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# **SAR Reference Dipole Calibration Report**

Ref: ACR.165.2.17.SATU.A

# SIEMIC TESTING AND CERTIFICATION SERVICES

ZONE A,FLOOR 1,BUILDING 2,WAN YE LONG TECHNOLOGY PARK,SOUTH SIDE OF ZHOUSHI ROAD, SHIYAN STREET,BAO'AN DISTRICT, SHENZHEN 518108, GUANGDONG, P.R.C.

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ SERIAL NO.: SN 18/11 DIPC150

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





Calibration Date: 06/8/2017

# 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.



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Issue	Date	Modifications
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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 835 MHz REFERENCE DIPOLE	
Manufacturer	MVG	
Model	SID835	
Serial Number	SN 18/11 DIPC150	
Product Condition (new / used)	Used	

A yearly calibration interval is recommended.

# 3 PRODUCT DESCRIPTION

# 3.1 <u>GENERAL INFORMATION</u>

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 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 <u>VALIDATION MEASUREMENT</u>

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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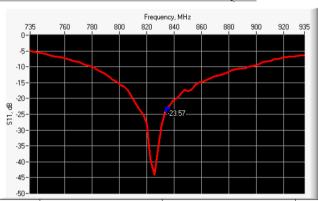


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10 g	20.1 %

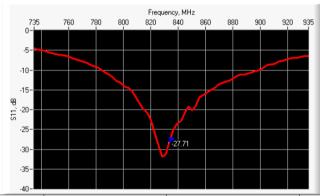
# 6 CALIBRATION MEASUREMENT RESULTS

# 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)Return Loss (dB)Requirement (dB)Impedance835-23.57-20 $57.0 \Omega + 1.2 j\Omega$ 

# 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-27.71	-20	$52.9 \Omega + 3.1 j\Omega$

# 6.3 MECHANICAL DIMENSIONS

Frequency MHz L mm		mm	h mm		<b>d</b> 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 %.	PASS	89.8 ±1 %.	PASS	3.6 ±1 %.	PASS
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 %.		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 <sub>r</sub> ')	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 %	PASS	0.90 ±5 %	PASS
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	

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

# 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.

C 0	ODENICAD III
Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps': 40.0 sigma: 0.90
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	835 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR	(W/kg/W)
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56	9.64 (0.96)	6.22	6.20 (0.62)
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	

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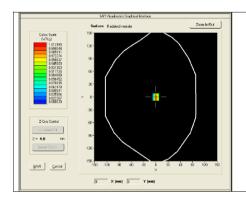


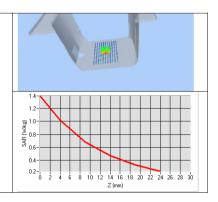
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Ref: ACR.165.2.17.SATU.A

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	
3700	67.4	24.2	





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity ( $\epsilon_r$ ')		Conductivity (σ) 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 %	PASS	0.97 ±5 %	PASS
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 %	

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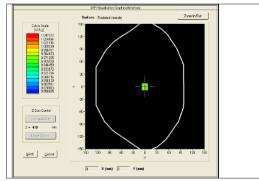
Ref: ACR.165.2.17.SATU.A

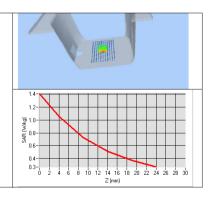
E2 0 . E 0/		
52.9 ±5 %	1.81 ±5 %	
52.7 ±5 %	1.95 ±5 %	
52.5 ±5 %	2.16 ±5 %	
52.0 ±5 %	2.73 ±5 %	
51.3 ±5 %	3.31 ±5 %	
51.0 ±5 %	3.55 ±5 %	
49.0 ±10 %	5.30 ±10 %	
48.9 ±10 %	5.42 ±10 %	
48.7 ±10 %	5.53 ±10 %	
48.6 ±10 %	5.65 ±10 %	
48.5 ±10 %	5.77 ±10 %	
48.2 ±10 %	6.00 ±10 %	
	52.7 ±5 % 52.5 ±5 % 52.0 ±5 % 51.0 ±5 % 49.0 ±10 % 48.9 ±10 % 48.7 ±10 % 48.6 ±10 % 48.5 ±10 %	52.7 ±5 % 1.95 ±5 %   52.5 ±5 % 2.16 ±5 %   52.0 ±5 % 2.73 ±5 %   51.3 ±5 % 3.31 ±5 %   51.0 ±5 % 3.55 ±5 %   49.0 ±10 % 5.30 ±10 %   48.9 ±10 % 5.42 ±10 %   48.7 ±10 % 5.65 ±10 %   48.5 ±10 % 5.77 ±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': 57.5 sigma: 0.96
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	835 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)	
	measured	measured	
835	9.96 (1.00)	6.53 (0.65)	





