

ANNEX C: Calibration Reports

EP261 Probe Calibration Report		
EP276 Probe Calibration Report		
SID835 Dipole Calibration Report		
SID1900 Dipole Calibration Report		
SID2450 Dipole Calibration Report		
SID2600 Dipole Calibration Report		
SID5200 Dipole Calibration Report		

CCIC-SET/T-I (00) Page 1 of 76



EP261 Probe Calibration Report



COMOSAR E-Field Probe Calibration Report

Ref: ACR.332.2.17.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD

ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI JIEDAO, NANSHAN DISTRICT SHENZHEN, GUANGDONG, CHINA

MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 27/15 EPGO261

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





Calibration Date: 11/27/17

Summary:

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

CCIC-SET/T-I (00) Page 2 of 76





Baf: ACR 332217.8AIU A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	11/28/2017	JES
Checked by :	Jérôme LUC	Product Manager	11/28/2017	JE
Approved by :	Kim RUTKOWSKI	Quality Manager	11/28/2017	from Authoriti

	Customer Name
Distribution :	CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd

Issue	Date	Modifications
Α	11/28/2017	Initial release

Page: 2/9

This document that not be reproduced, except in full or in part, without the written approval of WPG. The information contained herein is to be used only for the purpose for which is it submitted and is not to be released in whole or part without written approval of WPG.

CCIC-SET/T-I (00) Page 3 of 76





Baf: ACR.332217.8ATU.A

TABLE OF CONTENTS

1	Dev	ice Under Test	
2	Prod	uct Description4	
	2.1	General Information	4
3	Mea	sure ment Method	
	3.1	Linearity	4
	3.2	Sensitivity	5
	3.3	Lower Detection Limit	
	3.4	Isotropy	5
	3.5		5
4	Mea	sure ment Uncertainty	
5	Cali	oration Measurement Results	
	5.1	Sensitivity in air	6
	5.2	Linearity	7
	5.3	Sensitivity in liquid	7
	5.4		8
6	List	of Equipment 9	

Page: 3/9

This document thall not be reproduced, except in full or to part, without the written approval of MPG.
The information-constitued herein it to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MPG.





Baf: ACR.332217.8AIU.A

1 DEVICE UNDER TEST

Device Under Test		
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE	
Manufacturer	MVG	
Model	SSE2	
Serial Number	SN 27/15 EPGO261	
Product Condition (new / used)	Used	
FrequencyRange of Probe	0.7 GHz-6GHz	
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.219 MΩ	
_	Dipole 2: R2=0.220 MΩ	
	Dipole 3: R3=0.226 MΩ	

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

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



Figure 1 - MVG COMOSAR Dosimetric E field Dipole

Probe Length	330 mm
Length of Individual Dipoles	2 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	2.5 mm
Distance between dipoles / probe extremity	1 mm

3 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

3.1 LINEARITY

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

Page: 4/9

This document thall not be reproduced, except in full or in part, without the written approval of MPG. The information constitued herein it to be used only for the purpose for which it is submitted and it not to be released in whole or part without written approval of MPG.

CCIC-SET/T-I (00) Page 5 of 76





Baf: ACR 332217.8ATU A

3.2 SENSITIVITY

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

3.3 LOWER DETECTION LIMIT

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

3.4 ISOTROPY

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

3.5 BOUNDARY EFFECT

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

4 MEASUREMENT UNCERTAINTY

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

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	á	Standard Uncertainty (%)
Incident or forward power	3.00%	Rectangular	√3	1	1.732%
Reflected power	3.00%	Rectangular	√3 i	1	1.732%
Liquid conductivity	5.00%	Rectangular	√3 i	1	2.887%
Liquidpermittivity	4.00%	Rectangular	√3 i	1	2309%
Field homogeneity	3.00%	Rectangular	√3	1	1.732%
Field probe positioning	5.00%	Rectangular	-√3	1	2.887%

Page: 5/9

This document thall not be reproduced, except in full or to part, without the written approval of MPG. The information constitued herein it to be used only for the purpose for which it is submitted and it not to be released in whole or part without written approval of MPG.

CCIC-SET/T-I (00) Page 6 of 76





Raf: ACR.332217.8ATU.A

Field probe linearity	3.00%	Rectangular	√3	1	1.732%
Combined standard uncertainty					5.831%
Expanded uncertainty 95 % confidence levelk = 2					12.0%

5 CALIBRATION MEASUREMENT RESULTS

Cal	ibration Parameters
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

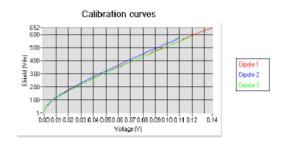
5.1 SENSITIVITY IN AIR

		Normz dipole
$1 \left(\mu V / (V/m)^2 \right)$	$2 (\mu V/(V/m)^2)$	$3 (\mu V / (V / m)^2)$
0.89	0.63	0.72

DCP dipole 1	DCP dipole 2	DCP dipole 3
(mV)	(mV)	(mV)
91	94	

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

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



Page: 6/9

This document thail not be reproduced, except in full or in part, without the written approval of MPG.
The information constitued herein is to be used only for the purpose for which it is submitted and is not to
be released in whole or part without written approval of MPG.

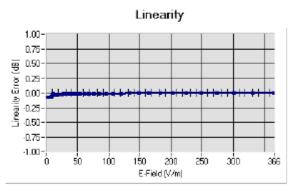
CCIC-SET/T-I (00) Page 7 of 76





Raf: ACR 332217.8AIU.A

5.2 LINEARITY



Linearity:0+/-1.75% (+/-0.08dB)

5.3 SENSITIVITY IN LIQUID

<u>Liquid</u>	Fre quency (MHz +/- 100MHz)	Permittivity	Epsilon (Shn)	<u>ConvF</u>
HL5200	5200	35.14	4.74	2.20
BL5200	5200	49.01	527	2.27
HL5400	5400	34.52	4.77	2.07
BL5400	5400	49.67	5.45	2.14
HL5600	5600	37.08	5.03	2.18
BL5600	5600	47.57	5.69	2.24
HL5800	5800	34.64	5.19	2.26
BL5800	5800	49.82	594	2.32

LOWER DETECTION LIMIT: 9mW/kg

Page: 7/9

This document thall not be reproduced, except in full or in part, without the written approval of MPG. The information considered herein it to be used only for the purpose for which it is submitted and it not to be released in whole or part without written approval of MPG.

CCIC-SET/T-I (00) Page 8 of 76



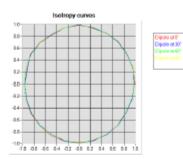


Baf: ACR 332217.8AIU A

5.4 ISOTROPY

HL5600 MHz

- Axial isotropy: 0.06 dB - Hemispherical isotropy: 0.10 dB



Page: 8/9

This document thall not be reproduced, except in full or in part, without the written approval of MPG.
The information constitued havely is to be used only for the purpose for which it is subwitted and is not to
be released in whole or part without written approval of MPG.

CCIC-SET/T-I (00) Page 9 of 76





Ref: ACR.332217.8AIU.A

6 LIST OF EQUIPMENT

Equip ment Description			Current Calib ration Date	Next Calibration Date
Flat 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.
N etwork Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019
Reference Probe	MVG	EP 94 SN 37,08	10/2017	10/2018
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	U \$37181460	01/2017	01/2020
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Control Company	150798832	11/2017	11/2020

Page: 9/9

This document thall not be reproduced, except in full or to part, without the written approval of MPG.
The information-constitued herein it to be used only for the purpose for which it is submitted and it not to
be released in whole or part without written approval of MPG.

