

Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
5200	-21.40	-20	$57.13 \Omega - 4.54 j\Omega$
5400	-26.95	-20	$54.47 \Omega - 0.31 j\Omega$
5600	-31.14	-20	$52.65 \Omega + 0.81 j\Omega$
5800	-26.91	-20	$49.92 \Omega - 4.51 j\Omega$

6.3 MECHANICAL DIMENSIONS

Frequency MHz	L mm		h mm		d mm	
	required	measured	required	measured	required	measured
5000 to 6000	$20.6 \pm 1 \%$.	20.78	$40.3 \pm 1 \%$.	40.59	$3.6 \pm 1 \%$.	3.59

7 VALIDATION MEASUREMENT

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ϵ_r')		Conductivity (σ) S/m	
	required	measured	required	measured
5000	$36.2 \pm 10 \%$		$4.45 \pm 10 \%$	
5100	$36.1 \pm 10 \%$		$4.56 \pm 10 \%$	
5200	$36.0 \pm 10 \%$	34.44	$4.66 \pm 10 \%$	4.64
5300	$35.9 \pm 10 \%$		$4.76 \pm 10 \%$	
5400	$35.8 \pm 10 \%$	33.63	$4.86 \pm 10 \%$	4.88
5500	$35.6 \pm 10 \%$		$4.97 \pm 10 \%$	
5600	$35.5 \pm 10 \%$	32.80	$5.07 \pm 10 \%$	5.12
5700	$35.4 \pm 10 \%$		$5.17 \pm 10 \%$	
5800	$35.3 \pm 10 \%$	32.63	$5.27 \pm 10 \%$	5.31
5900	$35.2 \pm 10 \%$		$5.38 \pm 10 \%$	
6000	$35.1 \pm 10 \%$		$5.48 \pm 10 \%$	

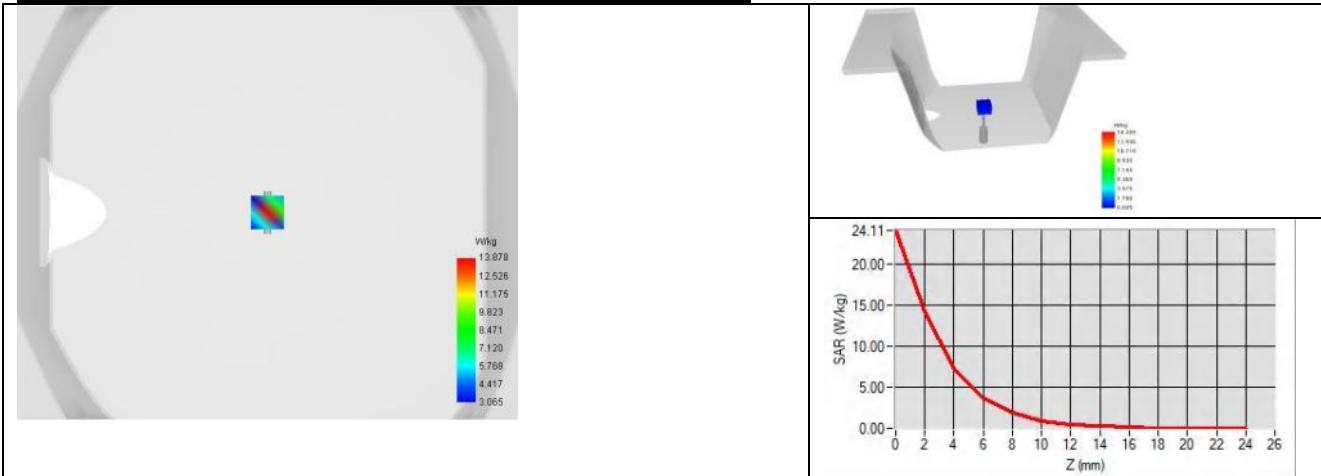
7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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.

