



# **SAR Reference Dipole Calibration Report**

Ref: ACR.156.6.15.SATU.A

## SHENZHEN TONGCE TESTING LAB

2101&2201, ZHENCHANG FACTORY, RENSHAN INDUSTRIAL ZONE, FUHAI SUBDISTRICT, BAOAN DISTRICT, SHENZHEN, GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1800 MHZ SERIAL NO.: SN 16/15 DIP 1G800-371

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



Calibration Date: 06/05/2024

#### 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.





#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.6.15.SATU.A

	Name	Function	Date	Signature
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	Customer Name
Distribution :	SSHENZHEN TONGCE TESTING LAB

Issue	Date	Modifications
A	06/05/2024	Initial release

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Ref: ACR.156.6.15.SATU.A

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Ref: ACR.156.6.15.SATU.A

### 1 INTRODUCTION

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

#### 2 DEVICE UNDER TEST

Device Under Test				
Device Type COMOSAR 1800 MHz REFERENCE DIPO				
Manufacturer	MVG			
Model	SID1800			
Serial Number	SN 16/15 DIP 1G800-371			
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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Report No.: TCT240513E009

#### 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 <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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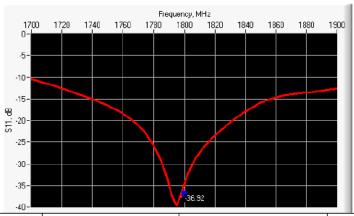
#### SAR REFERENCE DIPOLE CALIBRATION REPORT

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10 g	20.1 %

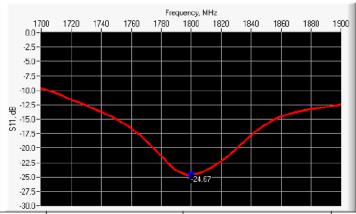
#### 6 CALIBRATION MEASUREMENT RESULTS

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



Frequency (MHz) Return Loss (dB)		Requirement (dB)	Impedance	
1800	-36.92	-20	$48.3 \Omega - 0.5 j\Omega$	

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



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1800	-24.67	-20	47.6 Ω - 5.1 iΩ

## 6.3 MECHANICAL DIMENSIONS

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

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

#### 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε <sub>r</sub> ')		Conductivi	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': 41.8 sigma: 1.38
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	37.67(3.60)	20.1	20.23 (2.15)

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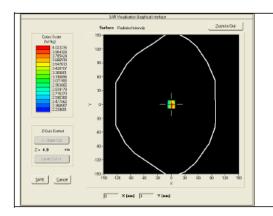


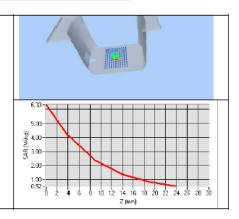


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1900	39.7	20.5	
1950	40.5	20.9	
2000	41.1	21.1	
2100	43.6	21.9	
2300	48.7	23.3	
2450	52.4	24	
2600	55.3	24.6	
3000	63.8	25.7	
3500	67.1	25	





### 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε <sub>r</sub> ')		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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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

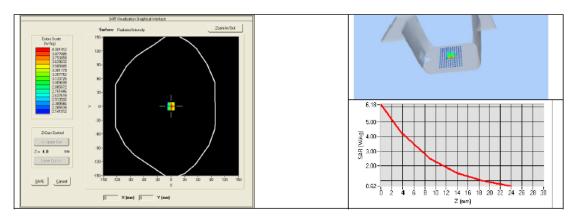
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2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5 %	3.31 ±5 %
5200	49.0 ±10 %	5.30 ±10 %
5300	48.9 ±10 %	5.42 ±10 %
5400	48.7 ±10 %	5.53 ±10 %
5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2 ±10 %	6.00 ±10 %

## 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=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	37.69 (3.65)	20.57 (2.00)



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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Report No.: TCT240513E009

Ref: ACR.156.6.15.SATU.A

## 8 LIST OF EQUIPMENT

Equipment Summary Sheet					
Equipment Description	Identification No.		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	02/2024	02/2027	
Calipers	Carrera	CALIPER-01	02/2024	02/2027	
Reference Probe	MVG	EPG122 SN 18/11	02/2024	02/2025	
Multimeter	Keithley 2000	1188656	02/2024	02/2027	
Signal Generator	Agilent E4438C	MY49070581	02/2024 02/2027		
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Power Meter	HP E4418A	US38261498	02/2024 02/2027		
Power Sensor	HP ECP-E26A	US37181460	02/2024	02/2027	
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	02/2024	02/2027	

