

# CALIBRATION DATA PROBE CALIBRATION DATA



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

Ref: ACR.352.1.20.MVGB.A

# ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

1-2/F, BUILDING 19, JUNFENG INDUSTRIAL PARK, CHONGQING ROAD, HEPING COMMUNITY, FUHAI STREET

BAO 'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 03/18 EP327

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 12/17/2020



Accreditations (Q-6789 and #2-6814

#### Summary:

This document presents the method and results from an accredited COMOSAR E-Field Probe calibration performed at MVG, using the CALIPROBE test bench, for use with a MVG COMOSAR system only. The test results covered by accreditation are traceable to the International System of Units (SI).

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Issue	Name	Date	Modifications
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#### DEVICE UNDER TEST

Device Under Test				
Device Type	COMOS AR DOSIMETRIC E FIELD PROBE			
Manufacturer	MVG			
Model	SSE5			
Serial Number	SN 03/18 EP327			
Product Condition (new / used)	Used			
Frequency Range of Probe	0.15 GHz-3GHz			
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.225 MΩ			
	Dipole 2: R2=0.223 MΩ			
	Dipole 3: R3=0.234 MΩ			

#### PRODUCT DESCRIPTION

#### GENERAL INFORMATION 2.1

MVG's COMOSAR E field Probes are built in accordance to the IEEE 1528, FCC KDB865664 D01, CENELEC EN62209 and CEI/IEC 62209 standards.



Figure 1 – MVG COMOSAR Dosimetric E field Dipole

Probe Length	330 mm	
Length of Individual Dipoles	4.5 mm	
Maximum external diameter	8 mm	
Probe Tip External Diameter	5 mm	
Distance between dipoles / probe extremity	2.7 mm	

### 3 MEASUREMENT METHOD

The IEEE 1528, PCC KDB865664 D01, CENELEC EN62209 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

### 3.1 LINEARITY

The evaluation of the linearity was done in free space using the waveguide, performing a power sweep to cover the SAR range 0.01W/kg to 100W/kg.

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#### 3.2 SENSITIVITY

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

### 3.3 LOWER DETECTION LIMIT

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

### 3.4 ISOTROPY

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

### 3.1 BOUNDARY EFFECT

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

The boundary effect uncertainty can be estimated according to the following uncertainty approximation formula based on linear and exponential extrapolations between the surface and  $d_{be}$  +  $d_{\text{sten}}$  along lines that are approximately normal to the surface:

$$SAR_{internation}[\%] = \delta SAR_{be} \frac{\left(d_{be} + d_{stop}\right)^2 \left(e^{-d_{int}(\delta \rho)}\right)}{2d_{stop}}$$
 for  $\left(d_{be} + d_{stop}\right) < 10 \text{ mm}$ 

is the uncertainty in percent of the probe boundary effect SARuncertainty

is the distance between the surface and the closest zoom-scan measurement dbe

point, in millimetre

is the separation distance between the first and second measurement points that  $\Delta_{\text{step}}$ 

are closest to the phantom surface, in millimetre, assuming the boundary effect

at the second location is negligible

is the minimum penetration depth in millimetres of the head tissue-equivalent

liquids defined in this standard, i.e.,  $\delta$ = 14 mm at 3 GHz;

in percent of SAR is the deviation between the measured SAR value, at the 4SARbe

distance dbe from the boundary, and the analytical SAR value.

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The measured worst case boundary effect SARuncertainty[%] for scanning distances larger than 4mm is 1.0% Limit ,2%).

### MEASUREMENT UNCERTAINTY

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

certainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%
Expanded uncertainty 95 % confidence level k = 2					14 %

### 5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters				
Liquid Temperature 20 +/- 1 °C				
Lab Temperature	20 +/- 1 °C			
Lab Humidity	30-80 %			

### 5.1 SENSITIVITY IN AIR

	Normy dipole 2 (μV/(V/m) <sup>2</sup> )	
6.05	7.64	5.09

DCP dipole 1	DCP dipole 2	DCP dipole 3
(mV)	(mV)	(mV)
109	111	112

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

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

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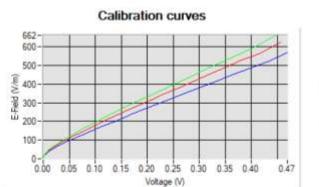
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Dipole 2

### 5.2 LINEARITY

### Linearity 1.00 0.75 0.50 Fron 0.00 -0.25-0.50-0.75-1.00400 200 300 500 600 660 E-Field (V/m)

Linearity:+/-1.74% (+/-0.08dB)

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### 5.3 SENSITIVITY IN LIQUID

