.70 sigma. \$11 Body Liquid Values \$400 MHz; eps. 50.01 sigms. 5.64 Body Liquid Values \$600 MHz; eps. 49.34 sigms. 5.85 Body Liquid Values \$800 MHz; eps. 48.54 sigms. 6.22		
Distance between dipole waveguide and liquid	0.000		
Area scan resolution	dx 8mm/dy 3mm		
Zoon Scan Resolution	dx 4mm/dy 4m/dz 2mm		
Frequency	\$200 MHz \$400 MHz \$600 MHz \$800 MHz		
Input power	20 Æm		
Liquid Temperature	21 ℃		
Lab Temperature	2U X		
Lab Humidity	45%		

Frequency (MHz)	1 g SAR (Wkg)	10 g SAR (W/kg)	
	measured	measured	
5200	155,12 (15.51)	54.66 (5.47)	
5400	162,06 (16.21)	56.46 (5.65)	
3600	167.13 (16.71)	57.78 (5.78)	
5800	173.19 (17.32)	39.30 (5.93)	

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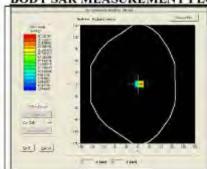
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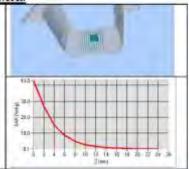




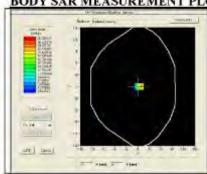
Ref: ACR.75.15.14.SATU.A.

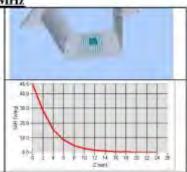
### BODY SAR MEASUREMENT PLOTS @ 5200 MHz



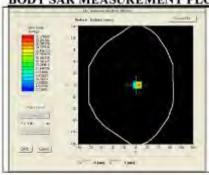


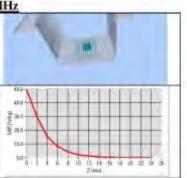
# BODY SAR MEASUREMENT PLOTS @ 5400 MHz





# BODY SAR MEASUREMENT PLOTS @ 5600 MHz





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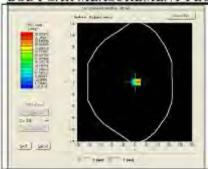


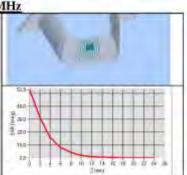




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# 8 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date			
Flat Phantom	MVG	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	511100132	02/2013	02/2016			
Calipers	Carrera	CALIPER-01	12/2013	12/2016			
Reference Probe	MVG	EPG122 SN 18/11	10/2014	10/2015			
Multimeter	Kelthley 2000	1188656	12/2013	12/2016			
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016			
Amplifier	Aethercomm	SN 048	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 4215-20	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			