

CALIBRATION REPORT

F.1 E-Field Probe



COMOSAR E-Field Probe Calibration Report

Ref: ACR.294.1.16.SATU.A

SHENZHEN BALUN TECHNOLOGY CO.,LTD.
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MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 34/15 EPGO265

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





Calibration Date: 09/15/2016

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.



Report No.: BL-SZ1740113-701



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.294.1.16.SATU.A

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Issue	Date	Modifications
A	9/24/2016	Initial release





Ref: ACR.294.1.16.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 34/15 EPGO265		
Product Condition (new / used)	New		
Frequency Range of Probe	0.45 GHz-6GHz		
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.192 MΩ		
	Dipole 2: R2=0.230 MΩ		
	Dipole 3: R3=0.205 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° - 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.

ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ei	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	—√3—	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	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 %	

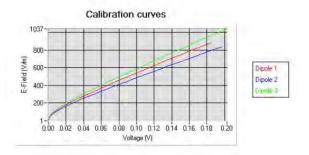
5.1 SENSITIVITY IN AIR

	Normy dipole	
$1 (\mu V/(V/m)^2)$	$2 (\mu V/(V/m)^2)$	$3 (\mu V/(V/m)^2)$
0.72	0.81	0.85

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

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

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



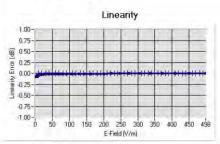
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5.2 LINEARITY



Linearity:0+/-1.61% (+/-0.07dB)

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL450	450	44.12	0.88	1.85
BL450	450	58.92	1.00	1.90
HL750	750	42.24	0.90	1.81
BL750	750	56,85	0.99	1.88
HL850	835	43.02	0.90	2.04
BL850	835	53.72	0.98	2.12
HL900	900	42.47	0.99	1.86
BL900	900	56.97	1.09	1.92
HL1800	1800	42.24	1.40	2.04
BL1800	1800	53.53	1.53	2.08
HL1900	1900	40.79	1.42	2.35
BL1900	1900	54.47	1.57	2.42
HL2000	2000	40.52	1.44	2.23
BL2000	2000	54.18	1.56	2.32
HL2450	2450	38.73	1.81	2.47
BL2450	2450	53.23	1.96	2.55
HL2600	2600	38.54	1.95	2.36
BL2600	2600	52.07	2,23	2.43
HL5200	5200	36.80	4.84	1.81
BL5200	5200	51.21	5.16	1.85
HL5400	5400	36.35	4.96	2.04
BL5400	5400	50.51	5.70	2.11
HL5600	5600	35.57	5.23	2.08
BL5600	5600	49.83	5.91	2.15
HL5800	5800	35,30	5.47	1.88
BL5800	5800	49.03	6.28	1.93

LOWER DETECTION LIMIT: 7mW/kg

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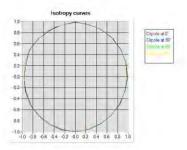


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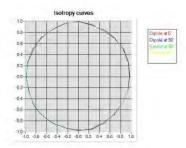
5.4 ISOTROPY

HL900 MHz

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



HL1800 MHz
- Axial isotropy:
- Hemispherical isotropy: 0.04 dB $0.06~\mathrm{dB}$



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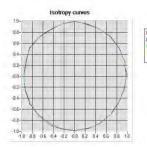
Report No.: BL-SZ1740113-701



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.294.1.16.SATU.A

HL5600 MHz
- Axial isotropy:
- Hemispherical isotropy: $0.06~\mathrm{dB}$ $0.09~\mathrm{dB}$







Ref: ACR.294.1.16.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	10/2013	10/2016
Reference Probe	MVG	EP 94 SN 37/08	12/2015	12/2016
Multimeter	Keithley 2000	1188656	12/2013	12/2016
Signal Generator	Agilent E4438C	MY49070581	12/2013	12/2016
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2013	12/2016
Power Sensor	HP ECP-E26A	US37181460	12/2013	12/2016
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
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.





SAR Reference Dipole Calibration Report

Ref ACR.75.8.15.SATU.A

SHENZHEN BALUN TECHNOLOGY CO.,LTD.