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# 8 LIST OF EQUIPMENT

Equipment Summary Sheet					
Equipment Description	Tidentification No. 1		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 cal required.	Validated. No cal required.	
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019	
Calipers	Carrera	CALIPER-01	01/2017	01/2020	
Reference Probe	MVG	EPG122 SN 18/11	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.	
Temperature and Humidity Sensor	Control Company	150798832	10/2015	10/2017	



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# **SAR Reference Dipole Calibration Report**

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# SIEMIC TESTING AND CERTIFICATION SERVICES

ZONE A,FLOOR 1,BUILDING 2,WAN YE LONG TECHNOLOGY PARK,SOUTH SIDE OF ZHOUSHI ROAD, SHIYAN STREET,BAO'AN DISTRICT, SHENZHEN 518108, GUANGDONG, P.R.C.

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1800 MHZ SERIAL NO.: SN 18/11 DIPF152

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





Calibration Date: 06/8/2017

# 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.



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	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	6/14/2017	JES
Checked by :	Jérôme LUC	Product Manager	6/14/2017	JE
Approved by:	Kim RUTKOWSKI	Quality Manager	6/14/2017	him Puthowski

	Customer Name
Distribution :	SIEMIC Testing and Certification Services

Issue	Date	Modifications
A	6/14/2017	Initial release



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	7.1	Head Liquid Measurement	7
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8	List	of Equipment11	



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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 1800 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID1800
Serial Number	SN 18/11 DIPF152
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 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 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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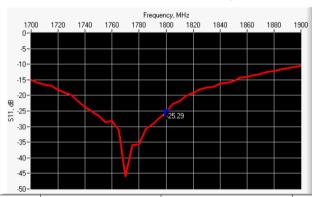


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10 g	20.1 %

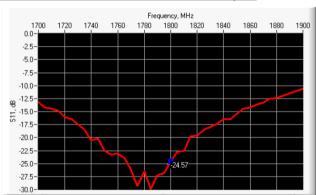
# 6 CALIBRATION MEASUREMENT RESULTS

# 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)Return Loss (dB)Requirement (dB)Impedance1800-25.29-20 $44.9 \Omega + 0.2 j\Omega$ 