CCIC-SET/T-I (00) Page 10 of 76



EP276 Probe Calibration Report



COMOSAR E-Field Probe Calibration Report

Ref: ACR.332.1.17.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD

ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI JIEDAO, NANSHAN DISTRICT SHENZHEN, GUANGDONG, CHINA MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 43/15 EP276

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





Calibration Date: 11/27/17

Summary:

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

CCIC-SET/T-I (00) Page 11 of 76





Ref: ACR.332.1.17.SATU.A

	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	11/28/2017	JS
Checked by :	Jérôme LUC	Product Manager	11/28/2017	JES
Approved by :	Kim RUTKOWSKI	Quality Manager	11/28/2017	Aim Puthowshi

Customer Name

CCIC SOUTHERN
ELECTRONIC
PRODUCT
TESTING
(SHENZHEN) Co.,
Ltd

Issue	Date	Modifications
A	11/28/2017	Initial release

Page: 2/9

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 12 of 76





Ref: ACR.332.1.17.SATU.A

TABLE OF CONTENTS

1	Devi	ce Under Test4	
2	Prod	uct Description4	
	2.1	General Information	4
3		surement Method	
	3.1	Linearity	4
	3.2	Sensitivity	5
	3.3	Lower Detection Limit	5
	3.4	Isotropy	
	3.5	Boundary Effect	
4	Meas	surement Uncertainty5	
5	Calit	oration Measurement Results	
	5.1	Sensitivity in air	6
	5.2	Linearity	7
	5.3	Sensitivity in liquid	7
	5.4	Isotropy	8
6	List	of Equipment9	

Page: 3/9

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.





Ref: ACR 332 L17 SATU A

1 DEVICE UNDER TEST

Device Under Test				
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE			
Manufacturer	MVG			
Model	SSE5			
Serial Number	SN 43/15 EP276			
Product Condition (new / used)	Used			
Frequency Range of Probe	0.7 GHz-3GHz			
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.213 MΩ			
	Dipole 2: R2=0.208 MΩ			
	Dipole 3: R3=0.213 MΩ			

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

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



Figure 1 - MVG COMOSAR Dosimetric E field Dipole

Probe Length	330 mm
Length of Individual Dipoles	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, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

3.1 LINEARITY

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

Page: 4/9

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 14 of 76





Ref: ACR.332.1.17.SATU.A

3.2 SENSITIVITY

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

3.3 LOWER DETECTION LIMIT

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

3.4 ISOTROPY

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

3.5 BOUNDARY EFFECT

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

4 MEASUREMENT UNCERTAINTY

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

ERROR SOURCES	Uncertainty value (%)	Probability Distribution	Divisor	ci	Standard Uncertainty (%)
Incident or forward power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Reflected power	3.00%	Rectangular	√3	1	1.732%
Liquid conductivity	5.00%	Rectangular	√3	1	2.887%
Liquid permittivity	4.00%	Rectangular	√3	1	2.309%
Field homogeneity	3.00%	Rectangular	√3	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%

Page: 5/9

This document shall not be reproduced, except in full or in part, without the written approval of MVG.

The information contained herein is to be used only for the purpose for which it is submitted and is not to
be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 15 of 76





Ref: ACR.332.1.17.SATU.A

Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Combined standard uncertainty					5.831%
Expanded uncertainty 95 % confidence level k = 2					12.0%

5 CALIBRATION MEASUREMENT RESULTS

Cali	bration Parameters
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

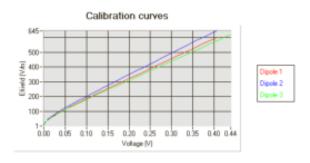
5.1 SENSITIVITY IN AIR

	Normy dipole 2 (μV/(V/m) ²)	
5.51	5.53	6.41

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

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

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



Page: 6/9

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

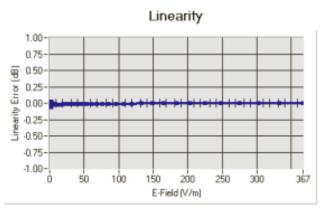
CCIC-SET/T-I (00) Page 16 of 76





Ref: ACR.332.1.17.SATU.A

5.2 LINEARITY



Linearity: 1+/-1.50% (+/-0.07dB)

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	<u>ConvF</u>
HL750	750	42.09	0.91	4.80
BL750	750	55.69	0.95	4.94
HL850	835	42.71	0.89	4.99
BL850	835	57.52	1.03	5.18
HL900	900	41.94	0.93	4.95
BL900	900	52.87	1.09	5.14
HL1800	1800	40.62	1.39	4.29
BL1800	1800	53.22	1.47	4.43
HL1900	1900	41.22	1.37	4.73
BL1900	1900	50.99	1.52	4.83
HL2000	2000	40.39	1.36	4.56
BL2000	2000	54.39	1.54	4.69
HL2300	2300	38.10	1.74	4.59
BL2300	2300	53.33	1.86	4.77
HL2450	2450	40.46	1.87	4.46
BL2450	2450	54.62	1.95	4.61
HL2600	2600	38.46	2.01	4.16
BL2600	2600	51.98	2.16	4.28

LOWER DETECTION LIMIT: 7mW/kg

Page: 7/9

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 17 of 76



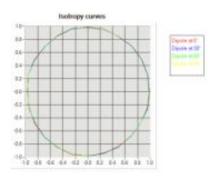


Ref: ACR.332.1.17.SATU.A

5.4 ISOTROPY

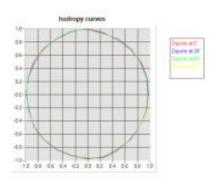
HL900 MHz

- Axial isotropy: 0.04 dB - Hemispherical isotropy: 0.07 dB



HL1800 MHz

- Axial isotropy: 0.04 dB - Hemispherical isotropy: 0.08 dB



Page: 8/9

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 18 of 76





Ref: ACR.332.1.17.SATU.A

6 LIST OF EQUIPMENT

Equipment Summary Sheet					
Equipment Description	Manufacturer / Model	Identification No.		Next Calibration Date	
Flat Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.	
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.	
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019	
Reference Probe	MVG	EP 94 SN 37/08	10/2017	10/2018	
Multimeter	Keithley 2000	1188656	01/2017	01/2020	
Signal Generator	Agilent E4438C	MY49070581	01/2017	01/2020	
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Power Meter	HP E4418A	US38261498	01/2017	01/2020	
Power Sensor	HP ECP-E26A	US37181460	01/2017	01/2020	
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.	
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.	
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.	
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.	
Temperature / Humidity Sensor	Control Company	150798832	11/2017	11/2020	

Page: 9/9

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 19 of 76



SID835 Dipole Calibration Report



SAR Reference Dipole Calibration Report

Ref: ACR.332.4.17.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD

ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI JIEDAO, NANSHAN DISTRICT SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

> FREQUENCY: 835 MHZ SERIAL NO.: SN 09/13 DIP 0G835-217

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





Calibration Date: 11/27/17

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.