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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 beach. All calibration results are traceable to actional metrology institutions.



Report No.: BL-SZ1740113-701



SAR REFERENCE DIPOLE CALIBRATION REPORT

RE: AUR. 75.8, (5.8A) (1.A)

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

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A	3/16/2015	Initial release
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RE: ACR. 75.8,15.8A(I) 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	Device 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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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 that phantom, with the phantom constructed as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

The IFEE Std. 1528 and CEVIEC 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

F	requency 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 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.

1 0 70.3 %	Scan Volume	Expanded Uncertainty
4 8	1 g.	20.3 %

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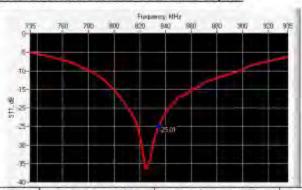
Impedance

 $52.1 \Omega + 3.8 j\Omega$

10 g	20.1 %

6 CALIBRATION MEASUREMENT RESULTS

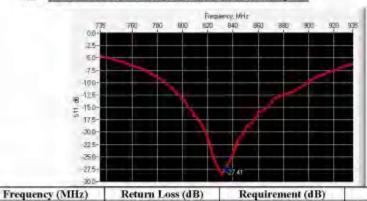
6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



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

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID

-27.41



6.3 MECHANICAL DIMENSIONS

835

Frequency MH2	Limit		hrmm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 p1 %		6.35 ±1 %.	

-20

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Bat ACR. 758, (5.SATU A.

450	290.0 ±1 %		196.7±1%.		5.35±1%	
750	176.0 ±1 %		100,0±1%		6.35 ±1%	
885	161x0±1 %.	PASS	89.8 ±1 %	PASS	3.6±1%	PASS
900	IA9.0 ±1 %		83.3 ±1.1%		3.6 11%	
1450	89,1 ±1 %	2-	51,7 ±1 %		3.6 ±1%	
1500	805±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%	
1500	72.0±1%		41.7±1%		3.6 11%	
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 at W.		32.6 11.%		16:1%	
2450	51.5±1%.		30,4 ±2 1/4		3,6 21 %	
2600	485±1%		288±1%		3.6 11%	
3000	41.5±1%		25,0 ±1 %		3,6:1%	
3500	37.0±1 H.		26.4±136		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 permittivity (s.')		Conductivity (a) 5/m	
	required	measured	required	measured
300	45.3.45 %		0.87±5%	
450	43.5 ±5 %		0.8715%	
750	41.9 25 %		0,89±5%	
7.35	41.5 ±5.54	PASS.	0.90±5%	PASS.
9000	V1,5±5%		0.9715%	
1450	40,5 45 11		1.20±5%	
3500	40.0 45 %		1.23-15%	
1640	40.2.25%		1,31 ±5%	
1750	40.1 ±55%		1.37 25 %	

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1800	40.045%	1.40 ±5%
3900	VID.07 ±5 %	1,40 ±5 %
1950	40.0 45 %	1.40 ±5 %
2080	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%
2500	39.0 丝宝	1.06±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	SIN 18/11 EPG122	
Liquid	Head Liquid Values, gps . 42.1 sigma : 0.92	
Distance between dipole center and liquid	15.0 mm	
Anni squi resolution	ds-Kmm dy-Kmm	
Zoon Son Resolution	dx 8mm/dy 8m/dz 5mm	
Frequency	835 MHz	
Inpor power	10 dBm	
Liquid Temperature	21 ℃	
Lab Temperature	10°C	
Lab Burndov	65 °a	

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	8,45		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	
3.800	38,4		20.0	
		1		

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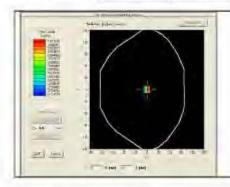
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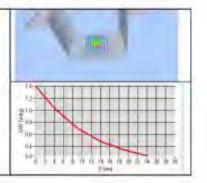




Ret: ACR. 75.8.15.SATU A.