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# **SAR Reference Dipole Calibration Report**

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## SHENZHEN TONGCE TESTING LAB

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FREQUENCY: 1900 MHZ SERIAL NO.: SN 16/15 DIP 1G900-372

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





Calibration Date: 06/05/2024

#### 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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Prepared by :	Jérôme LUC	Product Manager	06/05/2024	JES
Checked by:	Jérôme LUC	Product Manager	06/05/2024	JE
Approved by:	Kim RUTKOWSKI	Quality Manager	06/05/2024	thim Puthowski

Distribution : Customer Name

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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

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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 DIPO					
Manufacturer MVG					
Model	SID1900				
Serial Number	SN 16/15 DIP 1G900-372				
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

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#### 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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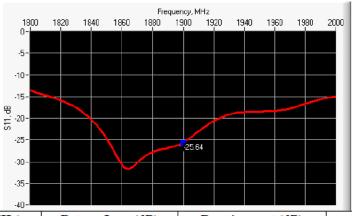
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10 g	20.1 %

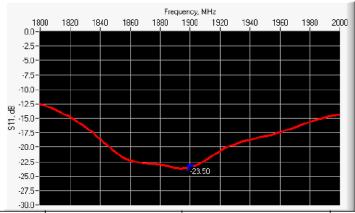
#### 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-25.64	-20	$51.6 \Omega + 4.9 j\Omega$

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



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-23.50	-20	$48.5 \Omega + 6.4 i\Omega$

### 6.3 MECHANICAL DIMENSIONS

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

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### 7 VALIDATION MEASUREMENT

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#### 7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε <sub>r</sub> ')		Conductiv	ity (σ) S/m
	required	measured	required	measured
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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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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.7.15.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': 40.4 sigma: 1.41
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 (	1 g SAR (W/kg/W)		(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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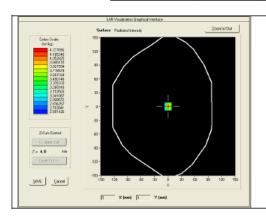


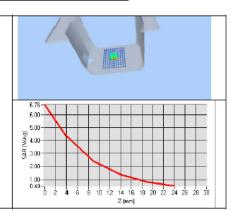


#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.7.15.SATU.A

	_			
1900	39.7	39.26 (3.85)	20.5	20.49 (2.12)
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

Relative permittivity (ε <sub>r</sub> ')		Conductivi	ity (σ) S/m
required	measured	required	measured
61.9 ±5 %		0.80 ±5 %	
58.2 ±5 %		0.92 ±5 %	
56.7 ±5 %		0.94 ±5 %	
55.5 ±5 %		0.96 ±5 %	
55.2 ±5 %		0.97 ±5 %	
55.0 ±5 %		1.05 ±5 %	
55.0 ±5 %		1.06 ±5 %	
54.0 ±5 %		1.30 ±5 %	
53.8 ±5 %		1.40 ±5 %	
53.3 ±5 %		1.52 ±5 %	
53.3 ±5 %	PASS	1.52 ±5 %	PASS
53.3 ±5 %		1.52 ±5 %	
53.2 ±5 %		1.62 ±5 %	
52.7 ±5 %		1.95 ±5 %	
	required 61.9 ±5 % 58.2 ±5 % 56.7 ±5 % 55.5 ±5 % 55.0 ±5 % 55.0 ±5 % 54.0 ±5 % 53.3 ±5 % 53.3 ±5 % 53.3 ±5 %	required measured 61.9 ±5 % 58.2 ±5 % 56.7 ±5 % 55.2 ±5 % 55.0 ±5 % 54.0 ±5 % 53.8 ±5 % 53.3 ±5 % PASS 53.3 ±5 % 53.2 ±5 %	required         measured         required           61.9 ± 5 %         0.80 ± 5 %           58.2 ± 5 %         0.92 ± 5 %           56.7 ± 5 %         0.94 ± 5 %           55.5 ± 5 %         0.96 ± 5 %           55.2 ± 5 %         0.97 ± 5 %           55.0 ± 5 %         1.05 ± 5 %           54.0 ± 5 %         1.30 ± 5 %           53.8 ± 5 %         1.40 ± 5 %           53.3 ± 5 %         1.52 ± 5 %           53.3 ± 5 %         1.52 ± 5 %           53.2 ± 5 %         1.62 ± 5 %

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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