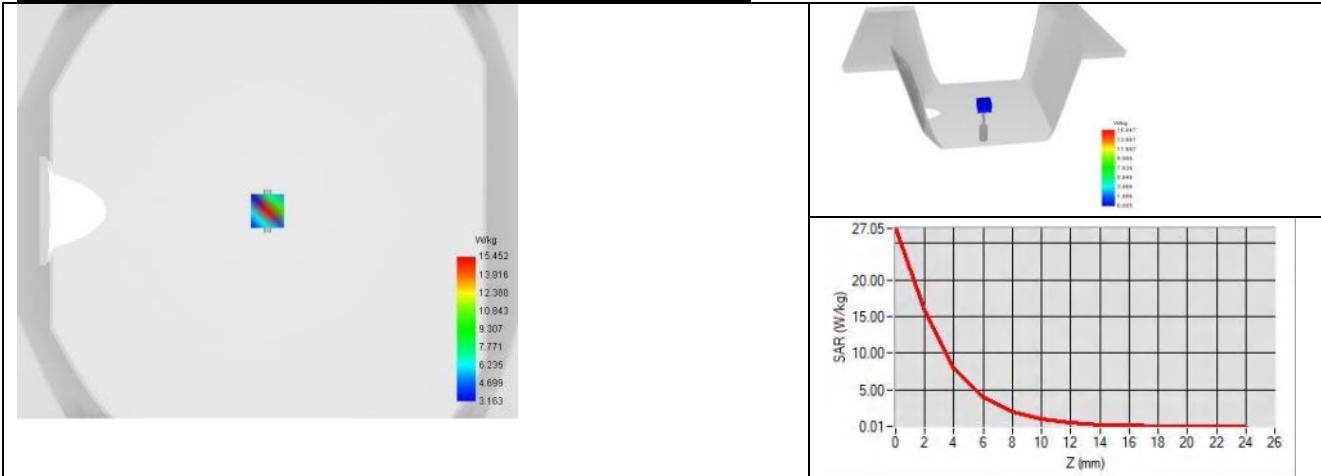
Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Head Liquid Values 5200 MHz: eps' :34.44 sigma : 4.64 Head Liquid Values 5400 MHz: eps' :33.63 sigma : 4.88 Head Liquid Values 5600 MHz: eps' :32.80 sigma : 5.12 Head Liquid Values 5800 MHz: eps' :32.63 sigma : 5.31
Distance between dipole and liquid	10 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	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

Frequency (MHz)	1 g SAR (W/kg)		10 g SAR (W/kg)	
	required	measured	required	measured
5200	76.50	73.88 (7.39)	21.60	21.29 (2.13)
5400	-	81.47 (8.15)	-	23.23 (2.32)
5600	-	78.71 (7.87)	-	22.64 (2.26)
5800	78.00	74.21 (7.42)	21.90	21.50 (2.15)