Liquid	Erequency (MHz +/- 100MHz)	ConvF
HL750	750	5.18
HL850	835	5.24
HL900	900	5.25
HL1450	1450	5.07
HL1750	1750	4.56
HL1800	1800	4.48
HL2000	2000	4.61
HL2300	2300	4.36
HL2450	2450	4.32
HL2600	2600	3.87

LOWER DETECTION LIMIT: 9mW/kg

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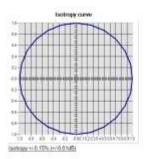




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### 5.4 ISOTROPY

### HL1800 MHz



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### LIST OF EQUIPMENT

Equipment Summary Sheet					
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date	
Flat Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No ca required.	
COMOSAR Test Bench	Version 3	NA	Validated, No cal required,	Validated. No ca required.	
Network Analyzer	Rohde & Schwarz ZVM	100203	05/2019	05/2022	
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	05/2019	05/2022	
Multimeter	Keithley 2000	1160271	02/2020	02/2023	
Signal Generator	Rohde & Schwarz SMB	106589	04/2019	04/2022	
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Power Meter	NI-USB 5680	170100013	05/2019	05/2022	
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.	
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated, No cal required.	Validated. No cal required.	
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.	
Temperature / Humidity Sensor	Testo 184 H1	44220687	05/2020	05/2023	

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### **DIPOLE CALIBRATION DATA**



### SAR Reference Dipole Calibration Report

Ref: ACR.116.3.19.SATU.A

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BAO 'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 750 MHZ

SERIAL NO.: SN 47/14 DIP 0G750-340

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





Calibration Date: 04/26/2019

Summery:

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

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Checked by:	Jérôme LUC	Product Manager	4/26/2019	25
Approved by :	Kim RUTKOWSKI	Quality Manager	4/26/2019	ALL ALVANIAN

Distribution : Compliance

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Issue	Date	Modifications
A	4/26/2019	Initial release

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### 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.

### DEVICE UNDER TEST

Device Under Test					
Device Type	COMOSAR 750 MHz REFERENCE DIPOLE				
Manufacturer	MVG				
Model	SID750				
Serial Number	SN 47/14 DIP 0G750-340				
Product Condition (new / used)					

A yearly calibration interval is recommended.

#### 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 constructed as outlined in the fore mentioned standards.

#### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 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 0.1 dB		
400-6000MHz			

### 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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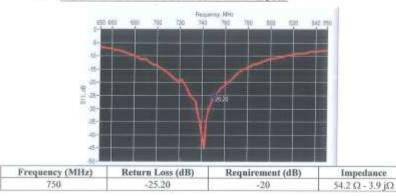
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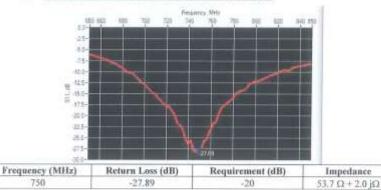
10 g 20.1 %

#### 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



### 6.3 MECHANICAL DIMENSIONS

Frequency MHz	E mm		hmm		d mm	
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1 %		6.35 ±1 %.	

Page: 6/11

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450	290.0±1%.		366.7 ±1.16.		8.35 ±1 %.	
790	1760±1%.	PASS:	300.0 ±1 %	PASS	6.35 ±1 %.	PAS
835	161.0±1%		89.8±1%.		3.611%	
900	149.0 ±1.%		83.3 ±1 %.		3.6 ±1%.	
3450	89.1 ±1 %.		51.7±1%.		3.6:11%	
1500	80.5 ±1 %.		50.0 ±1 %		3.6 21 %.	
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 11 %		38.5 ±1.%.		3.6 ±3 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 11 %.	
2100	61.0 ±1 %.		35.7.11%		3.6 ±1 %.	
2380	55.5 ±1 %.		32.6 ±1.%		3.6 ±1 %	
2450	\$1.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %	
2500	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 (c.*)		Conductivity (a) S/r	
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9±5 %	PASS	0.89:15 %	PA55
835	41.5 25 %		0.90:15 %	
900	41.5 ±5 %		0.97 ±5%	
1450	40.5 ±5 %		1.20±5%	
1500	40.4.15 %		1.23 ±5 %	
1640	40.2 :5%		1.31 ±5 %	
1750	40.1±5%		1.37 ±5 %	