CCIC-SET/T-I (00) Page 20 of 76





Ref: ACR.332.4.17.SATU.A

	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	11/28/2017	JES
Checked by:	Jérôme LUC	Product Manager	11/28/2017	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	11/28/2017	Kim Puthowski

	Customer Name
	CCIC SOUTHERN
	ELECTRONIC
Distribution :	PRODUCT
Distribution :	TESTING
	(SHENZHEN) Co.,
	Ltd

Issue	Date	Modifications
A	11/28/2017	Initial release

Page: 2/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 21 of 76





Ref: ACR.332.4.17.SATU.A

TABLE OF CONTENTS

1	Intro	oduction4	
2	Dev	ice Under Test4	
3	Proc	duct Description4	
	3.1	General Information	4
4	Mea	surement Method5	
	4.1	Return Loss Requirements	5
	4.2	Mechanical Requirements	5
5	Mea	surement Uncertainty5	
	5.1	Return Loss	5
	5.2	Dimension Measurement	5
	5.3	Validation Measurement	
6	Cali	bration Measurement Results6	
	6.1	Return Loss and Impedance In Head Liquid	6
	6.2	Return Loss and Impedance In Body Liquid	6
	6.3	Mechanical Dimensions	6
7	Vali	dation measurement	
	7.1	Head Liquid Measurement	7
	7.2	SAR Measurement Result With Head Liquid	
	7.3	Body Liquid Measurement	9
	7.4	SAR Measurement Result With Body Liquid	
g	List	of Equipment 11	

Page: 3/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.





Ref: ACR.332.4.17.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 835 MHz REFERENCE DIPOLE		
Manufacturer	MVG		
Model	SID835		
Serial Number SN 09/13 DIP 0G835-217			
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

Page: 4/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 23 of 76





Ref: ACR.332.4.17.SATU.A

4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constucted as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

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

5 MEASUREMENT UNCERTAINTY

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

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

5.2 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 %

Page: 5/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 24 of 76



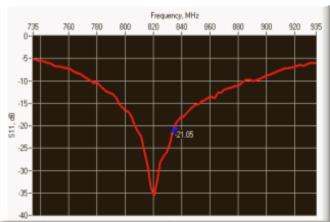


Ref: ACR.332.4.17.SATU.A

10 g	20.1 %

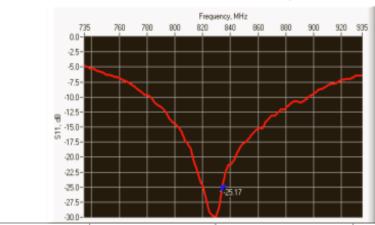
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-21.05	-20	$59.7 \Omega + 0.2 j\Omega$

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-25.17	-20	$55.1 \Omega + 2.7 j\Omega$

6.3 MECHANICAL DIMENSIONS

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

Page: 6/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 25 of 76





Ref: ACR.332.4.17.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 %.	PASS	89.8 ±1 %.	PASS	3.6 ±1 %.	PASS
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
1800	72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.	
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.	
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7±1 %.		26.4 ±1 %.		3.6 ±1 %.	

7 VALIDATION MEASUREMENT

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

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε _r ')		Conductiv	ity (σ) S/m
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %		0.89 ±5 %	
835	41.5 ±5 %	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 %	

Page: 7/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 26 of 76





Ref: ACR.332.4.17.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 %	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': 40.7 sigma: 0.92
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	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	9.61 (0.96)	6.22	6.19 (0.62
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	

Page: 8/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

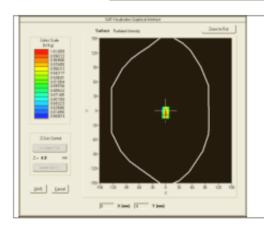
CCIC-SET/T-I (00) Page 27 of 76

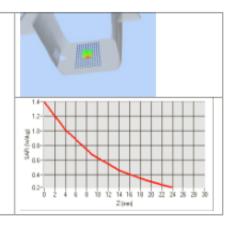




Ref: ACR.332.4.17.SATU.A

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





7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ε _r ')		Conductiv	ity (σ) S/m
	required	measured	required	measured
150	61.9 ±5 %		0.80 ±5 %	
300	58.2 ±5 %		0.92 ±5 %	
450	56.7 ±5 %		0.94 ±5 %	
750	55.5 ±5 %		0.96 ±5 %	
835	55.2 ±5 %	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 %	
2300	52.9 ±5 %		1.81 ±5 %	

Page: 9/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 28 of 76





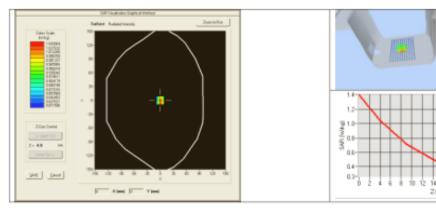
Ref: ACR.332.4.17.SATU.A

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': 55.1 sigma: 1.00
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	835 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)	
	measured	measured	
835	9.88 (0.99)	6.47 (0.65)	



Page: 10/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 29 of 76





Ref: ACR.332.4.17.SATU.A

8 LIST OF EQUIPMENT

Equipment Summary Sheet								
Equipment Manufacturer / Description Model		Identification No.	Current Calibration Date	Next Calibration Date				
SAM Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.				
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.				
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019				
Calipers	Carrera	CALIPER-01	01/2017	01/2020				
Reference Probe	MVG	EPG122 SN 18/11	10/2017	10/2018				
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				

Page: 11/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 30 of 76



SID1900 Dipole Calibration Report



SAR Reference Dipole Calibration Report

Ref: ACR.332.7.17.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD

ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI JIEDAO, NANSHAN DISTRICT SHENZHEN, GUANGDONG, CHINA

MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 1900 MHZ

SERIAL NO.: SN 09/13 DIP 1G900-218

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





Calibration Date: 11/27/17

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.

CCIC-SET/T-I (00) Page 31 of 76





Ref: ACR 332.7.17.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	11/28/2017	JE
Checked by :	Jérôme LUC	Product Manager	11/28/2017	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	11/28/2017	tum theethoughi

	Customer Name
	CCIC SOUTHERN ELECTRONIC
Distribution :	PRODUCT TESTING
	(SHENZHEN) Co.,
	Ltd

Issue	Date	Modifications
Α	11/28/2017	Initial release

Page: 2/11

This document shall not be reproduced, except in full or in part, without the written approval of hAVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of hAVG.

CCIC-SET/T-I (00) Page 32 of 76





Ref: ACR 332.7.17.SATU.A

TABLE OF CONTENTS

1	lmr	oduction. 4	
2	Dev	ice Under Test4	
3	Prod	luct Description4	
	3.1	General Information	4
4	Mea	surement Method	
	4.1	Return Loss Requirements	5
	4.2	Mechanical Requirements	
5	Mea	surement Uncertainty	
	5.1	Return Loss	5
	5.2	Dimension Measurement	5
	5.3	Validation Measurement	5
б	C ali	bration Measurement Results	
	6.1	Return Loss and Impedance In Head Liquid	6
	6.2	Return Loss and Impedance In Body Liquid	
	6.3	Mechanical Dimensions	6
7	V ali	dation measurement	
	7.1	HeadLiquid Measurement	7
	7.2	SAR Measurement Result With Head Liquid	8
	7.3	Body Liquid Measurement	
	7.4	SAR Measurement Result With Body Liquid	
8	List	of Equipment 11	

Page: 3/11

This document shall not be reproduced, except in full or in part, without the written approval of IAPG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of IAPG.





Ref: ACR 332.7.17.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 COMOS AR 1900 MHz REFERENC				
Manufacturer	MVG			
Model	SID1900			
Serial Number	SN 09/13 DIP 1G900-218			
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

Page: 4/11

This document shall not be reproduced, except in full or in part, without the written approval of IAVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of IAVG.

