Docusign Envelope ID: 691C3E09-7794-43A0-BF36-C536093756C8

# COMOSAR E-Field Probe Calibration Report

Ref : ACR.9.6.25.BES.B

Cancel and replace the report ACR.9.6.25.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 COMOSAR DOSIMETRIC E-FIELD PROBE

**SERIAL NO.: 0125-EPGO-445**

**Calibrated at MVG**

**Z.I. de la pointe du diable**

**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**

**29280 PLOUZANE - FRANCE**

**Calibration date: 01/02/2025**

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

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*Summary:*

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

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| | *Name* | *Function* | *Date* | *Signature* |
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| *Distribution :* | BTF Testing Lab (Shenzhen) Co., Ltd. |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Pedro Ruiz | 1/9/2025 | Initial release |
| B | Pedro Ruiz | 2/12/2025 | Change freq label 850 to 835 |
| | | | |
| | | | |



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# TABLE OF CONTENTS

1 Device Under Test ..... 4
2 Product Description ..... 4
2.1 General Information ..... 4
3 Measurement Method ..... 4
3.1 Sensitivity ..... 4
3.2 Linearity ..... 5
3.3 Isotropy ..... 5
3.4 Boundary Effect ..... 5
3.5 Probe Modulation Response ..... 6
4 Measurement Uncertainty ..... 6
5 Calibration Results ..... 6
5.1 Calibration in air ..... 6
5.2 Calibration in liquid ..... 7
6 Verification Results ..... 8
7 List of Equipment ..... 10



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# 1 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | MVG |
| Model | SSE2 |
| Serial Number | 0125-EPGO-445 |
| Product Condition (new / used) | New |
| Frequency Range of Probe | 0.15 GHz-7.5GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.206 MΩ<br>Dipole 2: R2=0.208 MΩ<br>Dipole 3: R3=0.226 MΩ |

# 2 PRODUCT DESCRIPTION

## 2.1 GENERAL INFORMATION

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

**Figure 1** – *MVG COMOSAR Dosimetric E field Probe*

| | |
|---|---|
| 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 IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their effect. All calibrations / measurements performed meet the fore-mentioned standards.

## 3.1 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 for frequency range 600-7500MHz and using the calorimeter cell method (transfer method) as outlined in the standards for frequency 150-450 MHz.



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## 3.2 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.

## 3.3 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 to 360 degrees in 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°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

## 3.4 BOUNDARY EFFECT

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

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

$$\mathrm{SAR}_{\mathrm{uncertainty}}[\%] = \delta\mathrm{SAR}_{be}\,\frac{(d_{be}+d_{step})^2}{2d_{step}}\,\frac{\left(e^{-d_{be}/(\delta/2)}\right)}{\delta/2} \quad \text{for } (d_{be}+d_{step}) < 10\ \mathrm{mm}$$

where

| | |
|---|---|
| $\mathrm{SAR}_{\mathrm{uncertainty}}$ | is the uncertainty in percent of the probe boundary effect |
| $d_{be}$ | is the distance between the surface and the closest *zoom-scan* measurement point, in millimetre |
| $\Delta_{step}$ | is the separation distance between the first and second measurement points that are closest to the phantom surface, in millimetre, assuming the boundary effect at the second location is negligible |
| $\delta$ | is the minimum penetration depth in millimetres of the head tissue-equivalent liquids defined in this standard, i.e., $\delta \approx 14$ mm at 3 GHz; |
| $\Delta\mathrm{SAR}_{be}$ | in percent of SAR is the deviation between the measured SAR value, at the distance $d_{be}$ from the boundary, and the analytical SAR value. |

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



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### 3.5 PROBE MODULATION RESPONSE

MVG's probe were evaluated experimentally with various modulated signal and the deviation from CW response were found neglectable in the used power range of the probe. So the correction to taking into account the linearization parameters for different modulation is null, therefore the CW factor given in this report can be used whatever the measured modulation

## 4 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.

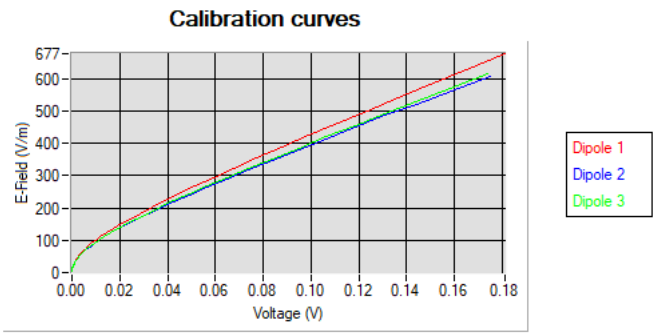
The estimated expanded uncertainty (k=2) in calibration for SAR (W/kg) is +/-11% for the frequency range 150-450MHz.
The estimated expanded uncertainty (k=2) in calibration for SAR (W/kg) is +/-14% for the frequency range 600-7500MHz.