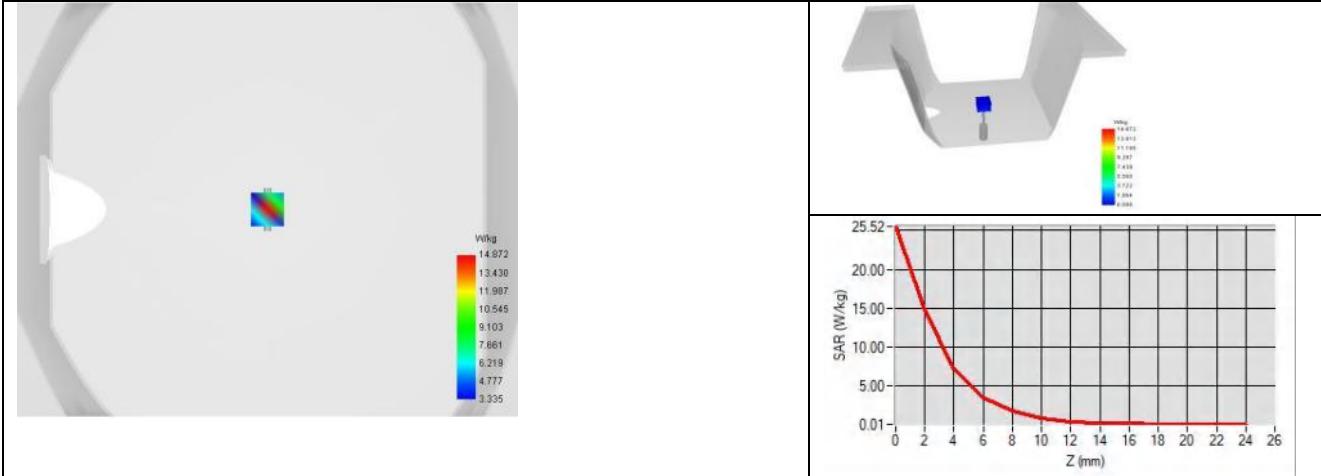
SAR MEASUREMENT PLOTS @ 5200 MHz



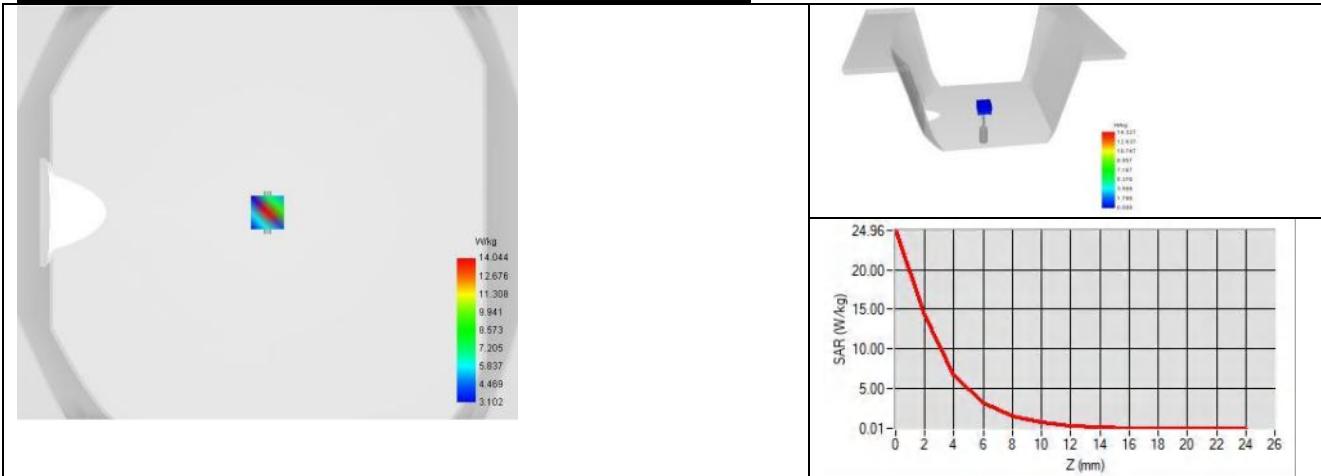
SAR MEASUREMENT PLOTS @ 5400 MHz



SAR MEASUREMENT PLOTS @ 5600 MHz



SAR MEASUREMENT PLOTS @ 5800 MHz



7.3 BODY LIQUID MEASUREMENT

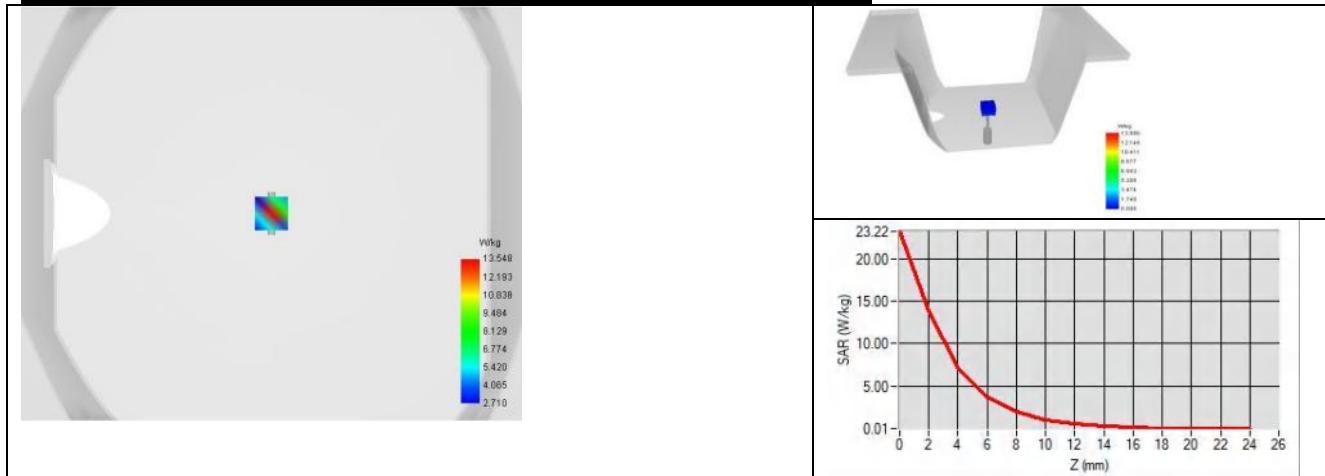
Frequency MHz	Relative permittivity (ϵ_r')		Conductivity (σ) S/m	
	required	measured	required	measured
5200	49.0 \pm 10 %	45.50	5.30 \pm 10 %	5.63
5300	48.9 \pm 10 %		5.42 \pm 10 %	
5400	48.7 \pm 10 %	44.78	5.53 \pm 10 %	5.95
5500	48.6 \pm 10 %		5.65 \pm 10 %	
5600	48.5 \pm 10 %	44.85	5.77 \pm 10 %	6.26
5800	48.2 \pm 10 %	44.45	6.00 \pm 10 %	6.58