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 permittivity (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 15 %	
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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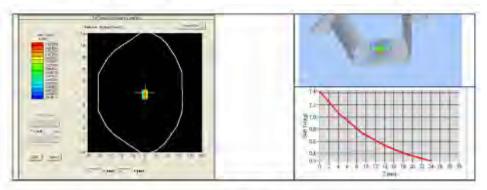
Ref: ACR.75.8.(5.SA)(U.A)

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±10.5V	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

OPENSAR V4	
SN 20/09 SAM71	
SN 18/11 EPG122	
Body Liquid Values: eps : 53/8 sagma : 0.98	
15.0 mm	
dx=8mm/dy=8mm	
dx=8mm/dy=8m/dz=5mm	
835 MHz	
20 dBm	
21°C	
21°C	
43 %	

Frequency MHz	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





RECACR.758.(5.8A)() 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 ca 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	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 Couples	Marda 4216-20	01988	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	B/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-SZ1740113-701



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	nem Patthemes 187

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

Issue	Date	Modifications
A	3/16/2015	Initial release
1		





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

De	evice 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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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 Lo		
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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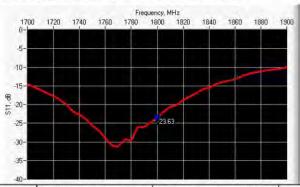


Ref: ACR.75.10.15.SATU.A

10 -	20.1.0/
10 2	20.1 %

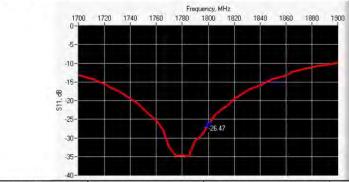
6 CALIBRATION MEASUREMENT RESULTS

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	Ln	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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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 per	mittivity (ϵ_r')	Conductivity (a) 5/n	
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %		0.89 ±5 %	
835	41.5 ±5 %		0.90 ±5 %	
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	

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Ref: ACR.75.10.15.SATU.A

1800	40.0 ±5 %	PASS	1.40 ±5 %	PASS	
1900	40.0 ±5 %	40.0 ±5 % 1.40 ±5 %			
1950	40.0 ±5 %	40.0 ±5 % 1.40 ±5 %			
2000	40.0 ±5 %	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 %	39.0 ±5 % 1.96 ±5 %			
3000	38.5 ±5 %	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	- 1
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

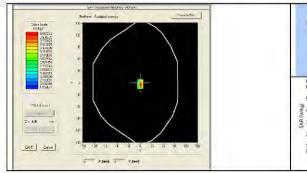
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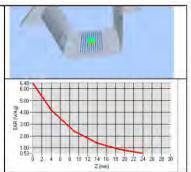




Ref: ACR.75.10.15.SATU.A

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 per	mittivity (ε _r ')	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 %	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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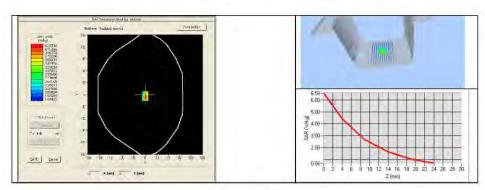
Ref: ACR.75.10.15.SATU.A

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 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 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.



Report No.: BL-SZ1740113-701



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.75.11.15.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	3/16/2015	Je5
Checked by:	Jérôme LUC	Product Manager	3/16/2015	JES
Approved by :	Kim RUTKOWSKI	Quality Manager	3/16/2015	hem Authowski

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

Issue	Date	Modifications
A	3/16/2015	Initial release
1		





Ref: ACR.75.11.15.SATU.A

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Ref: ACR.75.11.15.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 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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Ref: ACR.75.11.15.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 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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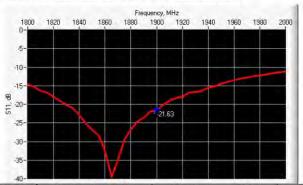


Ref: ACR.75.11.15.SATU.A

10 g	20.1 %

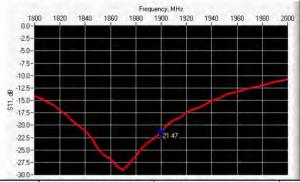
6 CALIBRATION MEASUREMENT RESULTS

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	$48.9 \Omega + 8.4 i\Omega$

6.3 MECHANICAL DIMENSIONS

Frequency MHz	Ln	L mm h mm d r		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 %.	
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 %.	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,')		Conductivity (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 %		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	