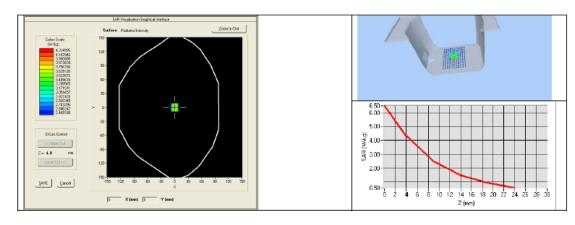
Ref: ACR.156.7.15.SATU.A

52.5 ±5 %	2.16 ±5 %
52.0 ±5 %	2.73 ±5 %
51.3 ±5 %	3.31 ±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 %
	52.0 ±5 % 51.3 ±5 % 49.0 ±10 % 48.9 ±10 % 48.7 ±10 % 48.6 ±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=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	38.71 (3.70)	20.53 (2.12)	



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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Report No.: TCT240513E009

Ref: ACR.156.7.15.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 cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2024	02/2027
Calipers	Carrera	CALIPER-01	02/2024	02/2027
Reference Probe	MVG	EPG122 SN 18/11	02/2024	02/2025
Multimeter	Keithley 2000	1188656	02/2024	02/2027
Signal Generator	Agilent E4438C	MY49070581	02/2024	02/2027
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	02/2024	02/2027
Power Sensor	HP ECP-E26A	US37181460	02/2024	02/2027
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	02/2024	02/2027

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# **SAR Reference Dipole Calibration Report**

Ref: ACR.156.9.15.SATU.A

## SHENZHEN TONGCE TESTING LAB

2101&2201, ZHENCHANG FACTORY, RENSHAN INDUSTRIAL FUHAI SUBDISTRICT, BAOAN DISTRICT, SHENZHEN, GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA

MVG COMOSAR REFERENCE DIPOLE FREQUENCY: 2450 MHZ

SERIAL NO.: SN 16/15 DIP 2G450-374

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



Calibration Date: 06/05/2024

### 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.





#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	06/05/2024	JES
Checked by :	Jérôme LUC	Product Manager	06/05/2024	JES
Approved by :	Kim RUTKOWSKI	Quality Manager	06/05/2024	thim Putthowski

	Customer Name
Distribution:	SHENZHEN TONGCE
Distribution .	TESTING LAB

Issue	Date	Modifications
A	06/05/2024	Initial release

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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.SATU.A

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### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.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 2450 MHz REFERENCE DIPOLE					
Manufacturer	MVG					
Model	SID2450					
Serial Number	SN 16/15 DIP 2G450-374					
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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mvg

#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.SATU.A

Report No.: TCT240513E009

#### 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.

#### 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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Hotline: 400-6611-140 Tel: 86-755-27673339 Fax: 86-755-27673332 http://www.tct-lab.com





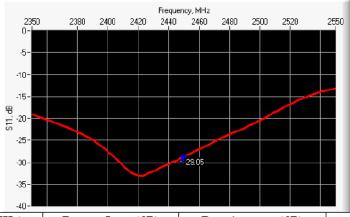
#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.SATU.A

10 g	20.1 %

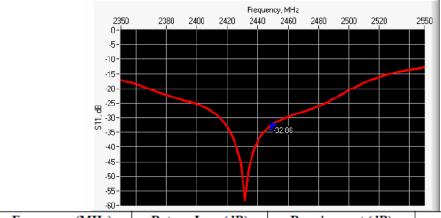
### 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	<b>-</b> 29.05	-20	46.7 Ω <b>-</b> 0.2 jΩ

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



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-32.86	-20	48.6 Ω <b>-</b> 1.9 jΩ

## 6.3 MECHANICAL DIMENSIONS

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

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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.SATU.A