CCIC-SET/T-I (00) Page 34 of 76





Ref: ACR 332.7.17.SATU.A

4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the forementioned 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 <u>RETURN LOSS</u>

The following uncertainties apply to the return loss measurement:

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

5.2 <u>DIMENSION MEASUREMENT</u>

The following uncertainties apply to the dimension measurements:

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

5.3 VALIDATION MEASUREMENT

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

Scan Volume	Expanded Uncertainty		
1 g	20.3 %		

Page: 5/11

This document skall not be reproduced, except in full or in part, without the written approval of IAVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of IAVG.

CCIC-SET/T-I (00) Page 35 of 76



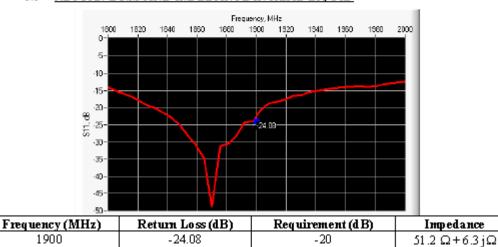


Ref: ACR 332.7.17.SATU A

10 g	20.1 %

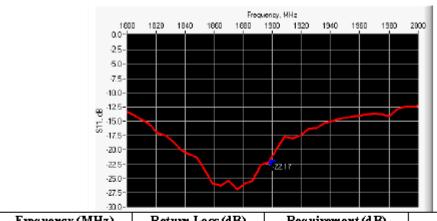
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



21.00

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (d B)	Інфедансе
1900	-22.17	-20	46.8 Ω+6.8 jΩ

6.3 MECHANICAL DIMENSIONS

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

Page: 6/11

This document shall not be reproduced, except in full or in part, without the written approval of IAPG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of IAPG.

CCIC-SET/T-I (00) Page 36 of 76





Ref: ACR 332.7.17.SATU A

290.0±1.%.		1667±1%.		6.35±1.%.	
1760±1 % .		100.0±1%.		6.35±1.%.	
161.0±1%.		89 8 ±1 %.		3.6±1 %.	
149.0±1%.		83.3 ±1 %.		3.6±1 %.	
89.1 ±1 %.		51.7 ±1 %.		3.6±1 %.	
80.5 ±1 %.		50.0 ±1 % .		3.6±1 %.	
79.0±1%.		45.7 ±1.%.		3.6±1 %.	
75.2±1 %.		429 ±1 %.		3.6±1 %.	
72.0 ±1 % .		41.7 ±1 %.		3.6±1 %.	
68.0±1%.	PASS	395±1%.	PASS	3.6±1 %.	PASS
66.3 ±1 %.		385±1%.		3.6±1 %.	
64.5 ±1 %.		375 ±1 %.		3.6±1 %.	
61.0±1%.		35.7 ±1.%.		3.6±1 %.	
55.5 ±1 %.		32.6 ±1 %.		3.6±1 %.	
51.5 ±1 %.		30.4 ±1 %.		3.6±1 %.	
48.5 ±1 %.		28.8 ±1.%.		3.6±1 %.	
41.5 ±1 %.		50 1%.		3.6±1 %.	
37.0±1.%.		264 ±1 %.		3.6±1 %.	
34.7±1 %.		264 ±1 %.		3.6±1 %.	
	1760±1%. 1610±1%. 1490±1%. 89.1±1%. 80.5±1%. 79.0±1%. 72.0±1%. 68.0±1%. 66.3±1%. 64.5±1%. 61.0±1%. 55.5±1%. 48.5±1%. 48.5±1%. 41.5±1%.	1760±1%. 1610±1%. 1490±1%. 89.1±%. 80.5±1%. 79.0±1%. 75.2±1%. 72.0±1%. 68.0±1%. 64.5±1%. 61.0±1%. 55.5±1%. 41.5±1%. 41.5±1%. 37.0±1%.	1760 世 %. 1000 世 %. 1610 世 %. 89 8 世 %. 89 8 世 %. 83.3 世 %. 89.1 世 %. 51.7 世 %. 50.0 世 %. 79.0 世 %. 45.7 世 %. 42.9 世 %. 75.2 世 %. 42.9 世 %. 72.0 世 %. 66.3 世 %. 83.5 世 %. 66.3 世 %. 66.3 世 %. 66.5 世 %. 37.5 世 %. 66.0 世 %. 55.5 世 %. 32.6 世 %. 55.5 世 %. 51.5 世 %. 30.4 世 %. 43.5 世 %. 44.5 世 %. 26.4 世 %. 26.4 世 %. 26.4 世 %.	1760 ± %. 1000 ± %. 189 ± 1 %. 149 0 ± %. 89 ± 1 %. 89 ± 1 %. 89 ± 1 %. 89 ± 1 %. 89 ± 1 %. 80 ± 1 %. 51.7 ± %. 80.5 ± %. 50.0 ± %. 79.0 ± %. 45.7 ± %. 42.9 ± %. 75.2 ± %. 42.9 ± %. 72.0 ± %. 83.5 ± %. 8	1760 11 %. 1000 11 %. 6.変 1 %. 1610 11 %. 89 8 11 %. 3.6 11 %. 149 0 11 %. 83.3 11 %. 3.6 11 %. 89.1 11 %. 51.7 11 %. 3.6 11 %. 80.5 11 %. 50.0 11 %. 3.6 11 %. 79.0 11 %. 45.7 11 %. 3.6 11 %. 75.2 11 %. 429 11 %. 3.6 11 %. 72.0 11 %. 41.7 11 %. 3.6 11 %. 63.0 11 %. 9458 39.5 11 %. 94.5 11 %. 64.5 11 %. 37.5 11 %. 3.6 11 %. 3.6 11 %. 61.0 11 %. 35.7 11 %. 3.6 11 %. 3.6 11 %. 55.5 11 %. 30.4 11 %. 3.6 11 %. 3.6 11 %. 43.5 11 %. 30.4 11 %. 3.6 11 %. 3.6 11 %. 41.5 11 %. 26.4 11 %. 3.6 11 %. 3.6 11 %.

7 VALIDATION MEASUREMENT

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

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (s /)		Conductivity (a) S/m	
	required	measured	required	measured
300	45.3±5%		0.87 ±5 %	
450	435±5%		0.87 ±5 %	
750	419±5%		0.89 ±5 %	
835	415±5%		0.90±5%	
900	415±5%		0.97 ±5 %	
1450	405±5%		1.20±5%	
1500	40.4±5%		1.23±5%	
1640	40.2±5 %		1.31±5%	
1750	401±5%		1.37 ±5 %	

Page: 7/11

This document shall not be reproduced, except in full or in part, without the written approval of IAVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of IAVG.

CCIC-SET/T-I (00) Page 37 of 76





Ref: ACR 332.7.17.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	398±5%		1.49 ±5 %	
2300	395±5%		1.67±5%	
2450	39.2±5 %		1.80±5 %	
2600	39.0±5%		1.96±5%	
3000	385±5%		2.40±5%	
3500	379±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 2009 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps': 41 2 sigma: 1 37
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
Imput power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1gsar (1gSAR (W/kg/W)		(w/kg/w)
	required	measured	required	measured
300	2.85		194	
450	4.58		3.06	
750	8.49		5.55	
835	9.56		6.22	
900	10.9		699	
1450	29		16	
1500	30.5		168	
1640	34.2		18 <i>4</i>	
1750	36.4		19.3	
1800	38.4		201	

Page: &II

This document shall not be reproduced, except in full or in part, without the written approval of IAVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of IAVG.