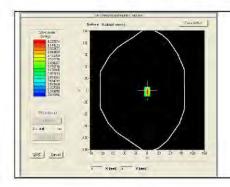
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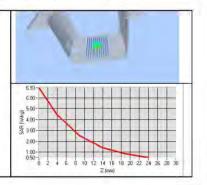




Ref: ACR.75.11.15.SATU.A

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	1	25	





7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (s _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 %		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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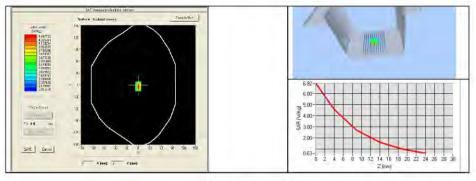
Ref: ACR.75.11.15.SATU.A

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

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps': 53.9 sigma: 1.55
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)
	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 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.75.13.15.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.



Report No.: BL-SZ1740113-701



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.75.13.15.SATU A

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

Customer Name
SHENZHEN
BALUN
TECHNOLOGY
Co.,Ltd.

Issue	Date	Modifications
A	3/16/2015	Initial release





Ref: ACR.75.13.15.SATU.A

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Ref: ACR.75.13.15.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 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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Ref: ACR.75.13.15.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 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.

Expanded Uncertainty
20.3 %

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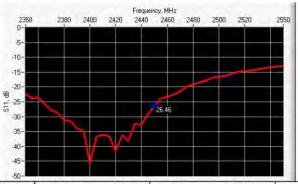


Ref: ACR.75.13.15.SATU.A

10 0	20.1 %
10 g	20.1 70

6 CALIBRATION MEASUREMENT RESULTS

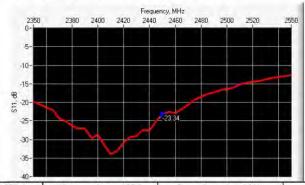
6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



 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 jΩ

6.3 MECHANICAL DIMENSIONS

Frequency MHz	L n	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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Ref: ACR.75.13.15.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 %.		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 (ɛ,')		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 %		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 %	7	1.37 ±5 %	

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Ref: ACR.75.13.15.SATU A

	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	1	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	

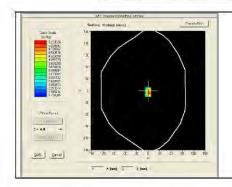
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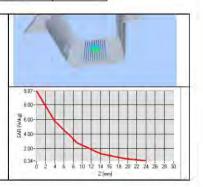




Ref: ACR.75.13.15.SATU.A

1900	39.7	1	20.5	
1950	40.5		20.9	
2000	41.1	11	21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4	54.29 (5.43)	24	24.20 (2.42)
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	





7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ɛˌ²)		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 %	1 1	0.96 ±5 %	
835	55.2 ±5 %	1	0.97 ±5 %	
900	55.0 ±5 %		1.05 ±5 %	
915	55.0 ±5 %		1.06 ±5 %	
1450	54.0 ±5 %	n ii	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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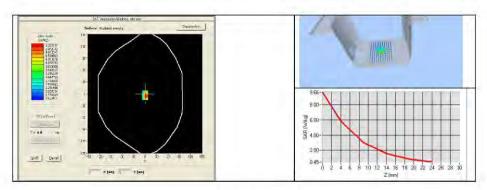
Ref: ACR.75.13.15.SATU.A

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

Summary:

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 retional metrology institutions.



Report No.: BL-SZ1740113-701



SAR REFERENCE DIPOLE CALIBRATION REPORT

RECORD TO LABORATE

	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	3/16/2015	J=
Checked by:	Jérôme LUC	Product Manager	3/16/2015	75
Approved by:	Kim RUTKOWSKI	Quality Manager	3/16/2015	dom northwest

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

Insue	Duie	Modifications
A	3/16/2015	Initial release
77.5	Section Control	





RECEIVED A SANDA

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ROS ACR. 75-14-15 SAITE 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 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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Ref: XCR:7514 (5.5A)TU-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 jeturn 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	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
l g	20.3 %

Page: 5/11

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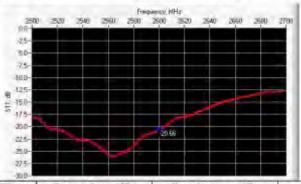


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20.1 %

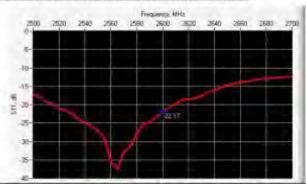
6 CALIBRATION MEASUREMENT RESULTS

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	Le	mm	hm	im	di	mm
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 p1%		6.35 ±1 %.	