Page: 7/11

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1800	40.0 ±5 %	1.40 ±5.5
1900	40.0 :5 %	1.40 :5 %
1950	40.0 ±5 %	1.40 ±5 %
7000	40.0 ±5.%	1.40±5%
2100	39.8 45 %	1.49 ±5 %
2300	39.5 ±5 %	1.67 ±5 %
2450	39.2 ±5 %	1.80 15 %
2600	39.0 ±5 %	1.96 :5 %
3000	38.5 ±5 %	2.40 ±5 %
3500	37.9 ±5 %	2.91.55%

### 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' : 40.8 sigma : 0.93		
Distance between dipole center and liquid	15.0 mm		
Area scan resolution	dx=8mm/dy=8mm		
Zoon Scan Resolution	ds=8mm/ds=8mm/de=5mm		
Frequency	750 MHz		
Input power	20 dBm		
Liquid Temperature	21 ℃		
Lab Temperature	21 °C		
Lub 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	4.51		1.06	
750	8.49	8.31 (0.83)	5.55	5.45 (0.55
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30,5		16.8	
1640	34.2		18.4	
1758	36.4		29.3	
1800	38.4		20.1	

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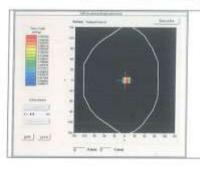
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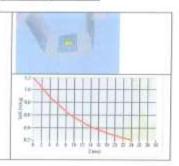




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1900	39.7	20.5
1950	40.5	20.9
2000	41.1	21.1
2100	43.6	21.9
2000	48.7	23.3
2450	52.4	24
2600	55.3	20.6:
3000	63.8	25.7
3500	67.3	25
3700	67.4	24.2





/Inspection The test results

### 7.3 BODY LIQUID MEASUREMENT

Frequency	Relative permittivity (c,')		Conductiv	ity (a) S/m
	required	measured	required	measures
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94.65%	
750	55.5 ±5 %	PASS	0.96 ±5 %	PASS
835	55.2 45 %		0.97.±5 %	
900	55.035%		1.05.15%	
915	55.0 ±5.%		1.06 ±5 %	
1450	54.0 ±5 %		1.30 15 %	
1610	53.8 ±5%		1.40 15 %	
1800	53.3 ±5 %		1.52 ±5 %	
1900	53,3 25 %		1.52 ±5 %	
2000	53.3.15%		152±5%	
2100	53.2.15%		1.62 ±5 %	

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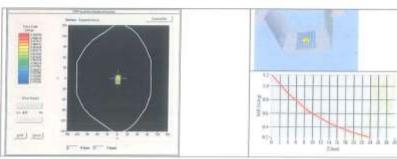
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2300	52.9 ±5 %	1.81 :5%
2450	52.7 ±5 %	1.95 15 %
2600	52.5 ±5 %	2.1615.%
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 (5 %	3.31 ±5 %
3700	51.0 ±5 %	3.55 ±5 %
5200	49.0 ±10 %	5.30 ±10 %
5300	48.9 ±10 %	5.42 ±10 %
5400	48.7 ±10 %	5.53 ±10 %
5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2 ±10 %	6.00 ±10 %

### 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OMENCAD MA
CUSATURE IN CONTRACTOR OF THE	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: eps. : 56.7 sigma : 0.98
Distance between dipole center and fiquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/ilz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lith Humidity	45 %

Frequency	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
750	8.45 (0.85)	5.67 (0.57)



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### 8 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No car required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No car required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2019	02/2022
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	10/2018	10/2019
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	11/2017	11/2020

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Tel: +86-755 2523 4088 E-mail: agc@agc-cert.com Web: http://cn.agc-cert.com/





# SAR Reference Dipole Calibration Report

Ref: ACR.116.4.19.SATU.A

# ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

1-2/F, BUILDING 19, JUNFENG INDUSTRIAL PARK, CHONGQING ROAD, HEPING COMMUNITY, FUHAI STREET

BAO 'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ

SERIAL NO.: SN 29/15 DIP 0G835-383

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





Calibration Date: 04/26/2019

#### 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.

he test results

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	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	4/26/2019	75
Checked by:	Jérôme LUC	Product Manager	4/26/2019	JS
Approved by:	Kim RUTKOWSKI	Quality Manager	4/26/2019	-ALM Authoriti

	Customer Name
Distribution :	ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

Issue	Date	Modifications
A	4/26/2019	Initial release
	10. 0.000	**CONTACT ** CONTACT **

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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 DIPO				
Manufacturer	MVG			
Model	SID835			
Serial Number	SN 29/15 DIP 0G835-383			
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 constructed as outlined in the fore mentioned standards.

#### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Los		
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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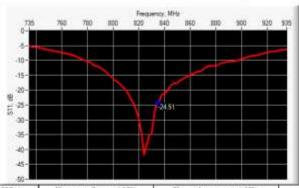


Ref: ACR.116.4.19.5ATU.A

10 g	20.1 %	

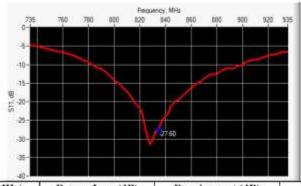
### 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance | 835 | -24.51 | -20 | 56.3 Ω + 0.8 jΩ

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-27.60	-20	52.3 Ω + 3.6 jΩ

### 6.3 MECHANICAL DIMENSIONS

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

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450	290.0±1 %		166.7±1%.		6.35 ±1 %.	
750	176.0±1 %		100.0 ±1 %.	V 2.521-1	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 ±3 %.		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 normittivity (c.)	Conductivi	ity (a) S/m	
	required	measured	required	measured
300	45,3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	1
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.

Software	OPENSAR V4		
Phantom	SN 20/09 SAM71		
Probe	SN 18/11 EPG122		
Liquid	Head Liquid Values: eps' : 43.0 sigma : 0.89		
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	9.85 (0.98)	6,22	6.27 (0.63)
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4	2	19,3	
1800	38.4		20.1	ļ,

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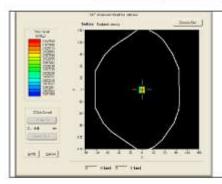
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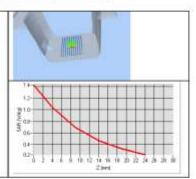




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1900	39.7	20.5
1950	40.5	20.9
2000	41.1	21.1
2100	43.6	21.9
2300	48.7	23.3
2450	52.4	24
2600	55,3	24.6
3000	63.8	25.7
3500	67.1	25
3700	67.4	24.2





### 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (e <sub>r</sub> ')		Conductiv	ity (a) S/m
	required	measured	required	measured
150	61.9 ±5 %	1	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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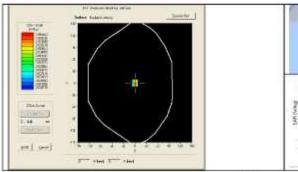
Ref: ACR:116.4.19.5ATU.A

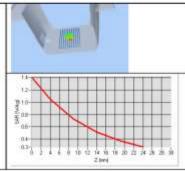
2300	52.9 ±5 %	1.81 ±5 %
2450	52.7 ±5 %	1.95 ±5 %
2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5 %	3.31 ±5 %
3700	51.0 ±5 %	3.55 ±5 %
5200	49.0 ±10 %	5.30 ±10 %
5300	48.9 ±10 %	5.42 ±10 %
5400	48.7 ±10 %	5.53 ±10 %
5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±10 %
5800	48.2 ±10 %	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' : 56.7 sigma : 0.98		
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 835 MHz		
Frequency			
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	9.95 (0.99)	6.50 (0.65)	





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### 8 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date	
SAM Phantom	MVG	SN-20/09-SAM71	Validated No cal required.	Validated. No ca required.	
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No ca required.	
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2019	02/2022	
Calipers	Carrera	CALIPER-01	01/2017	01/2020	
Reference Probe	MVG	EPG122 SN 18/11	10/2018	10/2019	
Multimeter	Keithley 2000	1168656	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	11/2017	11/2020	

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Attestation of Global Compliance(Shenzhen)Co., Ltd Attestation of Global Compliance(Shenzhen)Std & Tech Co., Ltd

Tel: +86-755 2523 4088 E-mail: agc@agc-cert.com Web: http://cn.agc-cert.com/

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# SAR Reference Dipole Calibration Report

Ref: ACR.116.5.19.SATU.A

# ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

1-2/F, BUILDING 19, JUNFENG INDUSTRIAL PARK, CHONGQING ROAD, HEPING COMMUNITY, FUHAI STREET

BAO 'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1800 MHZ

SERIAL NO.: SN 46/11 DIP 1G800-186

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





Calibration Date: 04/26/2019

#### 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.

he test results

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	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	4/26/2019	75
Checked by:	Jérôme LUC	Product Manager	4/26/2019	J5
Approved by:	Kim RUTKOWSKI	Quality Manager	4/26/2019	num Authorish

	Customer Name
Distribution :	ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

Issue	Date	Modifications	
A	4/26/2019	Initial release	
	10. 0.000	**CONTACT ** CONTACT **	

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he test report.

### 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.

### DEVICE UNDER TEST

Device Under Test		
Device Type COMOSAR 1800 MHz REFERENCE DI		
Manufacturer	MVG	
Model	SID1800	
Serial Number	SN 46/11 DIP 1G800-186	
Product Condition (new / used)	Used	

A yearly calibration interval is recommended.