# 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1800	-24.57	-20	46.2 Ω - 4.2 iΩ

# 6.3 <u>MECHANICAL DIMENSIONS</u>

Frequency MHz	L mm		<b>h</b> mi	h mm		<b>d</b> 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     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 %.     2450   51.5 ± 1 %.   30.4 ± 1 %.   3.6 ± 1 %.     2600   48.5 ± 1 %.   28.8 ± 1 %.   3.6 ± 1 %.     3500   37.0± 1 %.   26.4 ± 1 %.   3.6 ± 1 %.     3700   34.7± 1 %.   26.4 ± 1 %.   3.6 ± 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     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 %.     3000   41.5 ± 1 %.   25.0 ± 1 %.   3.6 ± 1 %.     3500   37.0 ± 1 %.   26.4 ± 1 %.   3.6 ± 1 %.	450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
900	750	176.0 ±1 %.		100.0 ±1 %.		6.35 ±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     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 %.	835	161.0 ±1 %.		89.8 ±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     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 %.	900	149.0 ±1 %.		83.3 ±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     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 %.	1450	89.1 ±1 %.		51.7 ±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 %.   3.6 ± 1 %.     2000   66.3 ± 1 %.   37.5 ± 1 %.   3.6 ± 1 %.   3.6 ± 1 %.     2100   61.0 ± 1 %.   35.7 ± 1 %.   3.6 ± 1 %.   3.6 ± 1 %.     2300   55.5 ± 1 %.   32.6 ± 1 %.   3.6 ± 1 %.   3.6 ± 1 %.     2450   51.5 ± 1 %.   30.4 ± 1 %.   3.6 ± 1 %.   3.6 ± 1 %.     2600   48.5 ± 1 %.   28.8 ± 1 %.   3.6 ± 1 %.   3.6 ± 1 %.     3000   41.5 ± 1 %.   25.0 ± 1 %.   3.6 ± 1 %.   3.6 ± 1 %.     3500   37.0 ± 1 %.   26.4 ± 1 %.   3.6 ± 1 %.   3.6 ± 1 %.	1500	80.5 ±1 %.		50.0 ±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 %.   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 %.	1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1900 68.0 ±1 %. 39.5 ±1 %. 3.6 ±1 %.	1750	75.2 ±1 %.		42.9 ±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 %.	1800	72.0 ±1 %.	PASS	41.7 ±1 %.	PASS	3.6 ±1 %.	PASS
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 %.	1900	68.0 ±1 %.		39.5 ±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 %.	1950	66.3 ±1 %.		38.5 ±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 %.	2000	64.5 ±1 %.		37.5 ±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 %.	2100	61.0 ±1 %.		35.7 ±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 %.	2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
3000 41.5 ±1 %. 25.0 ±1 %. 3.6 ±1 %. 3500 37.0±1 %. 26.4 ±1 %. 3.6 ±1 %.	2450	51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.	
3500 37.0±1%. 26.4±1%. 3.6±1%.	2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
	3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3700 34.7±1%. 26.4±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	Relative permittivity $(\epsilon_r')$		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 %		1.37 ±5 %	

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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': 41.7 sigma: 1.46
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/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	37.99 (3.80)	20.1	20.05 (2.00)

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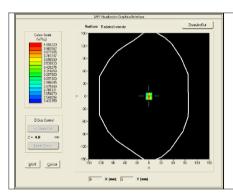


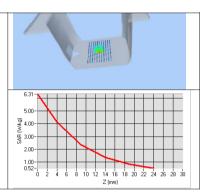
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1900	39.7	20.5
1950	40.5	20.9
2000	41.1	21.1
2100	43.6	21.9
2300	48.7	23.3
2450	52.4	24
2600	55.3	24.6
3000	63.8	25.7
3500	67.1	25
3700	67.4	24.2





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity $(\epsilon_{r}')$		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 %	

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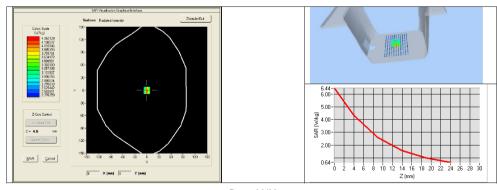
Ref: ACR.165.4.17.SATU.A

2300	52.9 ±5 %	1.81 ±5 %
2450	52.7 ±5 %	1.95 ±5 %
2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5 %	3.31 ±5 %
3700	51.0 ±5 %	3.55 ±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: 1.46
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/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	39.62 (3.96)	21.19 (2.12)



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# 8 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description			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 cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	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.
Temperature and Humidity Sensor	Control Company	150798832	10/2015	10/2017



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# **SAR Reference Dipole Calibration Report**

Ref: ACR.165.5.17.SATU.A

# SIEMIC TESTING AND CERTIFICATION SERVICES

ZONE A,FLOOR 1,BUILDING 2,WAN YE LONG TECHNOLOGY PARK,SOUTH SIDE OF ZHOUSHI ROAD, SHIYAN STREET,BAO'AN DISTRICT, SHENZHEN 518108, GUANGDONG, P.R.C.