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

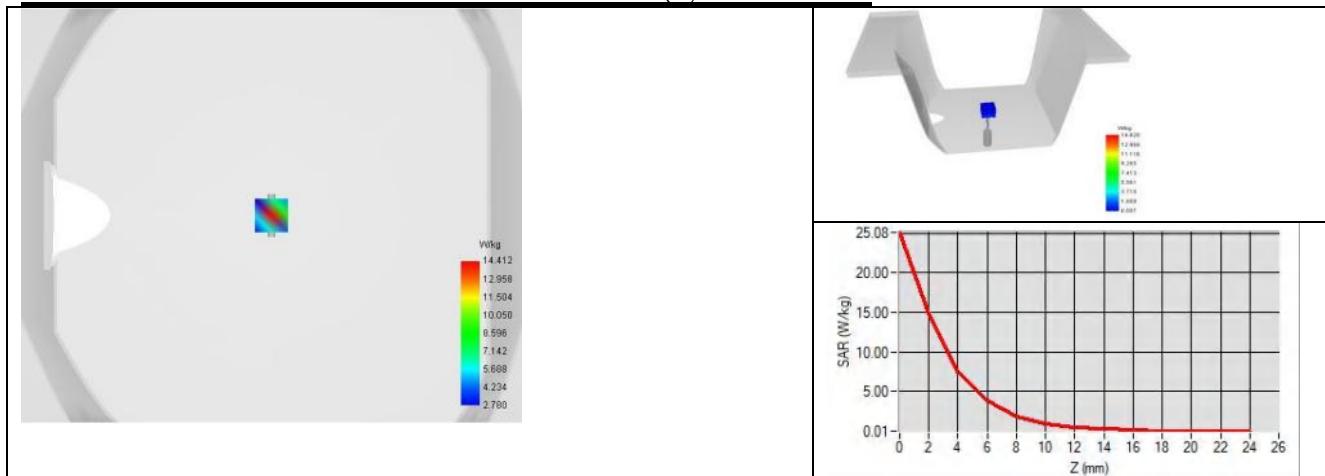
Software	OPENSAR V5
Phantom	SN 13/09 SAM68
Probe	SN 41/18 EPGO333
Liquid	Body Liquid Values 5200 MHz: ϵ_r' :45.50 sigma : 5.63 Body Liquid Values 5400 MHz: ϵ_r' :44.78 sigma : 5.95 Body Liquid Values 5600 MHz: ϵ_r' :44.85 sigma : 6.26 Body Liquid Values 5800 MHz: ϵ_r' :44.45 sigma : 6.58
Distance between dipole and liquid	10 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	20 \pm 1 °C
Lab Temperature	20 \pm 1 °C
Lab Humidity	30-70 %

Frequency (MHz)	1 g SAR (W/kg)	10 g SAR (W/kg)
	measured	measured
5200	71.75 (7.18)	20.38 (2.04)
5400	75.93 (7.59)	21.44 (2.14)
5600	77.44 (7.74)	22.16 (2.22)
5800	69.01 (6.90)	19.75 (1.97)