### PRODUCT DESCRIPTION

### 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 constructed as outlined in the fore mentioned standards.

#### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

## 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss
400-6000MHz	0.1 dB

## 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Leng		
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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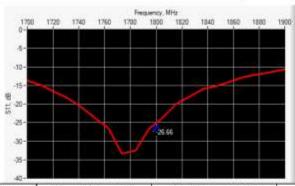
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10 g	20.1 %	

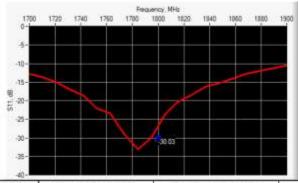
## 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1800	-26.66	-20	$46.7 \Omega + 3.0 j\Omega$

## 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1800	-30.03	-20	47.3 Ω - 1.6 įΩ

## 6.3 MECHANICAL DIMENSIONS

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

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450	290.0±1 %.		166.7±1%.		6.35 ±1 %.	
750	176.0±1 %		100.0 ±1 %.		6.35 ±1 %.	
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7±1%		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %		3.6±1%	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6±1%	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	115555
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 (c.')		Conductivity (a) S/m	
	required	measured	required	measured
300	45,3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	1
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%	Ĭ.	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.%	î	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' : 39.6 sigma : 1.40		
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	8	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	2	19,3	
1800	38.4	39.07 (3.91)	20.1	20.29 (2.03

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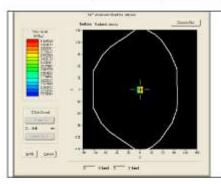
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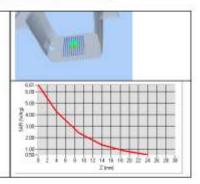




#### Ref: ACR:116.5.19.5ATU.A

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	





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## 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (c.)	Conductiv	ity (a) S/m	
	required	measured	required	measured
150	61.9 ±5 %	1	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 %	1
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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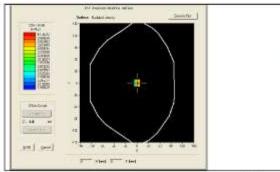
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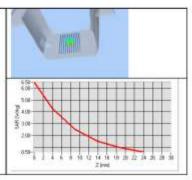
A SANCE OF THE SAN	The same of the sa	
2300	52.9 ±5 %	1.81±5%
2450	52.7 ±5 %	1.95 ±5 %
2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5%	3.31 ±5 %
3700	51.0 ±5 %	3.55 ±5 %
5200	49.0 ±10 %	5.30 ±10 %
5300	48.9 ±10 %	5.42 ±10 %
5400	48.7 ±10 %	5.53 ±10 %
5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±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' : 52.8 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	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	39.23 (3.92)	20.56 (2.06)





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## 8 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	SN-20/09-SAM71	Validated No cal required.	Validated No ca required.
COMOSAR Test Bench	Version 3	NA .	Validated. No cal required.	Validated. No ca required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2019	02/2022
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	10/2018	10/2019
Multimeter	Keithley 2000	1168656	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	11/2017	11/2020

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Attestation of Global Compliance(Shenzhen)Co., Ltd Attestation of Global Compliance(Shenzhen)Std & Tech Co., Ltd

Tel: +86-755 2523 4088 E-mail: agc@agc-cert.com Web: http://cn.agc-cert.com/

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## SAR Reference Dipole Calibration Report

Ref: ACR.116.6.19.SATU.A

# ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

1-2/F, BUILDING 19, JUNFENG INDUSTRIAL PARK, CHONGQING ROAD, HEPING COMMUNITY, FUHAI STREET

BAO 'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1900 MHZ

SERIAL NO.: SN 46/11 DIP 1G900-187

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





Calibration Date: 04/26/2019

#### 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	4/26/2019	75
Checked by:	Jérôme LUC	Product Manager	4/26/2019	JS
Approved by:	Kim RUTKOWSKI	Quality Manager	4/26/2019	-ALM Authoriti

	Customer Name
Distribution :	ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

Issue	Date	Modifications
A	4/26/2019	Initial release
	10. 0.000	**CONTACT ** CONTACT **

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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 46/11 DIP 1G900-187			
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 constructed as outlined in the fore mentioned standards.

#### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

## 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Los		
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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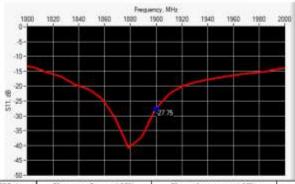
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10 g	20.1 %	

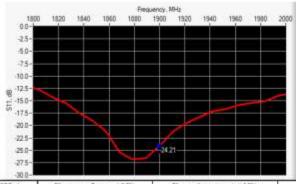
#### 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance | 1900 | -27.75 | -20 | 50.7 Ω + 4.1 jΩ

## 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
1900	-24.21	-20	$46.4 \Omega + 4.8 i\Omega$

## 6.3 MECHANICAL DIMENSIONS

Frequency MHz	Ln	Lmm		h mm		nm
	required	measured	required	measured	required	measured
300	420.0 ±1 %.		250.0 ±1%.		6.35 ±1 %.	

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450	290.0±1 %.		166.7±1%.		6.35±1%.	
750	176.0±1 %		100.0 ±1 %		6.35 ±1 %.	
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %,		51.7±1%		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %		3.6±1%	
1640	79.0 ±1 %.		45.7 ±3 %.		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 per	mittivity (c.')	Conductivity (a) S	
	required	measured	required	measured
300	45,3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	1
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 %	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.%	î	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' : 39.7 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	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	8	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	13	18.4	
1750	36.4	9	19,3	
1800	38.4		20.1	ļ.

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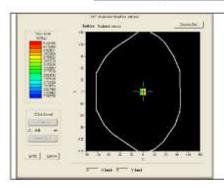
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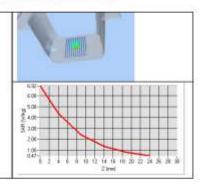




#### Ref: ACR:116.6.19.5ATU.A

1900	39.7	40.25 (4.02)	20.5	20.50 (2.05)
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7	6 1	23.3	
2450	52.4		24	
2600	55,3		24.6	
3000	63.8		25.7	
3500	67.1		25	
3700	67.4	17	24.2	





## 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (s/)		Conductiv	ity (a) S/m
	required	measured	required	measured
150	61.9 ±5 %	1	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 %	1
1800	53.3 ±5 %		1.52 ±5 %	
1900	53.3 ±5 %	PASS	1.52 ±5 %	PAS5
2000	53.3 ±5 %		1.52 ±5 %	
2100	53.2 ±5 %		1.62 ±5 %	

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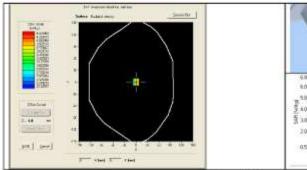
Ref: ACR:116.6.19.5ATU.A

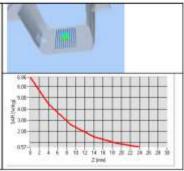
2300	22.00.000	1.81±5%
2500	52.9 ±5 %	1.61 15 %
2450	52.7 ±5 %	1.95 ±5 %
2600	52.5 ±5 %	2.16 ±5 %
3000	52.0 ±5 %	2.73 ±5 %
3500	51.3 ±5 %	3.31 ±5 %
3700	51.0 ±5 %	3.55 ±5 %
5200	49.0 ±10 %	5.30 ±10 %
5300	48.9 ±10 %	5.42 ±10 %
5400	48.7 ±10 %	5.53 ±10 %
5500	48.6 ±10 %	5.65 ±10 %
5600	48.5 ±10 %	5.77 ±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' : 52.8 sigma : 1.59
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	40.82 (4.08)	20.99 (2.10)





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## 8 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	SN-20/09-SAM71	Validated No cal required.	Validated No ca required.
COMOSAR Test Bench	Version 3	NA .	Validated. No cal required.	Validated. No ca required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2019	02/2022
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	10/2018	10/2019
Multimeter	Keithley 2000	1168656	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	11/2017	11/2020

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# SAR Reference Dipole Calibration Report

Ref: ACR.116.9.19.SATU.A

# ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

1-2/F, BUILDING 19, JUNFENG INDUSTRIAL PARK, CHONGQING ROAD, HEPING COMMUNITY, FUHAI STREET

BAO 'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ

SERIAL NO.: SN 46/11 DIP 2G450-189

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





Calibration Date: 04/26/2019

#### 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.

he test results

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	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	4/26/2019	75
Checked by:	Jérôme LUC	Product Manager	4/26/2019	JS
Approved by:	Kim RUTKOWSKI	Quality Manager	4/26/2019	-ALM Authoriti

	Customer Name
Distribution :	ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

Issue	Date	Modifications	
A	4/26/2019	Initial release	
	10. 0.000	5 CONTINUE STORY (1990)	

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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 46/11 DIP 2G450-189	
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 constructed as outlined in the fore mentioned standards.