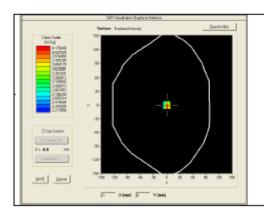
CCIC-SET/T-I (00) Page 38 of 76

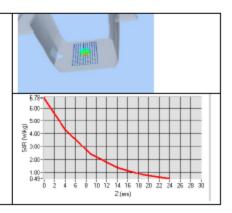




Ref: ACR 332.7.17.SATU.A

1900	39.7	39.35 (3.93)	205	20.48 (2.05)
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	
3700	67.4		24.2	





7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (年/)		Conductivity (a) S/m	
	required	measured	required	measured
150	619±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	538±5%		1.40±5%	
1800	53.3±5%		1.52±5%	
1900	53.3±5%	PASS	1.52±5%	PASS
2000	53.3±5%		1.52±5%	
2100	53.2±5 %		1.62±5%	
2300	529±5%		1.81 ±5 %	

Page: 9/11

This document shall not be reproduced, except in full or in part, without the written approval of IAVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of IAVG.

CCIC-SET/T-I (00) Page 39 of 76





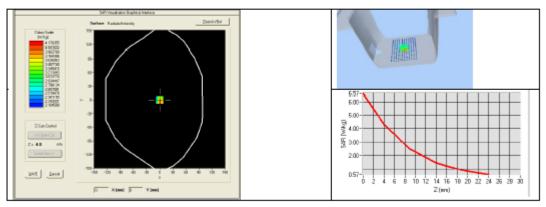
Ref: ACR 332.7.17.SATU A

2450	52.7 ±5 %	1.95 ±5 %
2600	525±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%	553±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 ' : 51.0 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	1900 MHz
Imput 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	38.84 (3.88)	20.47 (2.05)	



Page: 10/11

This document shall not be reproduced, except in full or in part, without the written approval of IAVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of IAVG.

CCIC-SET/T-I (00) Page 40 of 76





Ref: ACR 332.7.17.SATU.A

8 LIST OF EQUIPMENT

Equipment Summary Sheet					
Equipment Description	Manufacturer / Mod el	Identification No.	Current Calibration Date	Next Calibration Date	
SAM Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.	
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.	
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019	
Calipers	Carrera	CALIPER-01	01 <i>/</i> 2017	01/2020	
Reference Probe	M√G	EPG122 SN 18/11	10/2017	10/2018	
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.	
Temperature and Humidity Sensor	Control Company	150798832	11/2017	11/2020	

Page: 11/11

This document shall not be reproduced, except in full or in part, without the written approval of IAVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of IAVG.

CCIC-SET/T-I (00) Page 41 of 76



SID2450 Dipole Calibration Report



SAR Reference Dipole Calibration Report

Ref: ACR.332.9.17.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD

ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI JIEDAO, NANSHAN DISTRICT SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ

SERIAL NO.: SN 09/13 DIP 2G450-220

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





Calibration Date: 11/27/17

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.

CCIC-SET/T-I (00) Page 42 of 76





Ref: ACR.332.9.17.SATU.A

	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	11/28/2017	JE
Checked by :	Jérôme LUC	Product Manager	11/28/2017	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	11/28/2017	from Puethowski

	Customer Name			
	CCIC SOUTHERN			
	ELECTRONIC			
Distribution:	PRODUCT			
Distribution .	TESTING			
	(SHENZHEN) Co.,			
	Ltd			

Issue	Date	Modifications
A	11/28/2017	Initial release

Page: 2/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 43 of 76





Ref: ACR.332.9.17.SATU.A

TABLE OF CONTENTS

1	Intro	oduction 4	
2	Dev	ice Under Test4	
3	Proc	luct Description 4	
	3.1	General Information	4
4	Mea	surement Method5	
	4.1	Return Loss Requirements	5
	4.2	Mechanical Requirements	
5	Mea	surement Uncertainty	
	5.1	Return Loss	5
	5.2	Dimension Measurement	5
	5.3	Validation Measurement_	5
6	Cali	bration Measurement Results	
	6.1	Return Loss and Impedance In Head Liquid	6
	6.2	Return Loss and Impedance In Body Liquid	6
	6.3	Mechanical Dimensions	6
7	Vali	dation measurement	
	7.1	Head Liquid Measurement	7
	7.2	SAR Measurement Result With Head Liquid	8
	7.3	Body Liquid Measurement	9
	7.4	SAR Measurement Result With Body Liquid	10
8	List	of Equipment	

Page: 3/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG.

The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.





Ref: ACR.332.9.17.SATU.A

1 INTRODUCTION

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

2 DEVICE UNDER TEST

Device Under Test					
Device Type COMOSAR 2450 MHz REFERENCE DIPOLE					
Manufacturer MVG					
Model	SID2450				
Serial Number	SN 09/13 DIP 2G450-220				
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

Page: 4/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 45 of 76





Ref: ACR.332.9.17.SATU.A

4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constucted as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

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

5 MEASUREMENT UNCERTAINTY

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

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

5.2 <u>DIMENSION MEASUREMENT</u>

The following uncertainties apply to the dimension measurements:

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

5.3 VALIDATION MEASUREMENT

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

Scan Volume	Expanded Uncertainty		
1 g	20.3 %		

Page: 5/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 46 of 76



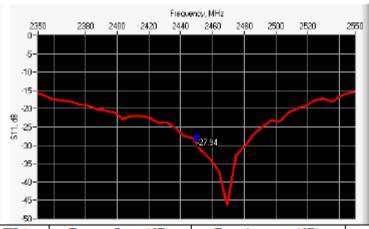


Ref: ACR.332.9.17.SATU.A

10 g	20.1 %
I .	1

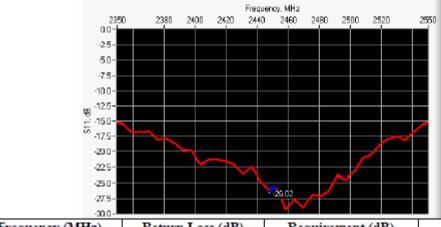
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-27.94	-20	$49.5 \Omega + 3.9 j\Omega$

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2450	-26.02	-20	$53.2 \Omega + 4.0 j\Omega$

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 %.	

Page: 6/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 47 of 76





Ref: ACR.332.9.17.SATU.A

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

7 VALIDATION MEASUREMENT

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

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (s _r ')		Conductiv	ity (σ) S/m
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %		0.89 ±5 %	
835	41.5 ±5 %		0.90 ±5 %	
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	

Page: 7/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 48 of 76





Ref: ACR.332.9.17.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 %	PASS	1.80 ±5 %	PASS
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': 40.5 sigma: 1.87
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	

Page: 8/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

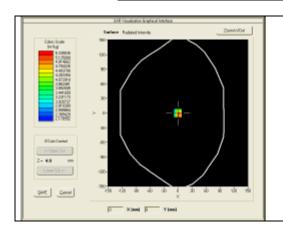
CCIC-SET/T-I (00) Page 49 of 76

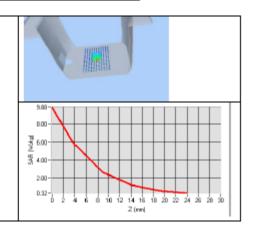




Ref: ACR.332.9.17.SATU.A

1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4	52.67 (5.27)	24	23.76 (2.38)
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 (s,')		Conductivi	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 %	
2300	52.9 ±5 %		1.81 ±5 %	