90.0 ±1 %.		1667410/		6.05.14.07	
		166.7 ±1 %.		6.35 ±1 %.	
76.0 ±1 %.		100.0 ±1 %.		6.35 ±1 %.	
61.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
49.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
39.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
30.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.	
58.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
56.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
54.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
51.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
51.5 ±1 %.	PASS	30.4 ±1 %.	PASS	3.6 ±1 %.	PASS
18.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
11.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
37.0±1 %.		26.4 ±1 %.		3.6 ±1 %.	
34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.	
	51.0 ±1 %. 49.0 ±1 %. 49.0 ±1 %. 99.1 ±1 %. 99.0 ±1 %. 52.2 ±1 %. 42.0 ±1 %. 48.0 ±1 %. 46.3 ±1 %. 41.0 ±1 %. 55.5 ±1 %. 41.5 ±1 %. 41.5 ±1 %. 41.5 ±1 %. 41.5 ±1 %. 41.7 ±1 %. 41.7 ±1 %. 41.7 ±1 %. 41.7 ±1 %. 41.7 ±1 %. 41.7 ±1 %. 41.7 ±1 %. 41.7 ±1 %. 41.7 ±1 %. 41.7 ±1 %. 41.7 ±1 %.	51.0 ±1 %. 49.0 ±1 %. 49.0 ±1 %. 99.1 ±1 %. 99.0 ±1 %. 52.2 ±1 %. 52.0 ±1 %. 63.3 ±1 %. 64.5 ±1 %. 61.0 ±1 %. FASS 8.5 ±1 %. 61.5 ±1 %. 63.5 ±1 %. 63.5 ±1 %. 63.5 ±1 %. 63.5 ±1 %. 63.5 ±1 %. 63.5 ±1 %. 63.5 ±1 %. 63.5 ±1 %. 63.5 ±1 %. 63.6 ±1 %. 64.5 ±1 %. 65.5 ±1 %. 65.5 ±1 %. 65.5 ±1 %. 65.5 ±1 %. 65.5 ±1 %. 65.5 ±1 %. 65.5 ±1 %. 65.5 ±1 %.	51.0 ±1 %.  89.8 ±1 %.  89.1 ±1 %.  51.7 ±1 %.  50.5 ±1 %.  50.0 ±1 %.  50.0 ±1 %.  45.7 ±1 %.  42.9 ±1 %.  42.9 ±1 %.  41.7 ±1 %.  88.0 ±1 %.  39.5 ±1 %.  39.5 ±1 %.  39.5 ±1 %.  31.5 ±1 %.  31.5 ±1 %.  32.6 ±1 %.  32.6 ±1 %.  32.6 ±1 %.  32.6 ±1 %.  33.5 ±1 %.  32.6 ±1 %.  32.6 ±1 %.  33.5 ±1 %.  32.6 ±1 %.  33.5 ±1 %.  34.5 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±1 %.  35.7 ±	51.0 ±1 %. 89.8 ±1 %. 83.3 ±1 %. 99.1 ±1 %. 51.7 ±1 %. 50.0 ±1 %. 99.0 ±1 %. 45.7 ±1 %. 99.0 ±1 %. 42.9 ±1 %. 22.0 ±1 %. 39.5 ±1 %. 39.5 ±1 %. 39.5 ±1 %. 39.5 ±1 %. 39.5 ±1 %. 37.5 ±1 %. 37.5 ±1 %. 37.5 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 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32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %. 32.6 ±1 %.	51.0 ±1 %.       89.8 ±1 %.       3.6 ±1 %.         49.0 ±1 %.       83.3 ±1 %.       3.6 ±1 %.         99.1 ±1 %.       51.7 ±1 %.       3.6 ±1 %.         90.5 ±1 %.       3.6 ±1 %.       3.6 ±1 %.         99.0 ±1 %.       45.7 ±1 %.       3.6 ±1 %.         52.2 ±1 %.       42.9 ±1 %.       3.6 ±1 %.         42.0 ±1 %.       3.6 ±1 %.       3.6 ±1 %.         48.0 ±1 %.       39.5 ±1 %.       3.6 ±1 %.         44.5 ±1 %.       37.5 ±1 %.       3.6 ±1 %.         41.0 ±1 %.       35.7 ±1 %.       3.6 ±1 %.         45.5 ±1 %.       32.6 ±1 %.       3.6 ±1 %.         45.5 ±1 %.       28.8 ±1 %.       3.6 ±1 %.         47.5 ±1 %.       3.6 ±1 %.       3.6 ±1 %.         47.5 ±1 %.       3.6 ±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 (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 %		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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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.SATU.A