## 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

## 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss
400-6000MHz	0.1 dB

## 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

## 5.3 VALIDATION MEASUREMENT

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

Expanded Uncertainty
20.3 %

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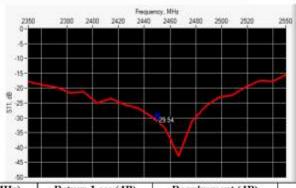
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10 g	20.1 %	

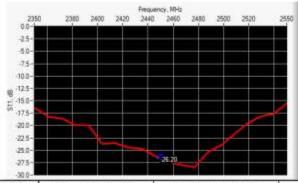
## 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance | 2450 | -29.54 | -20 | 49.8 Ω + 3.3 jΩ

## 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-26.20	-20	$53.4 \Omega + 3.8 j\Omega$

## 6.3 MECHANICAL DIMENSIONS

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

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450	290.0±1 %.		166.7±1%.		6.35±1%.	
750	176.0 ±1 56		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 ±3 %		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 %.	PAS
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 (c.')		Conductiv	ity (a) S/m
	required	measured	required	measured
300	45,3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	1
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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	1.40 ±5 %		40.0 ±5 %	1800
	1.40±5%		40.0 ±5 %	1900
	1.40 ±5 %		40.0 ±5 %	1950
	1.40±5%		40.0 ±5 %	2000
	1.49 ±5%		39.8 ±5 %	2100
	1,67 ±5 %		39.5 ±5 %	2300
PASS	1.80 ±5 %	PASS	39.2 ±5 %	2450
Lillene	1.96±5%		39.0 ±5 %	2600
	2.40 ±5 %		38.5 ±5 %	3000
	2.91 ±5 %		37.9 ±5 %	3500

## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

Software	OPENSAR V4		
Phantom	SN 20/09 SAM71		
Probe	SN 18/11 EPG122		
Liquid	Head Liquid Values: eps' : 38.7 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	AR (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	7	19,3		
1800	38.4		20.1		

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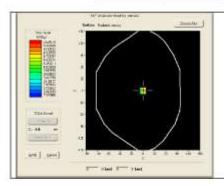
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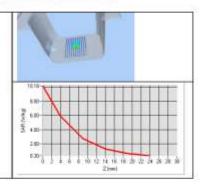




#### Ref: ACR:116.9.19.5ATU.A

1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7	6 1	23.3	
2450	52.4	53.97 (5.40)	24	24.01 (2.40)
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	
3700	67.4	17	24.2	





## 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (6,')		Conductiv	tivity (a) S/m	
	required	measured	required	measured	
150	61.9 ±5 %	1	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 %	1	
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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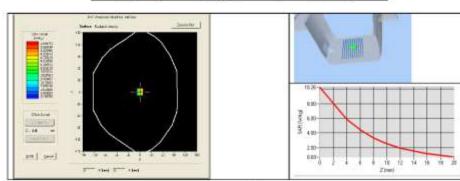
Ref: ACR:116.9.19.5ATU.A

2300	F183500		1.81±5%	
2500	52.9 ±5 %		1.61.15%	
2450	52.7 ±5 %	PASS	1.95 ±5 %	PASS
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': 54.9 sigma: 1.97
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	54.45 (5.45)	24.16 (2.42)



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Ref: ACR:116.9.19.5ATU.A

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## 8 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM Phantom	MVG	SN-20/09-SAM71	Validated No cal required.	Validated No ca required.
COMOSAR Test Bench	Version 3	NA .	Validated. No cal required.	Validated. No ca required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2019	02/2022
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	10/2018	10/2019
Multimeter	Keithley 2000	1168656	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	11/2017	11/2020

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# SAR Reference Dipole Calibration Report

Ref: ACR.116.10.19.SATU.A

# ATTESTATION OF GLOBAL COMPLIANCE CO.

1-2/F, BUILDING 19, JUNFENG INDUSTRIAL PARK, CHONGQING ROAD, HEPING COMMUNITY, FUHAI STREET

BAO 'AN DISTRICT, SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2600 MHZ

SERIAL NO.: SN 47/14 DIP 2G600-342

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





Calibration Date: 04/26/2019

#### 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	4/26/2019	75
Checked by:	Jérôme LUC	Product Manager	4/26/2019	JS
Approved by:	Kim RUTKOWSKI	Quality Manager	4/26/2019	-ALM Authoriti

	Customer Name
Distribution :	ATTESTATION OF GLOBAL COMPLIANCE CO. LTD.