Page: 9/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 50 of 76





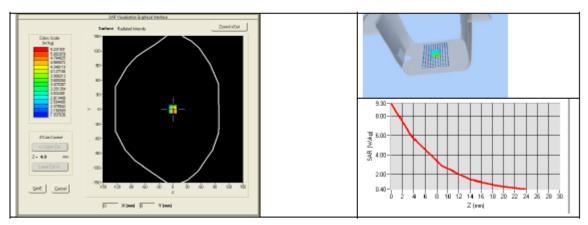
Ref: ACR.332.9.17.SATU.A

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': 54.6 sigma: 1.95
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	51.42 (5.14)	23.48 (2.35)



Page: 10/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 51 of 76





Ref: ACR.332.9.17.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	02/2016	02/2019
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	10/2017	10/2018
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

Page: 11/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 52 of 76



SID2600 Dipole Calibration Report



SAR Reference Dipole Calibration Report

Ref: ACR.332.10.17.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD

ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI JIEDAO, NANSHAN DISTRICT SHENZHEN, GUANGDONG, CHINA MVG COMOSAR REFERENCE DIPOLE

> FREQUENCY: 2600 MHZ SERIAL NO.: SN 32/14 DIP 2G600-338

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





Calibration Date: 11/27/17

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.

CCIC-SET/T-I (00) Page 53 of 76





Ref: ACR.332.10.17.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	11/28/2017	JS
Checked by:	Jérôme LUC	Product Manager	11/28/2017	JS
Approved by :	Kim RUTKOWSKI	Quality Manager	11/28/2017	tum Puthowski

	Customer Name
Distribution :	CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co., Ltd

Issue	Date	Modifications	
A	11/28/2017	Initial release	

Page: 2/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 54 of 76





Ref: ACR.332.10.17.SATU.A

TABLE OF CONTENTS

1	Intro	oduction4	
2	Dev	rice Under Test4	
3	Proc	duct Description4	
	3.1	General Information	4
4	Mea	asurement Method	
	4.1	Return Loss Requirements	5
	4.2	Mechanical Requirements	5
5	Mea	asurement Uncertainty5	
	5.1	Return Loss	5
	5.2	Dimension Measurement	5
	5.3	Validation Measurement	5
6	Cali	ibration Measurement Results 6	
	6.1	Return Loss and Impedance In Head Liquid	6
	6.2	Return Loss and Impedance In Body Liquid	6
	6.3	Mechanical Dimensions	6
7	Vali	idation measurement	
	7.1	Head Liquid Measurement	7
	7.2	SAR Measurement Result With Head Liquid	8
	7.3	Body Liquid Measurement	9
	7.4	SAR Measurement Result With Body Liquid	10
8	List	of Equipment 11	

Page: 3/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.





Ref. ACR.332.10.17.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 32/14 DIP 2G600-338						
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

Page: 4/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 56 of 76





Ref: ACR.332.10.17.SATU.A

4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constucted as outlined in the fore mentioned standards.

4.2 MECHANICAL REQUIREMENTS

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

5 MEASUREMENT UNCERTAINTY

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

5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

5.2 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 %		

Page: 5/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG.

The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 57 of 76



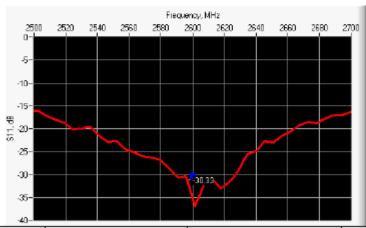


Ref: ACR.332.10.17.SATU.A

10 g	20.1 %
------	--------

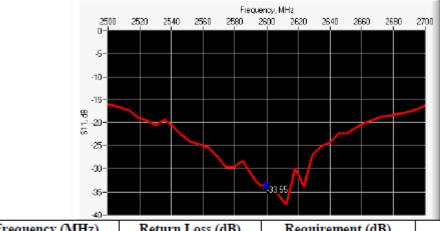
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2600	-30.33	-20	53.1 Ω - 0.7 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
2600	-33.55	-20	49 4 O - 2.1 iO

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 %.	

Page: 6/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 58 of 76





Ref: ACR.332.10.17.SATU.A

290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
176.0 ±1 %.		100.0 ±1 %.		6.35 ±1 %.	
161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
80.5 ±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 %.	
68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.	
48.5 ±1 %.	PASS	28.8 ±1 %.	PASS	3.6 ±1 %.	PASS
41.5 ±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 %.	
	176.0 ± 1 %. 161.0 ± 1 %. 149.0 ± 1 %. 89.1 ± 1 %. 80.5 ± 1 %. 79.0 ± 1 %. 75.2 ± 1 %. 68.0 ± 1 %. 66.3 ± 1 %. 61.0 ± 1 %. 55.5 ± 1 %. 51.5 ± 1 %. 48.5 ± 1 %. 41.5 ± 1 %. 37.0 ± 1 %.	176.0 ± 1 %. 161.0 ± 1 %. 149.0 ± 1 %. 89.1 ± 1 %. 80.5 ± 1 %. 79.0 ± 1 %. 75.2 ± 1 %. 68.0 ± 1 %. 66.3 ± 1 %. 64.5 ± 1 %. 51.5 ± 1 %. 48.5 ± 1 %. 48.5 ± 1 %. PASS 41.5 ± 1 %. 37.0 ± 1 %.	176.0 ± 1 %. 100.0 ± 1 %. 161.0 ± 1 %. 89.8 ± 1 %. 149.0 ± 1 %. 83.3 ± 1 %. 89.1 ± 1 %. 51.7 ± 1 %. 80.5 ± 1 %. 50.0 ± 1 %. 79.0 ± 1 %. 45.7 ± 1 %. 72.0 ± 1 %. 41.7 ± 1 %. 68.0 ± 1 %. 39.5 ± 1 %. 66.3 ± 1 %. 37.5 ± 1 %. 61.0 ± 1 %. 35.7 ± 1 %. 55.5 ± 1 %. 32.6 ± 1 %. 41.5 ± 1 %. 28.8 ± 1 %. 41.5 ± 1 %. 25.0 ± 1 %. 37.0± 1 %. 26.4 ± 1 %.	176.0 ± 1 %. 100.0 ± 1 %. 161.0 ± 1 %. 89.8 ± 1 %. 149.0 ± 1 %. 83.3 ± 1 %. 89.1 ± 1 %. 51.7 ± 1 %. 80.5 ± 1 %. 50.0 ± 1 %. 79.0 ± 1 %. 45.7 ± 1 %. 72.0 ± 1 %. 41.7 ± 1 %. 68.0 ± 1 %. 39.5 ± 1 %. 66.3 ± 1 %. 38.5 ± 1 %. 64.5 ± 1 %. 37.5 ± 1 %. 55.5 ± 1 %. 32.6 ± 1 %. 51.5 ± 1 %. PASS 41.5 ± 1 %. PASS 41.5 ± 1 %. 25.0 ± 1 %. 37.0± 1 %. 26.4 ± 1 %.	176.0 ± 1 %. 100.0 ± 1 %. 6.35 ± 1 %. 161.0 ± 1 %. 89.8 ± 1 %. 3.6 ± 1 %. 149.0 ± 1 %. 83.3 ± 1 %. 3.6 ± 1 %. 89.1 ± 1 %. 51.7 ± 1 %. 3.6 ± 1 %. 80.5 ± 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 %. 68.0 ± 1 %. 39.5 ± 1 %. 3.6 ± 1 %. 66.3 ± 1 %. 35.7 ± 1 %. 3.6 ± 1 %. 61.0 ± 1 %. 35.7 ± 1 %. 3.6 ± 1 %. 55.5 ± 1 %. 32.6 ± 1 %. 3.6 ± 1 %. 51.5 ± 1 %. PASS 28.8 ± 1 %. PASS 3.6 ± 1 %. 41.5 ± 1 %. 25.0 ± 1 %. 3.6 ± 1 %. 3.6 ± 1 %. 37.0 ± 1 %. 3.6 ± 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 (s _r ')		Conductivity (a) S/m		
	required	required measured		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 %		

Page: 7/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG.