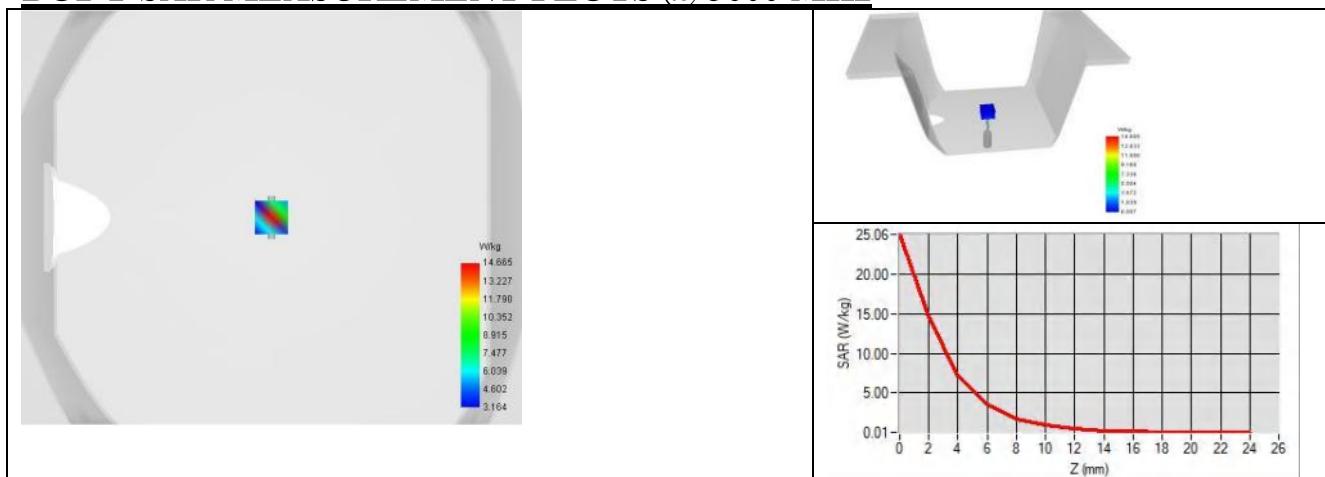
BODY SAR MEASUREMENT PLOTS @ 5200 MHz

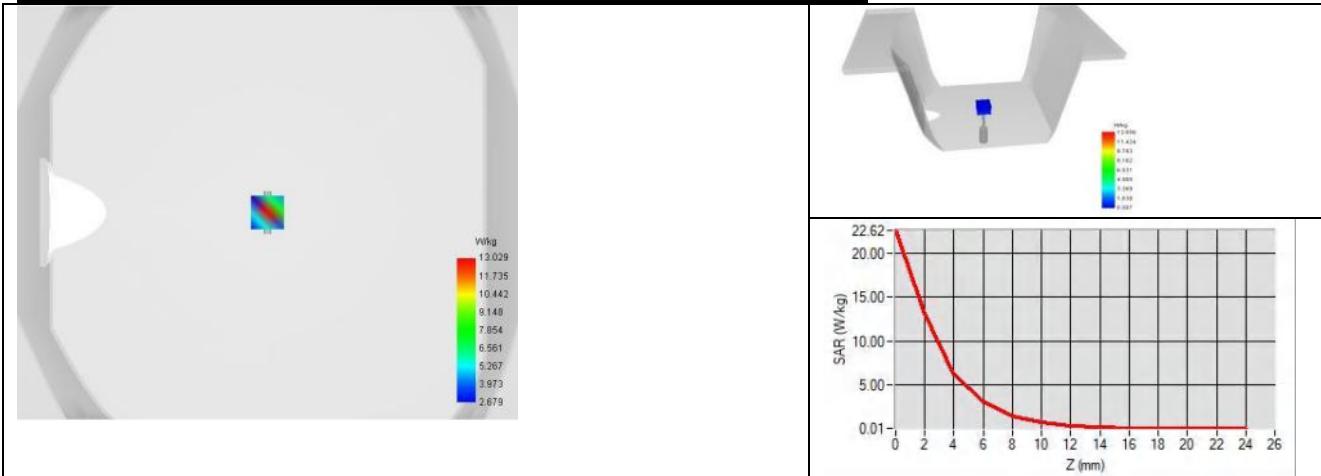


BODY SAR MEASUREMENT PLOTS @ 5400 MHz



BODY SAR MEASUREMENT PLOTS @ 5600 MHz



BODY SAR MEASUREMENT PLOTS @ 5800 MHz

8 LIST OF EQUIPMENT

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



校准证书

CALIBRATION CERTIFICATE



证书编号:



Certificate No.

S424079462

第 1 页 共 6 页
Page of

客户名称:
Name

信恒检测技术(深圳)有限公司

客户信息 Customer Information

客户地址:
Address

深圳市宝安区松岗街道潭头社区潭头工业城二区1栋厂房101.201.3
01

仪器名称:
Description

Coaxial mechanical calibration parts 同轴机械校准件

型号规格:
Model/Type

50Ω 35mm 9G

制造厂商:
Manufacturer

南京普纳科技设备有限公司

被校测量 器具信息 Information of Instrument under Calibration

出厂编号:
Serial No.

/

管理编号:
Asset No.

BTF-EM-068

接收日期:
Received Date

2024 / 10 / 25

接收状态:
As Received

正常/Normal

结论:
Conclusion

参照检测/校准结果使用。
The test or calibration results are referred to evaluate the validity of instrument measurement.



扫一扫查真伪

证书有效性声明:

- 证书首页盖有证书章
- 证书须有唯一防伪码
- 扫描信息与证书一致

校准日期:
Cal.Date

签发日期:
Issue Date

建议复校日期:
Next Cal. Date

校准:
Calibrated by

核验:
Inspected by

签发:
Approved by



校准说明

CALIBRATION DIRECTIONS

证书编号: S424079462
Certificate No.