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Rati ACR. 75 14 EASA ITEA

450	290.6 ±1 %.		166.7±1%.		5.35±1'%	
750	175.0 ±1 %		100,0±1%		6.35 ±1%	
835	161.0 ±1 %.		89.8±1.%		2.6:21%	
900	149.6 ±1 %.		83.3 :1%		36:1%	
1450	89.1 ±1 1%		51.7 t1 %		3.6:1%	
1500	80.5 ±1 %		50.0±1%		3.621	
1640	79.0±1%;		45.7±1%		16#1M	
1750	75.2 ±1%.		42,9 12 %		3,621%	
1800	72.0±1%		417:1%		3.6 11%	
1900	68.0±1%		39,5 ±2 %		3,6±1%	
1950	663±1%		38.5 £1.%		3.6 ±1%	
2000	64.5 £1.90		37.5 tl %		16:1	
2100	61.0±1 W.		36.7 ±3 %.		3,6±1%	
2300	55.5 td W.		32.6 11.76		16:1%	
2450	51.5 ±1 W.		30,4 ±2 1/4		3.6 21%	
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 permittivity (s.')		Conductivity (a) 5/m	
	required	measured	required	measured
300	45.3 45 %		0.87 ±5%	
450	43.5 15 %		0.87 #5%	
750	41.8 25 %		0,89 ±5 %	
835	41.5 ±5.5V		0.90 ±5 %	
900	VI,5 ±5 W		0.9715%	
1450	40.5 45 11		1.20±5 M	
3500	40.0 45 %		1.23-15%	
1540	402.5%		1,31 ±5%	
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 %	
2000	40.0 ±5 %		L40.25%	
2100	39,8 ±5 %		1,49 ±5%	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80±5%	
2500	39.0 ±5 %	PASS	1.06 ±5 %	PASS
3000	38,5 ±5 %		2.40 ±5 %	
3500	37.9 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	OPENSAR V4		
Phantam	SN 20/09 SAM7T		
Probe	SN 18/11 EPG122		
Liquid	Head Liquid Values, eps. 38 2 sigma 193		
Distance between dipole center and liquid	10.0 mm		
Aput sonn resolution	ds-Rmm dy-Smm		
Zoon Scan Resolution	dx 5mm dy 5mm da 5mm		
Frequency	3600 MHz		
Input power	20 dBm		
Liquid Temperature	21.30		
Lab Temperature	11 °C		
Lab Literately	45.44		

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		5.55	
835	9.56		6.22	
900	10,9		6.95	
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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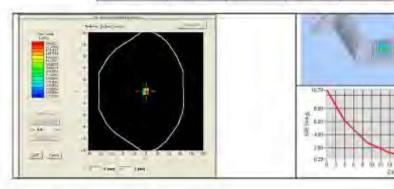
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1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	.43.6		21.9	1
2300	48.7		23.3	
2450	52.4		24	
2600	.55,3	57/37 (5.74)	24.6	24.68 [2,47]
3000	63.8		25.7	
3500	67,1		25	



7.3 BODY LIQUID MEASUREMENT

Frequency IMHz	Relative per	mittivity (c.')	Conductivity (a) S/n	
	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 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 %		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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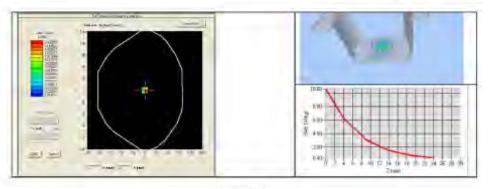
Rate ACRESS 14 (A.SA) (U.A.