40.0 ±5 %		1.40 ±5 %	
40.0 ±5 %		1.40 ±5 %	
40.0 ±5 %		1.40 ±5 %	
40.0 ±5 %		1.40 ±5 %	
39.8 ±5 %		1.49 ±5 %	
39.5 ±5 %		1.67 ±5 %	
39.2 ±5 %	PASS	1.80 ±5 %	PASS
39.0 ±5 %		1.96 ±5 %	
38.5 ±5 %		2.40 ±5 %	
37.9 ±5 %		2.91 ±5 %	
	40.0 ±5 % 40.0 ±5 % 40.0 ±5 % 39.8 ±5 % 39.5 ±5 % 39.2 ±5 % 39.0 ±5 %	40.0 ±5 % 40.0 ±5 % 40.0 ±5 % 39.8 ±5 % 39.5 ±5 % 39.2 ±5 % PASS 39.0 ±5 % 38.5 ±5 %	40.0 ±5 %       1.40 ±5 %         40.0 ±5 %       1.40 ±5 %         40.0 ±5 %       1.40 ±5 %         39.8 ±5 %       1.49 ±5 %         39.5 ±5 %       1.67 ±5 %         39.0 ±5 %       1.96 ±5 %         38.5 ±5 %       2.40 ±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': 38.3 sigma: 1.80
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=5mm
Frequency	2450 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR	(W/kg/W)
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		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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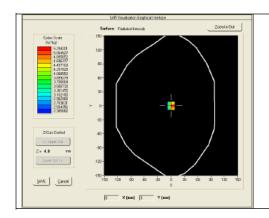


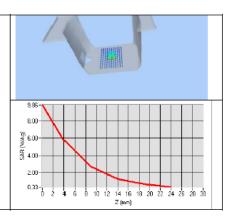


#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.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	53.26 (5.38)	24	24.15 (2.49)
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	





## 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity $(\epsilon_{r}')$		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 %		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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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

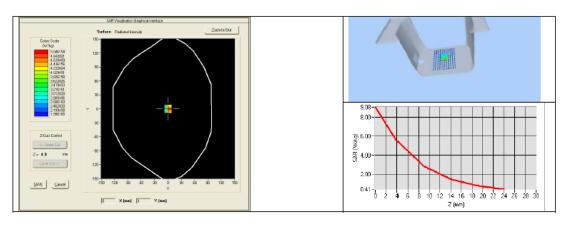
Ref: ACR.156.9.15.SATU.A

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=5mm/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	50.63 (5.01)	23.40 (2.37)



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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.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 cal required.	
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.	
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2024	02/2027	
Calipers	Carrera	CALIPER-01	02/2024	02/2027	
Reference Probe	MVG	EPG122 SN 18/11	02/2024	02/2025	
Multimeter	Keithley 2000	1188656	02/2024	02/2027	
Signal Generator	Agilent E4438C	MY49070581	02/2024	02/2027	
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Power Meter	HP E4418A	US38261498	02/2024	02/2027	
Power Sensor	HP ECP-E26A	US37181460	02/2024	02/2027	
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	02/2024	02/2027	

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# **SAR Reference Dipole Calibration Report**

Ref: ACR.156.10.15.SATU.A

## SHENZHEN TONGCE TESTING LAB

2101&2201, ZHENCHANG FACTORY, RENSHAN INDUSTRIAL ZONE, FUHAI SUBDISTRICT, BAOAN DISTRICT, SHENZHEN, GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA

## MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2600 MHZ SERIAL NO.: SN 16/15 DIP 2G600-375

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





Calibration Date: 06/05/2024

## 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.





### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.10.15.SATU.A

	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	06/05/2024	J3
Checked by :	Jérôme LUC	Product Manager	06/05/2024	JS
Approved by:	Kim RUTKOWSKI	Quality Manager	06/05/2024	Mim Puthroushi

Customer Name
SHENZHEN TONGCE TESTING LAB

Issue	Date	Modifications
A	06/05/2024	Initial release

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#### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.10.15.SATU.A

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### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 156 10.15 SATU A

# 1 INTRODUCTION

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

### 2 DEVICE UNDER TEST

Device Under Test			
Device Type	COMOSAR 2600 MHz REFERENCE DIPOLE		
Manufacturer	MVG		
Model SID2600			
Serial Number	SN 16/15 DIP 2G600-375		
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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Report No.: TCT240513E009

# 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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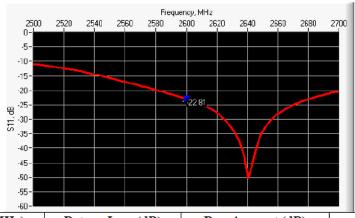
### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.10.15.SATU.A

	10 g	20.1 %
1		

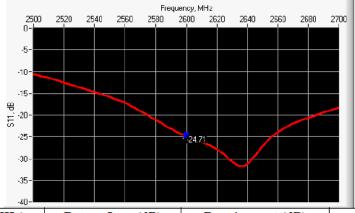
# 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2600	-22.81	-20	$55.3 \Omega - 5.1 j\Omega$

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2600	-24.71	-20	51.5 Ω - 5.5 iΩ