第 2 页共 6 页
Page of

1. 本公司实验室经中国合格评定国家认可委员会审核, 符合ISO/IEC17025《检测和校准实验室能力的通用要求》的要求, 认可证书号: No.L3103。

This laboratory is accredited to ISO/IEC 17025《Requirements for the competence of Testing and Calibration Laboratories》,CNAS Accreditation Certificate No.L3103.

2. 本证书中的校准结果均可溯源至国际单位制 (SI) 单位。

The calibration results in this certificate are traceable to International System of Units(SI)

3. 对本次校准若有异议, 委托方应于收到被校件之日起十五日内向本公司提出。

If there is any objection concerning the calibration, the Client should inform the issuing company within 15 days from the date of the device under test return to the client.

4. 未经本公司许可, 不得部分复印、摘用或篡改本证书的内容。

This report may not be reproduced, except in full, without the written approval of CCIC (ShenZhen) Metrology & Testing Service Co.,Ltd.

5. 本证书校准结果只与被校准仪器有关, 带'*'号的校准项目或参数不在本公司实验室认可范围内。

The results reported here in apply only to the calibrated equipment, Calibration items or parameter with '*' is beyond the scope of our laboratory accreditation.

6. 本次校准的技术依据:

Procedures for the Calibration:

参照 JJF 1495-2014《矢量网络分析仪校准规范》 C.S. for Vector network analyzer

JJF(军工)76-2014《微波二端口器件校准规范》 C.S. for Two-port Microwave Devices

7. 本次校准所使用的主要标准器具:

Standards Used in the Calibration:

器具名称/型号规格 Instrument Description/Model	编 号 Asset No.	证书编号 Certificate No.	有效期 Due Date	计量特性 Metrological Characteristic	溯源机构 Traceability institutions
网络分析仪/Vector Network Analyzer E5071C	CCIC-WX-1024	JL2402278931	2025/02/05	Sij模值: $U=0.12\text{dB}$; Sij相位: $U=0.9^\circ$; VSWR: $U=0.30$; ($k=2$)	深圳计量院
N型校准套件/Type-N Calibration Kit 85054B	CCIC-WX-1006	GFJGJL100222007 8220	2025/04/28	Reflection: $U=0.02$ ($k=2$); Phase: $U=1^\circ$ ($k=2$);	二〇三所

8. 校准地点和环境条件:

Place and environmental conditions:

地 点: 客户现场 实验室
Place of Calibration

温 度: (22.5 ~ 23) °C
Temperature

相 对 湿 度: (55 ~ 60)%
Relative Humidity



校准结果

CALIBRATION RESULT

证书编号: S424079462
Certificate No.

第 3 页共 6 页
Page of

1、外观及正常性检查: 正常

Check on Appearance and Function: Pass

2、50Ω负载驻波比

50Ω load VSWR

频率 Frequency	实测值 Measured
(MHz)	/
10	1.004
50	1.005
100	1.007
200	1.006
500	1.007
1000	1.011
2000	1.012
3000	1.018
4000	1.021
5000	1.023
6000	1.023
7000	1.019
8000	1.016
9000	1.017

3、开路反射

Open circuit reflex

频率 Frequency	实测值 Measured
(MHz)	/
10	1.000
50	1.000
100	1.000
200	1.000



校准结果

CALIBRATION RESULT

证书编号: S424079462
Certificate No.

第 4 页共 6 页
Page of

500	1.000
1000	1.000
2000	0.999
3000	0.998
4000	0.995
5000	0.993
6000	0.991
7000	0.989
8000	0.987
9000	0.987

4、开路相位

Open phase

频率	实测值
Frequency	Measured
(MHz)	(°)
10	-0.22
50	-1.12
100	-2.23
200	-4.42
500	-11.10
1000	-22.27
2000	-44.37
3000	-67.00
4000	-89.40
5000	-111.91
6000	-134.79
7000	-157.98
8000	179.05
9000	155.91

5、短路反射



校准结果

CALIBRATION RESULT

证书编号: S424079462
Certificate No.