2600	52.5.±5 %	PASS	2.16 ±5%	PASS
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 18/11 EPG122		
Laquid	Body Liquid Values, eps. 51.6 samu (22)		
Distance between dipole center and liquid	10.0 mm		
Area scan resolution	dx=8mm/dy=8mm		
Zoon Soan Resolution	dx 5mm/dy 5mm/dz 5mm		
Frequency	2600 MHz		
Input power	20 dBm		
Liquid Temperature	21°C		
Lab Temperature	2I °C		
Lab Hunidity	45 %		

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
2600	57.62 (5.76)	25.39 (2.54)



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Rati ACR. 7514 ELSA (U.A.

8 LIST OF EQUIPMENT

	DO VALUE OF THE PARTY OF			
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	02/2018
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	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	US37181480	12/2013	12/2016
Directional Couples	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



F.7 5 GHz Waveguide



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	JES
Checked by :	Jérôme LUC	Product Manager	3/16/2015	JES
Approved by :	Kim RUTKOWSKI	Quality Manager	3/16/2015	from Methowski

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

Issue	Date	Modifications
A	3/16/2015	Initial release
_		





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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 forementioned 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 hand	Expanded Uncertainty on Return Los			
400-6000MHz	0.1 dB			

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

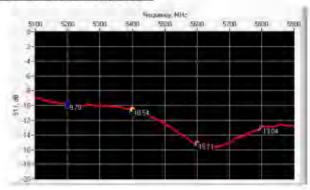
5.3 VALIDATION MEASUREMENT

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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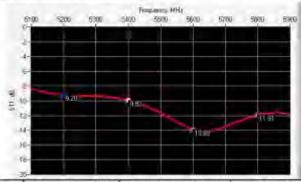




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Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
5200	-9.78	-8	$26.6 \Omega + 9.1 j\Omega$
5400	-10.54	-8	$89.7 \Omega = 12.3 j\Omega$
5600	-15.11	-8	38.1 Ω - 9.8 jΩ
5800	-13:04	-8	54.0 Ω = 23.4 jΩ

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

Decommon	1.0	moni)	WO	mm)	Lo	mani)	Wel	man)	Lo	nml
y (MHz)	Require	Measure d	Require	Measure d	Require	Measure	Require d	Measure	Roquie	Mossia
5300	40,39 = 0.13	PASS	70.19± 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

^{*} The tolerance for the matching layer is included in the return loss measurement.

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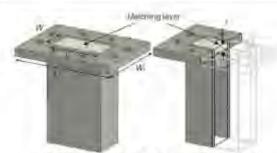


Figure 1: Validation Waveguide Dimensions

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 permittivity (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	35.9 410%		4.76±10%	
5400	35.8±10%	PASS	4.86 ±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%	
5000	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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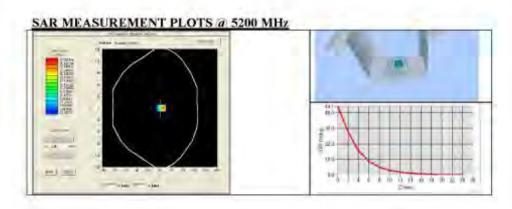




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Software	OPENSAR V4	
Phantom	SN 20/09 SAM71	
Probe	SN 18/11 EPG122	
Liquid	Head Liquid Values 5200 MHz: eps' 36.44 sigma 4.70 Head Liquid Values 5400 MHz: eps' 35.99 sigma 4.91 Head Liquid Values 5600 MHz: eps' 35.22 sigma 5.18 Head Liquid Values 5800 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	ds=4mm/dy=4m/dz=2mm	
Frequency	5200 MHz 5400 MHz 5600 MHz 5800 MHz	
Input power	20 dBm	
Liquid Temperature	21 °C	
Lab Temperature	21 °C	
Lab Humidity	45 %.	