### 6.3 MECHANICAL DIMENSIONS

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

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### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.10.15.SATU.A

450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.		100.0 ±1 %.		6.35 ±1 %.	
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
1800	72.0 ±1 %.		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 %.	PASS	28.8 ±1 %.	PASS	3.6 ±1 %.	PASS
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	Relative permittivity (ε <sub>r</sub> ')		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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# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.10.15.SATU.A

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 %	PASS	1.96 ±5 %	PASS
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': 38.2 sigma: 1.93
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=5mm
Frequency	2600 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (	1 g SAR (W/kg/W)		(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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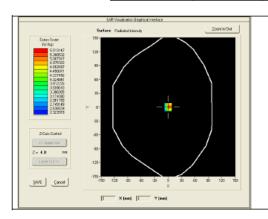


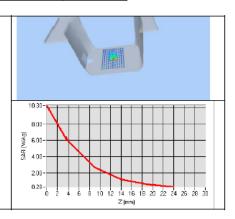


### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.10.15.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	54.31 (5.36)	24.6	24.14 (2.42)
3000	63.8		25.7	
3500	67.1		25	





# 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε <sub>r</sub> ')		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 %		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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### SAR REFERENCE DIPOLE CALIBRATION REPORT

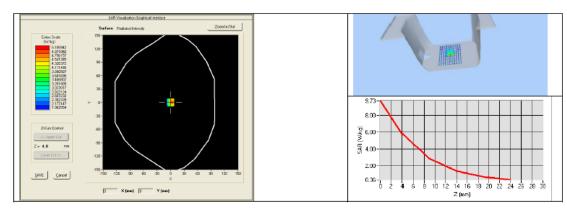
Ref: ACR.156.10.15.SATU.A

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 %		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

OPENSAR V4
SN 20/09 SAM71
SN 18/11 EPG122
Body Liquid Values: eps': 51.6 sigma: 2.21
10.0 mm
dx=8mm/dy=8mm
dx=5mm/dy=5mm/dz=5mm
2600 MHz
20 dBm
21 °C
21 °C
45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
2600	53.26 (5.12)	23.89 (2.30)



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Report No.: TCT240513E009

Ref. ACR.156.10.15.SATU.A

# 8 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	I IIdeni		Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	SN-20/09-SAM71	randatou. The oan	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2024	02 <i>1</i> 2024
Calipers	Carrera	CALIPER-01	02 <i>1</i> 2024	02/2027
Reference Probe	MVG	EPG122 SN 18/11	02/2024	02/2025
Multimeter	Keithley 2000	1188656	02/2024	02/2027
Signal Generator	Agilent E4438C	MY49070581	02 <i>1</i> 2024	02/2027
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	02/2024	02/2027
Power Sensor	HP ECP-E26A	US37181460	02/2024	02/2027
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	09/2023	09/2024

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# **SAR Reference Dipole Calibration Report**

Ref: ACR.49.13.22.BES.A

# SHENZHEN TONGCE TESTING LAB

2101&2201, ZHENCHANG FACTORY, RENSHAN INDUSTRIAL ZONE, FUHAI SUBDISTRICT, BAOAN DISTRICT, SHENZHEN, GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA FREQUENCY: 3500 MHZ

SERIAL NO.: SN 07/22 DIP3G500-664

### Calibrated at MVG

Z.I. de la pointe du diable Technopôle Brest Iroise – 295 avenue Alexis de Rochon 29280 PLOUZANE - FRANCE

Calibration date: 02/06/2023



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# Summary:

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

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Ref: ACR.49.13.22.BES.A

Report No.: TCT240513E009

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Distribution:	SHENZHEN TONGCE TESTING LAB

Issue	Name	Date	Modifications
A	Jérôme Luc	2/6/2023	Initial release

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### SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.49.13.22.BES.A

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#### INTRODUCTION 1

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

#### DEVICE UNDER TEST 2

Device Under Test		
Device Type	COMOSAR 3500 MHz REFERENCE DIPOLE	
Manufacturer	MVG	
Model	SID3500	
Serial Number	SN 07/22 DIP3G500-664	
Product Condition (new / used)	New	

#### 3 PRODUCT DESCRIPTION

#### 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 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 IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

### 4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

# 4.2 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's 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. A direct method is used with a ISO17025 calibrated caliper.