Issue	Date	Modifications
A	4/26/2019	Initial release
	10. 0.000	**CONTACT ** CONTACT **

Page: 2/11

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Ref: ACR.11610.19.5ATU.A

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## 1 INTRODUCTION

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

#### 2 DEVICE UNDER TEST

Device Under Test		
Device Type	COMOSAR 2600 MHz REFERENCE DIPOLE	
Manufacturer	MVG	
Model	SID2600	
Serial Number	SN 47/14 DIP 2G600-342	
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 constructed as outlined in the fore mentioned standards.

## 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2, traceable to the Internationally Accepted Guides to Measurement Uncertainty.

## 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

Frequency band	Expanded Uncertainty on Return Loss		
400-6000MHz	0.1 dB		

## 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

## 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and 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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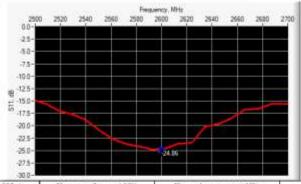
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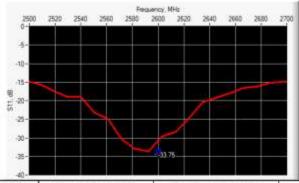
## 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance | 2600 | -24.86 | -20 | 55.5 Ω + 2.6 jΩ

## 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2600	-33.75	-20	51.6 Ω + 1.3 iΩ

## 6.3 MECHANICAL DIMENSIONS

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

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450	290.0±1 %.		166.7±1%.		6.35±1%.	
750	176.0±1 %		100.0 ±1 %		6.35 ±1 %.	
835	161.0 ±1 %.		89.8 ±1 %		3.6 ±1 %.	
900	149.0±1 %.		83.3 ±1 %		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7±1%		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %		3.6±1%	
1640	79.0 ±1 %.		45.7 ±3 %.		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 %.	PAS
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 (c.')		Conductivity (a) S/	
	required	measured	required	measured
300	45,3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	1
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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	1.40 ±5 %		40.0 ±5.%	1800
	1.40±5%		40.0±5%	1900
	1.40 ±5 %		40.0 ±5 %	1950
	1.40±5%		40.0 ±5 %	2000
	1.49 ±5%		39.8 ±5 %	2100
	1,67 ±5 %		39.5 ±5 %	2300
	1.80 ±5 %		39.2 ±5%	2450
PA55	1.96±5%	PASS	39.0 ±5 %	2600
	2.40 ±5 %		38.5 ±5 %	3000
	2.91 ±5%		37.9 ±5.%	3500

## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

Software	OPENSAR V4		
Phantom	SN 20/09 SAM71		
Probe	SN 18/11 EPG122		
Liquid	Head Liquid Values: eps' : 40.0 sigma : 1.89		
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 (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	7	19,3	
1800	38.4		20.1	

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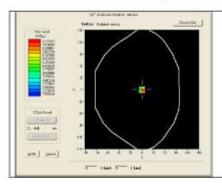
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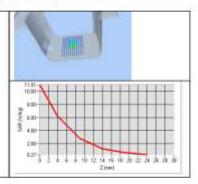




Ref: ACR.11610.19.5ATU.A

1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7	18 1	23.3	
2450	52.4		24	
2600	55,3	56.86 (5.69)	24.6	24.84 (2.48)
3000	63.8		25.7	
3500	67.1		25	
3700	67.4	11	24.2	





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## 7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	Relative permittivity (e,')		ity (a) S/m
	required	measured	required	measured
150	61.9 ±5 %	1	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 %	

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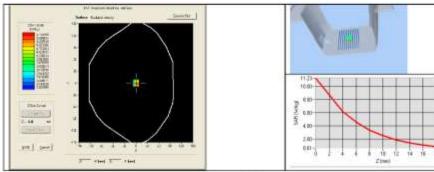
Ref: ACR.11610.19.5ATU.A

2300	52.9 ±5 %		1.81 ±5 %	
2450	52.7 ±5 %		1.95 ±5 %	
2600	52.5 ±5 %	PASS	2.16 ±5 %	PASS
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': 54.4 sigma: 2.18		
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 (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
2600	56.51 (5.65)	24.25 (2.43)



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## 8 LIST OF EQUIPMENT

Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date	
SAM Phantom	MVG	SN-20/09-SAM71	Validated No cal required.	Validated No ca required.	
COMOSAR Test Bench	Version 3	NA .	Validated. No cal required.	Validated. No ca required.	
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2019	02/2022	
Calipers	Carrera	CALIPER-01	01/2017	01/2020	
Reference Probe	MVG	EPG122 SN 18/11	10/2018	10/2019	
Multimeter	Keithley 2000	1168656	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-E28A	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	11/2017	11/2020	

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