Frequency (MHz)	I g SAR (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)



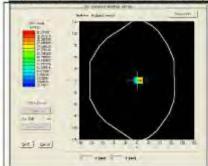
Page: 8/13

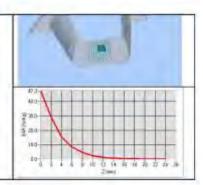




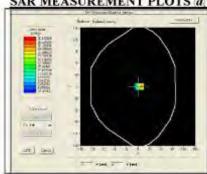
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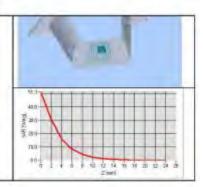




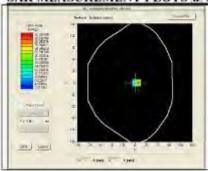


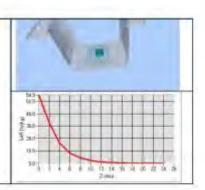
SAR MEASUREMENT PLOTS @ 5600 MHz





SAR MEASUREMENT PLOTS @ 5800 MHz





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7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (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 ±10/4	PASS	5.53±10 %	PASS
5500	48.6±10.%		5.65 ±30 %	
5600	48.5 ±10 %	PASS	5.77±10%	PASS
5800	48.2 ± 10 %	PASS	6.00 till %	PASS.

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

2009 SAM71 18/11 EPG122 y Liquid Values 5200 MHz: eps. 50:70 agma. 5:11 y Liquid Values 5400 MHz: eps. 50:01 agms. 5:64 y Liquid Values 5600 MHz: eps. 49:34 agms. 5:85 y Liquid Values 5800 MHz: eps. 48:54 agms. 6:22	
y Liquid Values 5200 MHz; eps; 50,70 sigma - 5,11 y Liquid Values 5400 MHz; eps; 50,01 sigms - 5,64 y Liquid Values 5600 MHz; eps; 49,34 sigms - 5,85 y Liquid Values 5800 MHz; eps; 48,54 sigms - 6,22	
y Liquid Values 5400 MHz; eps. 50 01 sigma - 5 64 y Liquid Values 5600 MHz; eps. 49 34 sigma - 5 85 y Liquid Values 5800 MHz; eps. 48 54 sigma - 6 22	
n	
ds: 8mm/dy 3mm	
dx-4mm/dy-4m/dz-2mm	
OMEZ OMEZ OMEZ OMEZ	
Elm	
C	
C	
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)
5600	167.13 (16.71)	57,78 (5.78)
5800	173.19 (17.32)	39.30 (5.93)

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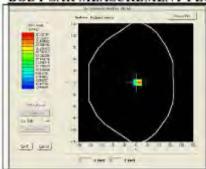
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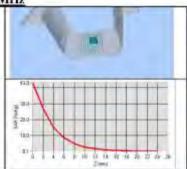




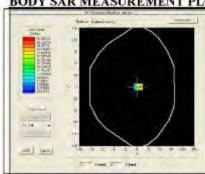
Ref: ACR.75.15.14.SATU.A.

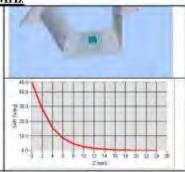
BODY SAR MEASUREMENT PLOTS @ 5200 MHz



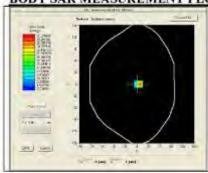


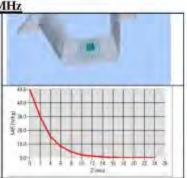
BODY SAR MEASUREMENT PLOTS @ 5400 MHz





BODY SAR MEASUREMENT PLOTS @ 5600 MHz





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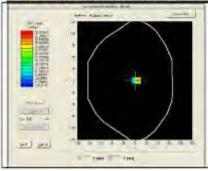
Report No.: BL-SZ1740113-701

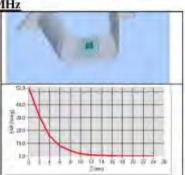


SAR REFERENCE WAVEGUIDE CALIBRATION REPORT

Ref: ACR.75.15.14.SATU.A.

BODY SAR MEASUREMENT PLOTS @ 5800 MHz





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8 LIST OF EQUIPMENT

Equipment Summary Sheet					
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date	
Flat Phantom	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 ca required.	
Network Analyzer	Rhode & Schwarz ZVA	51/100132	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-E28A	US37181460	12/2013	12/2016	
Directional Coupler	Narda 4215-20	01386	Characterized pnor 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	