第 5 页共 6 页
Page of

Short circuit reflex

频率 Frequency (MHz)	实测值 Measured
	/
10	0.999
50	0.998
100	0.997
200	0.996
500	0.994
1000	0.990
2000	0.988
3000	0.988
4000	0.988
5000	0.988
6000	0.990
7000	0.992
8000	0.990
9000	0.992

6、短路相位

Short phase

频率 Frequency (MHz)	实测值 Measured (°)
10	179.74
50	178.69
100	177.44
200	175.02
500	167.80
1000	155.90
2000	132.22



校准结果

CALIBRATION RESULT

证书编号: S424079462
Certificate No.

第 6 页共 6 页
Page of

3000	108.77
4000	89.80
5000	62.70
6000	40.54
7000	18.00
8000	-4.05
9000	-26.09

说明(Notes)

1. 本次校准的测量不确定度

Measurement Uncertainty in Calibration

1.1 依据JJF 1059.1-2012 测量不确定度评定与表示

Conform JJF 1059.1-2012 *Evaluation and Expression of Uncertainty in Measurement.*

1.2 本次测量结果的扩展不确定度 ($k=2$)

The Expanded Uncertainty of the Measurement Results

—— 反射系数相位(Reflective Phase)	$U = 1.7^\circ$
—— 反射系数模值 (Reflective Properties)	$U = 0.029$

以下空白

End of Report



Dielectric Probe Calibration Report

Ref : ACR.41.5.25.BES.A

BTF TESTING LAB (SHENZHEN) CO., LTD.
F101,201 AND 301, BUILDING 1, BLOCK 2, TANTOU
INDUSTRIAL PARK, TANTOU COMMUNITY
SONGGANG STREET, BAO'AN DISTRICT, SHENZHEN,
CHINA

MVG LIMESAR DIELECTRIC PROBE
FREQUENCY: 0.15-7.5 GHZ
SERIAL NO.: SN 06/22 OCPG 88

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

Calibration date: 02/05/2025



Accreditations #2-6789
Scope available on www.cofrac.fr

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Summary:

This document presents the method and results from an accredited Dielectric Probe calibration performed at MVG, using the LIMESAR test bench. The test results covered by accreditation are traceable to the International System of Units (SI).



SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.41.5.25.BES.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Pedro Ruiz	Technical Manager	2/10/2025	
<i>Checked & approved by:</i>	Pedro Ruiz	Technical Manager	2/10/2025	
<i>Authorized by:</i>	Geraldine Toutain	Quality Manager	2/10/2025	<p>DocuSigned by: A1C9AC91CB5441A...</p>

	<i>Customer Name</i>
<i>Distribution :</i>	BTF Testing Lab (Shenzhen) Co., Ltd.

<i>Issue</i>	<i>Name</i>	<i>Date</i>	<i>Modifications</i>
A	Pedro Ruiz	2/10/2025	Initial release



TABLE OF CONTENTS

1	Introduction.....	4
2	Device Under Test	4
3	Product Description	4
3.1	General Information	4
4	Measurement Method	5
4.1	Liquid complex Permittivity Measurements.....	5
5	Measurement Uncertainty.....	5
6	Calibration Results.....	5
6.1	Liquid complex Permittivity Measurement	5
7	List of Equipment	7



1 INTRODUCTION

This document contains a summary of the suggested methods and requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards for liquid permittivity measurements 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	LIMESAR DIELECTRIC PROBE
Manufacturer	MVG
Model	SCLMP
Serial Number	SN 06/22 OCPG 88
Product Condition (new / used)	Used

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's Dielectric Probes are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards. The product is designed for use with the LIMESAR test bench only.



Figure 1 – MVG LIMESAR Dielectric Probe



4 MEASUREMENT METHOD

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards outline techniques for dielectric property measurements. The LIMESAR test bench employs one of the methods outlined in the standards, using a contact probe or open-ended coaxial transmission-line probe and vector network analyzer. The standards recommend the measurement of two reference materials that have well established and stable dielectric properties to validate the system, one for the calibration and one for checking the calibration. The LIMESAR test bench uses De-ionized water as the reference for the calibration and either Ethanediol or Methanol as the reference for checking the calibration. The following measurements were performed to verify that the product complies with the fore-mentioned standards.

4.1 LIQUID COMPLEX PERMITTIVITY MEASUREMENTS

The complex permittivity of a liquid with known dielectric properties was measured and the measurement results compared to the values provided in the fore mentioned standards.

5 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty associated with a SAR probe calibration using the waveguide or calorimetric cell technique depending on the frequency.

The estimated expanded uncertainty ($k=2$) in calibration for relative permittivity is $+/- 10\%$ with respect to measurement conditions.

The estimated expanded uncertainty ($k=2$) in calibration for conductivity (S/m) is $+/- 8.2\%$ with respect to measurement conditions.

