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 DMS 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 PERMITTIVITY MEASUREMENTS

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

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 DIELECTRIC PERMITTIVITY MEASUREMENT

The following uncertainties apply to the Dielectric Permittivity measurement:

Uncertainty analysis of Permittivity Measurement					
ERROR SOURCES	**Uncertainty value (+/-%)**	**Probability Distribution**	**Divisor**	**ci**	**Standard Uncertainty (+/-%)**
Expanded uncertainty (confidence level of 95%, k = 2)					10 %

Uncertainty analysis of Conductivity Measurement					
ERROR SOURCES	**Uncertainty value (+/-%)**	**Probability Distribution**	**Divisor**	**ci**	**Standard Uncertainty (+/-%)**
Expanded uncertainty (confidence level of 95%, k = 2)					8.2%

6 CALIBRATION MEASUREMENT RESULTS

Measurement Condition

Software	LIMESAR
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

Template_ACR.DDD.N.YY.MVGB.ISSUE_Dielectric Probe vK
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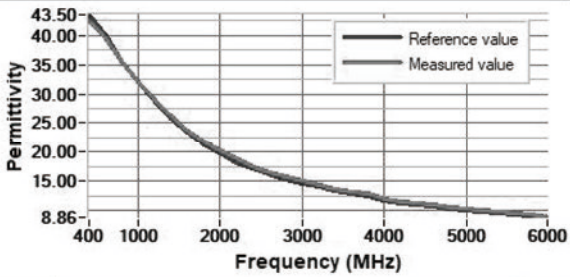
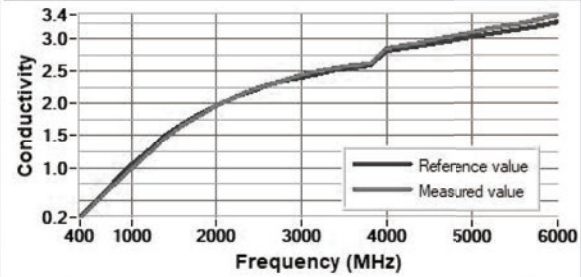
6.1 LIQUID PERMITTIVITY MEASUREMENT

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



Frequency (MHz)	Ethanediol Permittivity (Reference)	Ethanediol Permittivity (Measure)	Difference (%)	Limit (+/- %)
400	43.50	42.34	2.2	10.0
600	39.92	39.37	1.4	10.0
800	35.68	35.51	0.3	10.0
1000	31.98	32.06	-0.2	10.0
1200	28.77	29.01	-0.8	10.0
1400	25.86	26.26	-1.6	10.0
1600	23.36	22.78	-1.8	10.0
1800	21.33	21.68	-1.7	10.0
2000	19.78	20.82	-3.2	10.0
2200	18.27	18.78	-2.8	10.0
2400	17.17	17.48	-1.8	10.0
2600	16.16	16.79	-2.0	10.0
2800	15.29	15.74	-2.9	10.0
3000	14.60	14.97	-2.5	10.0
3200	14.03	14.51	-2.0	10.0
3400	13.49	13.75	-1.9	10.0
3600	12.95	13.24	-2.3	10.0
3800	12.53	12.83	-2.3	10.0
4000	11.62	11.29	-2.3	10.0
4200	11.28	11.53	-2.3	10.0
4400	10.97	11.23	-2.3	10.0
4600	10.68	10.96	-2.1	10.0
4800	10.40	10.60	-1.9	10.0
5000	10.11	10.39	-1.8	10.0
5200	9.85	10.01	-1.7	10.0
5400	9.59	9.73	-1.5	10.0
5600	9.35	9.48	-1.5	10.0
5800	9.14	9.25	-1.0	10.0
6000	8.86	8.95	-1.0	10.0



Frequency (MHz)	Ethanediol Conductivity (Reference)	Ethanediol Conductivity (Measure)	Difference (%)	Limit (+/- %)
400	0.24	0.23	3.5	8.2
600	0.50	0.46	6.9	8.2
800	0.78	0.74	5.4	8.2
1000	1.05	1.00	4.6	8.2
1200	1.27	1.20	3.4	8.2
1400	1.50	1.47	1.8	8.2
1600	1.69	1.64	1.8	8.2
1800	1.84	1.81	2.0	8.2
2000	1.97	1.94	0.4	8.2
2200	2.09	2.09	0.1	8.2
2400	2.19	2.22	-0.8	8.2
2600	2.29	2.29	0.1	8.2
2800	2.36	2.34	-0.1	8.2
3000	2.41	2.44	-1.2	8.2
3200	2.47	2.50	-1.5	8.2
3400	2.52	2.55	-1.0	8.2
3600	2.56	2.59	-1.3	8.2
3800	2.59	2.61	-1.3	8.2
4000	2.81	2.85	-1.5	8.2
4200	2.85	2.90	-1.8	8.2
4400	2.89	2.94	-1.7	8.2
4600	2.95	3.01	-2.1	8.2
4800	3.00	3.06	-2.1	8.2
5000	3.03	3.11	-2.3	8.2
5200	3.07	3.15	-2.6	8.2
5400	3.12	3.20	-2.7	8.2
5600	3.15	3.25	-3.0	8.2
5800	3.21	3.30	-3.0	8.2
6000	3.26	3.38	-3.5	8.2