The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 59 of 76





Ref: ACR.332.10.17.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': 38.5 sigma: 2.01
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		19.3	
1800	38.4		20.1	

Page: 8/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

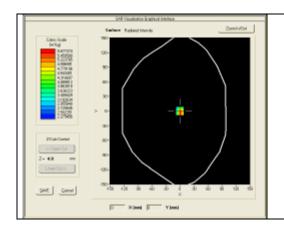
CCIC-SET/T-I (00) Page 60 of 76

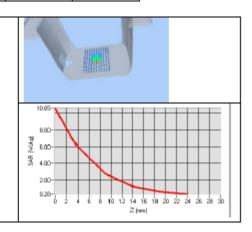




Ref: ACR.332.10.17.SATU.A

1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3	55.47 (5.55)	24.6	24.49 (2.45)
3000	63.8		25.7	
3500	67.1		25	
3700	67.4		24.2	





7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (s _r ')		Conductivi	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 %	
2300	52.9 ±5 %		1.81 ±5 %	

Page: 9/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 61 of 76





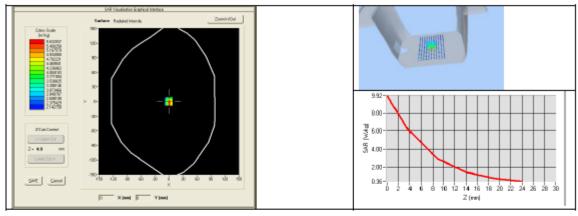
Ref: ACR.332.10.17.SATU.A

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' : 52.0 sigma : 2.16
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	53.45 (5.34)	24.00 (2.40)



Page: 10/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 62 of 76





Ref: ACR.332.10.17.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	02/2016	02/2019
Calipers	Carrera	CALIPER-01	01/2017	01/2020
Reference Probe	MVG	EPG122 SN 18/11	10/2017	10/2018
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

Page: 11/11

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 63 of 76



SID2600 Dipole Calibration Report



SAR Reference Waveguide Calibration Report

Ref: ACR.332.11.17.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO., LTD

ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD, XILI JIEDAO, NANSHAN DISTRICT SHENZHEN, GUANGDONG, CHINA

MVG COMOSAR REFERENCE WAVEGUIDE

FREQUENCY: 5000-6000 MHZ SERIAL NO.: SN 15/15 WGA39

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





Calibration Date: 11/27/17

Summary:

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

CCIC-SET/T-I (00) Page 64 of 76





Ref: ACR.332.11.17.SATU.A

	Name	Function	Date	Signature
Prepared by:	Jérôme LUC	Product Manager	11/28/2017	JS
Checked by:	Jérôme LUC	Product Manager	11/28/2017	JE
Approved by :	Kim RUTKOWSKI	Quality Manager	11/28/2017	Jum Puthowski

	Customer Name
Distribution :	CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) Co.,
	Ltd

Issue	Date	Modifications
A	11/28/2017	Initial release

Page: 2/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 65 of 76





Ref: ACR.332.11.17.SATU.A

TABLE OF CONTENTS

1	Intro	duction4	
2	Devi	ce Under Test4	
3	Prod	uct Description4	
	3.1	General Information	4
4	Mea	surement Method4	
	4.1	Return Loss Requirements	4
	4.2	Mechanical Requirements	
5	Mea	surement Uncertainty5	
	5.1	Return Loss	5
	5.2	Dimension Measurement	
	5.3	Validation Measurement	5
6	Calil	oration Measurement Results5	
	6.1	Return Loss	5
	6.2	Mechanical Dimensions	6
7	Valie	dation measurement7	
	7.1	Head Liquid Measurement	7
	7.2	Measurement Result	
	7.3	Body Measurement Result	
8	List	of Equipment13	

Page: 3/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.





Ref: ACR.332.11.17.SATU.A

1 INTRODUCTION

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

2 DEVICE UNDER TEST

	Device Under Test
Device Type	COMOSAR 5000-6000 MHz REFERENCE WAVEGUIDE
Manufacturer	MVG
Model	SWG5500
Serial Number	SN 15/15 WGA39
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

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

4 MEASUREMENT METHOD

The IEEE 1528 and CEI/IEC 62209 standards provide requirements for reference waveguides used for system validation measurements. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 RETURN LOSS REQUIREMENTS

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

4.2 MECHANICAL REQUIREMENTS

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

Page: 4/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 67 of 76





Ref: ACR.332.11.17.SATU.A

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		

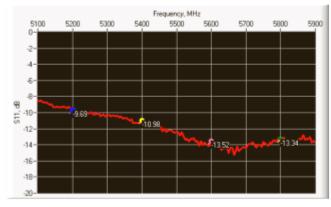
5.3 VALIDATION MEASUREMENT

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

Scan Volume	Expanded Uncertainty
1 g	20.3 %
10 g	20.1 %

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS IN HEAD LIQUID



Page: 5/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 68 of 76

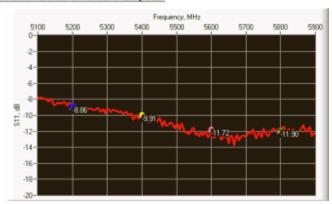




Ref: ACR.332.11.17.SATU.A

Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
5200	-9.69	-8	$25.64 \Omega + 4.71 j\Omega$
5400	-10.98	-8	$84.04 \Omega + 17.11 j\Omega$
5600	-13.52	-8	36.63 Ω - 12.55 jΩ
5800	-13.34	-8	$47.82 \Omega + 21.42 j\Omega$

6.2 RETURN LOSS IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
5200	-8.86	-8	$23.97 \Omega + 5.78 j\Omega$
5400	-9.91	-8	92.64 $Ω$ + 17.22 j $Ω$
5600	-11.72	-8	32.59 Ω - 13.02 jΩ
5800	-11.90	-8	$48.49 \Omega + 25.88 j\Omega$

6.3 MECHANICAL DIMENSIONS

Frequenc	L (mm)		W (mm)		L _f (mm)		W _f (mm)		T (mm)	
y (MHz)	Require d	Measure d	Require d	Measure d	Require d	Measure d	Require d	Measure d	Require d	Measure d
5200	40.39 ± 0.13	PASS	20.19 ± 0.13	PASS	81.03 ± 0.13	PASS	61.98 ± 0.13	PASS	5.3*	PASS
5800	40.39 ± 0.13	PASS	20.19 ± 0.13	PASS	81.03 ± 0.13	PASS	61.98 ± 0.13	PASS	4.3*	PASS