6 CALIBRATION RESULTS

Measurement Condition

Software	LIMESAR
Liquid Temperature	$20 +/- 1^{\circ}\text{C}$
Lab Temperature	$20 +/- 1^{\circ}\text{C}$
Lab Humidity	30-70 %

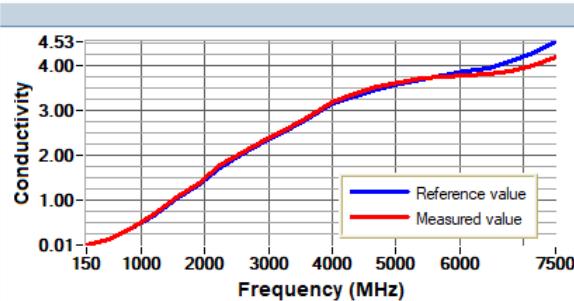
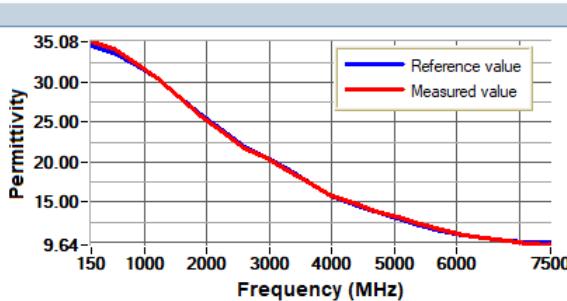
6.1 LIQUID COMPLEX PERMITTIVITY MEASUREMENT

A liquid of known characteristics (methanol or ethanediol) is measured with the probe and the results (complex permittivity $\epsilon' + j\epsilon''$) are compared with the reference values for this liquid.



SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.41.5.25.BES.A



Frequency (MHz)	Methanol Permittivity (Reference)	Methanol Permittivity (Measure)	Difference (%)	Limit (+/- %)
150	34.52	35.08	-1.6	10.0
500	33.73	34.18	-1.3	10.0
850	32.20	32.49	-0.9	10.0
1200	30.57	30.52	0.2	10.0
1550	28.17	28.17	0.0	10.0
1900	25.91	25.81	0.4	10.0
2250	24.02	23.86	0.7	10.0
2600	22.00	21.79	0.9	10.0
2950	20.53	20.43	0.5	10.0
3300	19.03	18.95	0.4	10.0
3650	17.44	17.44	-0.0	10.0
4000	15.76	15.84	-0.5	10.0
4350	14.75	14.84	-0.5	10.0
4700	13.82	13.92	-0.7	10.0
5050	12.97	13.08	-0.9	10.0
5400	12.18	12.27	-0.8	10.0
5750	11.44	11.51	-0.6	10.0
6100	10.88	10.90	-0.2	10.0
6450	10.52	10.47	0.4	10.0
6800	10.23	10.11	1.3	10.0
7150	10.06	9.81	2.5	10.0
7500	10.01	9.64	3.7	10.0

Frequency (MHz)	Methanol Conductivity (Reference)	Methanol Conductivity (Measure)	Difference (%)	Limit (+/- %)
150	0.01	0.01	-5.5	8.2
500	0.14	0.15	-7.0	8.2
850	0.37	0.39	-5.7	8.2
1200	0.67	0.69	-3.4	8.2
1550	1.04	1.08	-4.2	8.2
1900	1.36	1.40	-2.9	8.2
2250	1.74	1.79	-2.9	8.2
2600	2.04	2.07	-1.7	8.2
2950	2.32	2.35	-1.3	8.2
3300	2.57	2.61	-1.5	8.2
3650	2.84	2.88	-1.4	8.2
4000	3.15	3.20	-1.6	8.2
4350	3.33	3.38	-1.7	8.2
4700	3.48	3.52	-1.2	8.2
5050	3.60	3.63	-0.8	8.2
5400	3.70	3.71	-0.2	8.2
5750	3.78	3.74	1.0	8.2
6100	3.87	3.78	2.2	8.2
6450	3.95	3.81	3.6	8.2
6800	4.09	3.88	5.0	8.2
7150	4.29	4.01	6.5	8.2
7500	4.53	4.19	7.6	8.2



7 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
LIMESAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Liquid measurement probe	MVG	SN 35/10 OCPG37	01/2025	02/2026
Network Analyzer	Rohde & Schwarz ZVM	100203	08/2021	08/2026
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	07/2022	07/2027
Temperature / Humidity Sensor	Testo 184 H1	44235403	10/2024	10/2027