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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	11/2022	11/2023
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
Temperature / Humidity Sensor	Testo 184 H1	44225320	06/2021	06/2024

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校 准 证 书
CALIBRATION CERTIFICATE

证书编号：
Certificate No. S423066282

客户信息 Customer Information	客户名称: Name	信恒检测技术（深圳）有限公司
	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101.201.301
被校测量器具信息 Information of Instrument under Calibration	仪器名称: Description	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
	出厂编号: Serial No.	/
	管理编号: Asset No.	BTF-EM-068
	接收日期: Received Date	2023 / 11 / 16
	接收状态: As Received	正常
	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.

中检（深圳）计量测试服务有限公司 计量专用章
证书专用章
Issued by

扫一扫查真伪

证书有效性声明：
1、证书首页盖有证书章
2、证书须有唯一防伪码
3、扫描信息与证书一致

校准日期: 2023 / 11 / 16
Cal.Date

校准: 刘金辉
Calibrated by

签发日期: 2023 / 11 / 17
Issue Date

核验: 何联
Inspected by

建议复校日期: 2024 / 11 / 15
Next Cal. Date

签发: 杨帆
Approved by
（总经理助理）

校 准 说 明

CALIBRATION DIRECTIONS

证书编号：S423066282
Certificate No.

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. 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.

3. 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.

4. 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 acc reditation.

5. 本次校准的技术依据:

   Procedures for the Calibration:

参照JJG(电子)306001-2006《射频同轴阻抗标准器检定规程》 V.R. of RF Coaxial Impedance standard
参照 JZM 35118J-2017《微波元器件校准方法》 Microwave components calibration method

6. 本次校准所使用的主要标准器具:

   Standards Used in the Calibration:

器具名称 Instrument Description	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	CCIC-WX-1024	JL2315557151	2024/03/13	Sij模值:U=0.12dB;Sij相位:U=0.9°;VSWR:U=0.030;(k=2)	深圳计量院
N型校准套件/Type-N Calibration Kit	CCIC-WX-1006	GFJGJL1002220078220	2025/04/28	Reflection:U=0.02(k=2);Phase:U=1°(k=2);	二○三所

7.校准地点和环境条件:

   Place and environmental conditions:

地 点： 客户现场 实验室 温 度： （23.5 ~ 24.5）℃ 相对湿度： （58 ~ 68）%

Place of Calibration Temperature Relative Humidity

校 准 结 果

CALIBRATION RESULT

证书编号：S423066282
Certificate No.

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 (MHz)	实测值 Measured /
10	1.004
50	1.003
100	1.005
200	1.005
500	1.006
1000	1.009
2000	1.012
3000	1.017
4000	1.021
5000	1.023
6000	1.021
7000	1.018
8000	1.015
9000	1.017

3、 开路反射

Open circuit reflex

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

校 准 结 果

CALIBRATION RESULT

证书编号：S423066282
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500	1.000
1000	1.000
2000	0.999
3000	0.998
4000	0.996
5000	0.994
6000	0.992
7000	0.989
8000	0.988
9000	0.987

4、 开路相位

Open phase

频率 Frequency (MHz)	实测值 Measured (°)
10	-0.23
50	-1.11
100	-2.22
200	-4.43
500	-11.10
1000	-22.27
2000	-44.38
3000	-66.99
4000	-89.40
5000	-111.92
6000	-134.79
7000	-157.97
8000	179.05
9000	155.91

5、 短路反射

校 准 结 果

CALIBRATION RESULT

证书编号：S423066282
Certificate No.

Short circuit reflex

频率 Frequency (MHz)	实测值 Measured /
10	0.999
50	0.999
100	0.997
200	0.997
500	0.995
1000	0.990
2000	0.988
3000	0.987
4000	0.988
5000	0.987
6000	0.989
7000	0.991
8000	0.991
9000	0.992

6、 短路相位

Short phase

频率 Frequency (MHz)	实测值 Measured (°)
10	179.72
50	178.71
100	177.46
200	175.00
500	167.82
1000	155.88
2000	132.23

校 准 结 果

CALIBRATION RESULT

证书编号：S423066282
Certificate No.

3000	108.78
4000	89.78
5000	62.69
6000	40.52
7000	18.02
8000	-4.03
9000	-26.07

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°

—— 反射系数模值 (Reflective Properties) U = 0.029

以下空白

End of Report