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1900 MHZ SERIAL NO.: SN 18/11 DIPG153

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





Calibration Date: 06/8/2017

# 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.



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	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	6/14/2017	JES
Checked by :	Jérôme LUC	Product Manager	6/14/2017	JE
Approved by:	Kim RUTKOWSKI	Quality Manager	6/14/2017	him Puthowski

	Customer Name
Distribution :	SIEMIC Testing and Certification Services

Date	Modifications
6/14/2017	Initial release



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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 18/11 DIPG153	
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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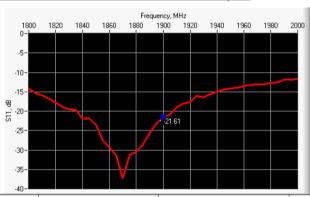


Ref: ACR.165.5.17.SATU.A

10 g	20.1 %
C	

# 6 CALIBRATION MEASUREMENT RESULTS

# 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)Return Loss (dB)Requirement (dB)Impedance1900-21.61-20 $52.8 \Omega + 8.1 \text{ j}\Omega$ 

# 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-22.99	-20	$47.9 \Omega + 6.6 j\Omega$

# 6.3 <u>MECHANICAL DIMENSIONS</u>

Frequency MHz	L mm		h mm		<b>d</b> 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 %.		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 permittivity ( $\epsilon_{r}$ ')		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 %		1.37 ±5 %	

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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': 38.5 sigma: 1.45
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/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		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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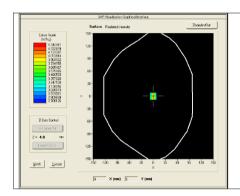


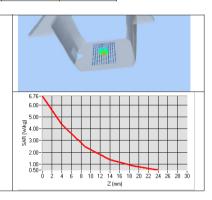
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1900	39.7	39.88 (3.99)	20.5	20.52 (2.05)
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	
3700	67.4		24.2	





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity $(\epsilon_r')$		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 %		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 %	

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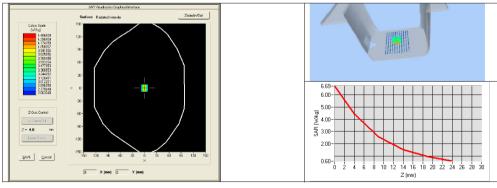
Ref: ACR.165.5.17.SATU.A

2300	52.9 ±5 %	1.81 ±5 %
2450	52.7 ±5 %	1.95 ±5 %
2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5 %	3.31 ±5 %
3700	51.0 ±5 %	3.55 ±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': 53.3 sigma: 1.56
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/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	40.38 (4.04)	20.98 (2.10)	



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# 8 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	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.
Temperature and Humidity Sensor	Control Company	150798832	10/2015	10/2017



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# **SAR Reference Dipole Calibration Report**

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# SIEMIC TESTING AND CERTIFICATION SERVICES

ZONE A,FLOOR 1,BUILDING 2,WAN YE LONG TECHNOLOGY PARK,SOUTH SIDE OF ZHOUSHI ROAD, SHIYAN STREET,BAO'AN DISTRICT, SHENZHEN 518108, GUANGDONG, P.R.C.

# MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ SERIAL NO.: SN 18/11 DIPJ155

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





Calibration Date: 06/8/2017

# 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.



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	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	6/14/2017	JE
Checked by :	Jérôme LUC	Product Manager	6/14/2017	JE
Approved by:	Kim RUTKOWSKI	Quality Manager	6/14/2017	thim Pruthowski

	Customer Name
Distribution :	SIEMIC Testing and Certification Services

Issue	Date	Modifications
A	6/14/2017	Initial release



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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 2450 MHz REFERENCE DIPOLE	
Manufacturer	MVG	
Model	SID2450	
Serial Number	SN 18/11 DIPJ155	
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 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 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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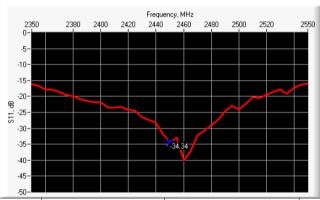


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10 g	20.1 %

# 6 CALIBRATION MEASUREMENT RESULTS

# 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)Return Loss (dB)Requirement (dB)Impedance2450-34.34-20 $50.3 \Omega + 1.9 j\Omega$ 

# 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-27.13	-20	$54.0 \Omega + 2.3 j\Omega$

# 6.3 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h mm		<b>d</b> 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 %.		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 <u>HEAD LIQUID MEASUREMENT</u>

Frequency MHz	Relative permittivity $(\epsilon_{r}')$		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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