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

Page: 6/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 69 of 76





Ref: ACR.332.11.17.SATU.A

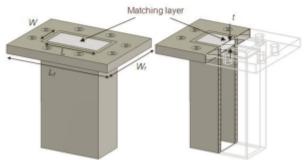


Figure 1: Validation Waveguide Dimensions

7 VALIDATION MEASUREMENT

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

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (ε _ε ')	Conductivity (a) S/m		
	required	measured	required	measured	
5000	36.2 ±10 %		4.45 ±10 %		
5100	36.1 ±10 %		4.56 ±10 %		
5200	36.0 ±10 %	PASS	4.66 ±10 %	PASS	
5300	35.9 ±10 %	PASS	4.76 ±10 %	PASS	
5400	35.8 ±10 %	PASS	4.86 ±10 %	PASS	
5500	35.6 ±10 %	PASS	4.97 ±10 %	PASS	
5600	35.5 ±10 %	PASS	5.07 ±10 %	PASS	
5700	35.4 ±10 %		5.17 ±10 %		
5800	35.3 ±10 %	PASS	5.27 ±10 %	PASS	
5900	35.2 ±10 %		5.38 ±10 %		
6000	35.1 ±10 %		5.48 ±10 %		

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

Page: 7/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 70 of 76



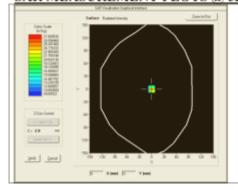


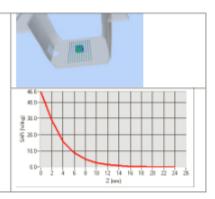
Ref: ACR.332.11.17.SATU.A

Software	OPENSAR V4		
Phantom	SN 20/09 SAM71		
Probe	SN 18/11 EPG122		
Liquid	Head Liquid Values 5200 MHz: eps':35.14 sigma: 4.74 Head Liquid Values 5400 MHz: eps':34.52 sigma: 4.77 Head Liquid Values 5600 MHz: eps':37.08 sigma: 5.03 Head Liquid Values 5800 MHz: eps':34.64 sigma: 5.19		
Distance between dipole waveguide and liquid	0 mm		
Area scan resolution	dx=8mm/dy=8mm		
Zoon Scan Resolution	dx=4mm/dy=4m/dz=2mm		
Frequency	5200 MHz 5400 MHz 5600 MHz 5800 MHz		
Input power	20 dBm		
Liquid Temperature	21 °C		
Lab Temperature	21 °C		
Lab Humidity	45 %		

Frequency (MHz)	1 g SAR (W/kg)		10 g SAR (W/kg)		
	required	required measured		measured	
5200	159.00	164.10 (16.41)	56.90	55.98 (5.60)	
5400	166.40	171.25 (17.13)	58.43	57.79 (5.78)	
5600	173.80	178.98 (17.90)	59.97	59.93 (5.99)	
5800	181.20	185.54 (18.55)	61.50	61.47 (6.15)	

SAR MEASUREMENT PLOTS @ 5200 MHz





Page: 8/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

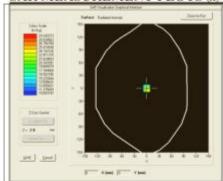
CCIC-SET/T-I (00) Page 71 of 76

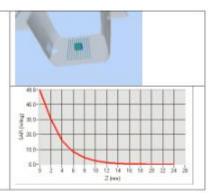




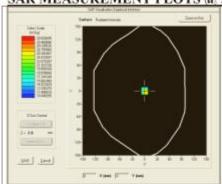
Ref: ACR.332.11.17.SATU.A

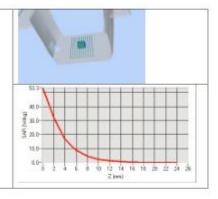




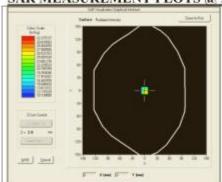


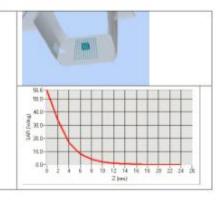
SAR MEASUREMENT PLOTS @ 5600 MHz





SAR MEASUREMENT PLOTS @ 5800 MHz





Page: 9/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 72 of 76





Ref: ACR.332.11.17.SATU.A

7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative per	mittivity (ε _τ ')	Conductivity (a) S/m		
	required	measured	required	measured	
5200	49.0 ±10 %	PASS	5.30 ±10 %	PASS	
5400	48.7 ±10 %	PASS	5.53 ±10 %	PASS	
5600	48.5 ±10 %	PASS	5.77 ±10 %	PASS	
5800	48.2 ±10 %	PASS	6.00 ±10 %	PASS	

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 5200 MHz: eps':49.01 sigma: 5.27 Body Liquid Values 5400 MHz: eps':49.67 sigma: 5.45 Body Liquid Values 5600 MHz: eps':47.57 sigma: 5.69 Body Liquid Values 5800 MHz: eps':49.82 sigma: 5.94		
Distance between dipole waveguide and liquid	0 mm		
Area scan resolution	dx=8mm/dy=8mm		
Zoon Scan Resolution	dx=4mm/dy=4m/dz=2mm		
Frequency	5200 MHz 5400 MHz 5600 MHz 5800 MHz		
Input power	20 dBm		
Liquid Temperature	21 °C		
Lab Temperature	21 °C		
Lab Humidity	45 %		

Frequency (MHz)	1 g SAR (W/kg)	10 g SAR (W/kg)
	measured	measured
5200	155.78 (15.58)	54.48 (5.45)
5400	160.24 (16.02)	55.34 (5.53)
5600	167.61 (16.76)	56.92 (5.69)
5800	170.49 (17.05)	57.26 (5.73)

Page: 10/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

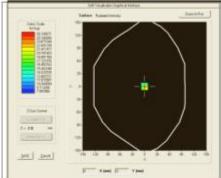
CCIC-SET/T-I (00) Page 73 of 76

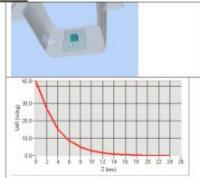




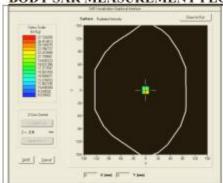
Ref: ACR.332.11.17.SATU.A

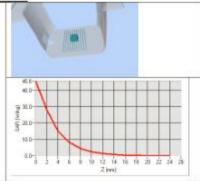




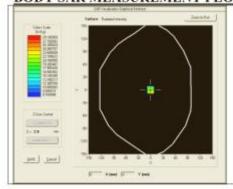


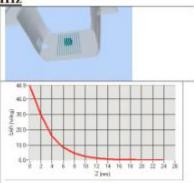
BODY SAR MEASUREMENT PLOTS @ 5400 MHz





BODY SAR MEASUREMENT PLOTS @ 5600 MHz





Page: 11/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

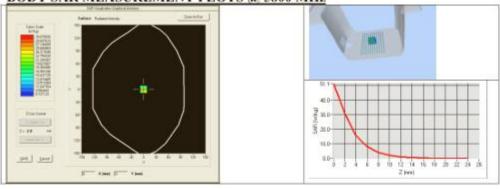
CCIC-SET/T-I (00) Page 74 of 76





Ref: ACR.332.11.17.SATU.A

BODY SAR MEASUREMENT PLOTS @ 5800 MHz



Page: 12/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

CCIC-SET/T-I (00) Page 75 of 76





Ref: ACR.332.11.17.SATU.A

8 LIST OF EQUIPMENT

Equipment Summary Sheet							
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date			
Flat Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.			
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.			
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2016	02/2019			
Calipers	Carrera	CALIPER-01	01/2017	01/2020			
Reference Probe	MVG	EPG122 SN 18/11	10/2017	10/2018			
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			

Page: 13/13

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

-End of the Report-

CCIC-SET/T-I (00) Page 76 of 76