### 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	0.08 LIN

# 5.2 <u>DIMENSION MEASUREMENT</u>

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
0 - 300	0.20 mm
300 - 450	0.44 mm

# 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty for validation measurements.

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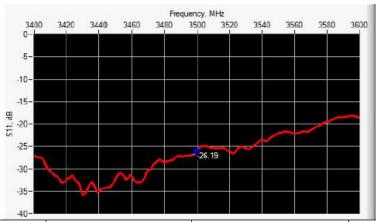
### SAR REFERENCE DIPOLE CALIBRATION REPORT

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Scan Volume	Expanded Uncertainty
1 g	19 % (SAR)
10 g	19 % (SAR)

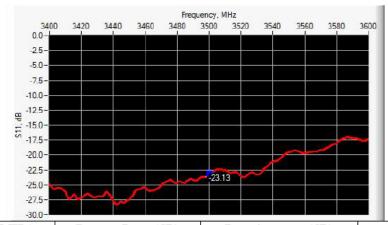
# 6 CALIBRATION MEASUREMENT RESULTS

# 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
3500	-26.19	-20	54.4 Ω - 2.0 iΩ

# 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
3500	-23.13	-20	56.7 Ω - 1.8 jΩ

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# 6.3 MECHANICAL DIMENSIONS

Frequency MHz	Ln	nm	h m	ım	d r	mm
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1 %.		6.35 ±1 %.	
450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.		100.0 ±1 %.		6.35 ±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	86.2 ±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 %.	
3300	-		-		-	
3500	37.0±1 %.	37.01	26.4 ±1 %.	26.43	3.6 ±1 %.	3.58
3700	34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3900	-		-		-	
4200	-		-		-	
4600	-		-		-	
4900	-		-			

# 7 VALIDATION MEASUREMENT

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

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### SAR REFERENCE DIPOLE CALIBRATION REPORT

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# 7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (s <sub>r</sub> ')	Conductiv	ity (σ) S/m
	required	measured	required	measured
300	45.3 ±10 %		0.87 ±10 %	
450	43.5 ±10 %		0.87 ±10 %	
750	41.9 ±10 %		0.89 ±10 %	
835	41.5 ±10 %		0.90 ±10 %	
900	41.5 ±10 %		0.97 ±10 %	
1450	40.5 ±10 %		1.20 ±10 %	
1500	40.4 ±10 %		1.23 ±10 %	
1640	40.2 ±10 %		1.31 ±10 %	
1750	40.1 ±10 %		1.37 ±10 %	
1800	40.0 ±10 %		1.40 ±10 %	
1900	40.0 ±10 %		1.40 ±10 %	
1950	40.0 ±10 %		1.40 ±10 %	
2000	40.0 ±10 %		1.40 ±10 %	
2100	39.8 ±10 %		1.49 ±10 %	
2300	39.5 ±10 %		1.67 ±10 %	
2450	39.2 ±10 %		1.80 ±10 %	
2600	39.0 ±10 %		1.96 ±10 %	
3000	38.5 ±10 %		2.40 ±10 %	
3300	38.2 ±10 %		2.71 ±10 %	
3500	37.9 ±10 %	37.1	2.91 ±10 %	3.05
3700	37.7 ±10 %		3.12 ±10 %	
3900	37.5 ±10 %		3.32 ±10 %	
4200	37.1 ±10 %		3.63 ±10 %	
4600	36.7 ±10 %		4.04 ±10 %	
4900	36.3 ±10 %		4.35 ±10 %	

# 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

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### SAR REFERENCE DIPOLE CALIBRATION REPORT

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Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values: eps': 37.1 sigma: 3.05
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=4mm
Frequency	3500 MHz
Input power	20 dBm
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

Frequency MHz	1 g SAR (	W/kg/W)	10 g SAR	(W/kg/W)
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3300	-		-	
3500	67.1	69.64 (6.96)	25	25.71 (2.57)
3700	67.4		24.2	
3900	-		-	
4200	-		-	
4600	-		-	
4900	-		-	

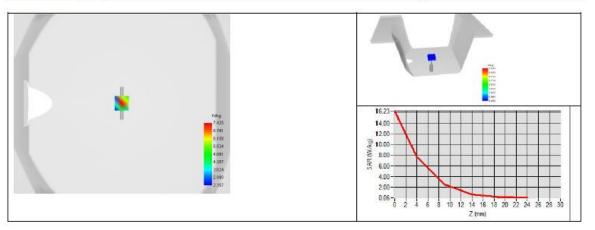
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### SAR REFERENCE DIPOLE CALIBRATION REPORT

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# BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (ε <sub>r</sub> ')	Conductiv	ity (σ) S/m
	required	measured	required	measured
150	61.9 ±10 %		0.80 ±10 %	
300	58.2 ±10 %		0.92 ±10 %	
450	56.7 ±10 %		0.94 ±10 %	
750	55.5 ±10 %		0.96 ±10 %	
835	55.2 ±10 %		0.97 ±10 %	
900	55.0 ±10 %		1.05 ±10 %	
915	55.0 ±10 %		1.06 ±10 %	
1450	54.0 ±10 %		1.30 ±10 %	
1610	53.8 ±10 %		1.40 ±10 %	
1800	53.3 ±10 %		1.52 ±10 %	
1900	53.3 ±10 %		1.52 ±10 %	
2000	53.3 ±10 %		1.52 ±10 %	
2100	53.2 ±10 %		1.62 ±10 %	
2300	52.9 ±10 %		1.81 ±10 %	
2450	52.7 ±10 %		1.95 ±10 %	
2600	52.5 ±10 %		2.16 ±10 %	
3000	52.0 ±10 %		2.73 ±10 %	
3300	51.6 ±10 %		3.08 ±10 %	
3500	51.3 ±10 %	48.6	3.31 ±10 %	3.29
3700	51.0 ±10 %		3.55 ±10 %	
3900	50.8 ±10 %		3.78 ±10 %	
4200	50.4 ±10 %		4.13 ±10 %	
4600	49.8 ±10 %		4.60 ±10 %	
4900	49.4 ±10 %		4.95 ±10 %	
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 %	

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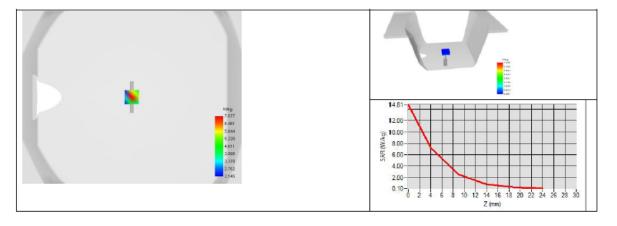
# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.49.13.22.BES.A

# SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Body Liquid Values: eps': 48.6 sigma: 3.29
Distance between dipole center and liquid	10.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=5mm/dy=5mm/dz=4mm
Frequency	3500 MHz
Input power	20 dBm
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
3500	65.20 (6.52)	24.68 (2.47)



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# LIST OF EQUIPMENT

Equipment Summary Sheet							
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date			
SAM Phantom	MVG	I SN 13/09 SAM68	Validated. No cal required.	Validated. No cal required.			
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.			
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2024			
Network Analyzer	Agilent 8753ES	MY40003210	10/2021	10/2024			
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	05/2021	05/2024			
Network Analyzer – Calibration kit	HP 85033D	3423A08186	06/2021	06/2027			
Calipers	Mitutoyo	SN 0009732	10/2021	10/2024			
Reference Probe	MVG	SN 41/18 EPGO333	10/2021	10/2024			
Multimeter	Keithley 2000	1160271	02/2021	02/2024			
Signal Generator	Rohde & Schwarz SMB	106589	04/2021	04/2024			
Amplifier	MVG	MODU-023-C-0002	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.			
Power Meter	NI-USB 5680	170100013	06/2021	06/2024			
Power Meter	Rohde & Schwarz NRVD	832839-056	11/2021	11/2024			
Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.				
Temperature / Humidity Sensor	Testo 184 H1	44225320	06/2021	06/2024			

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# **SAR Reference Dipole Calibration Report**

Ref: ACR.49.14.22.BES.A

# SHENZHEN TONGCE TESTING LAB

2101&2201, ZHENCHANG FACTORY, RENSHAN INDUSTRIAL ZONE, FUHAI SUBDISTRICT, BAOAN DISTRICT, SHENZHEN, GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA FREQUENCY: 3700 MHZ

SERIAL NO.: SN 07/22 DIP3G700-665

Calibrated at MVG
Z.I. de la pointe du diable
Technopôle Brest Iroise – 295 avenue Alexis de Rochon
29280 PLOUZANE - FRANCE

Calibration date: 02/06/2023



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

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Prepared by :	Jérôme Luc	Technical Manager	2/6/2023	JES
Checked by :	Jérôme Luc	Technical Manager	2/6/2023	JES
Approved by :	Yann Toutain	Laboratory Director	2/6/2023	Gann TOUTANN

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Customer Name SHENZHEN TONGCE Distribution: TESTING LAB

	Issue	Name	Date	Modifications
	A	Jérôme Luc	2/6/2023	Initial release
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