## 5 CALIBRATION RESULTS

| Ambient condition | |
|---|---|
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

### 5.1 CALIBRATION IN AIR

The following curve represents the measurement in waveguide of the voltage picked up by the probe toward the E-field generated inside the waveguide.




From this curve, the sensitivity in air is calculated using the below formula.

$$E^2 = \sum_{i=1}^{3} \frac{V_i\left(1 + {V_i}/{DCP_i}\right)}{Norm_i}$$



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where
Vi=voltage readings on the 3 channels of the probe
DCPi=diode compression point given below for the 3 channels of the probe
Normi=dipole sensitivity given below for the 3 channels of the probe

| Normx dipole 1 (µV/(V/m)$^2$) | Normy dipole 2 (µV/(V/m)$^2$) | Normz dipole 3 (µV/(V/m)$^2$) |
|---|---|---|
| 1.05 | 1.21 | 1.19 |

| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|---|---|---|
| 110 | 112 | 111 |

## 5.2 CALIBRATION IN LIQUID

The calorimeter cell or the waveguide is used to determine the calibration in liquid using the formula below.

$$ConvF = \frac{E_{liquid}^2}{E_{air}^2}$$

The E-field in the liquid is determined from the SAR measurement according to the below formula.

$$E_{liquid}^2 = \frac{\rho\, SAR}{\sigma}$$

where
σ=the conductivity of the liquid
ρ=the volumetric density of the liquid
SAR=the SAR measured from the formula that depends on the setup used. The SAR formulas are given below

For the calorimeter cell (150-450 MHz), the formula is:

$$SAR = c\frac{dT}{dt}$$

where
c=the specific heat for the liquid
dT/dt=the temperature rises over the time

For the waveguide setup (600-75000 MHz), the formula is:

$$SAR = \frac{4P_W}{ab\delta} e^{\frac{-2z}{\delta}}$$



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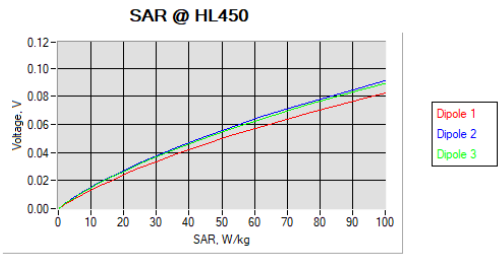
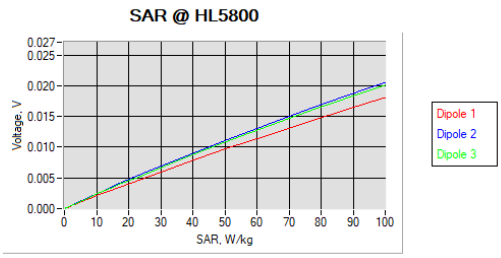
where
a=the larger cross-sectional of the waveguide
b=the smaller cross-sectional of the waveguide
δ=the skin depth for the liquid in the waveguide
Pw=the power delivered to the liquid

The below table summarize the ConvF for the calibrated liquid. The curves give examples for the measured SAR depending on the voltage in some liquid.

| Liquid | Frequency (MHz*) | ConvF |
|---|---|---|
| HL450 | 450 | 1.19 |
| HL750 | 750 | 1.24 |
| HL835 | 835 | 1.15 |
| HL1800 | 1800 | 1.20 |
| HL1900 | 1900 | 1.31 |
| HL2000 | 2000 | 1.35 |
| HL2100 | 2100 | 1.31 |
| HL2300 | 2300 | 1.38 |
| HL2450 | 2450 | 1.40 |
| HL2600 | 2600 | 1.27 |
| HL3500 | 3500 | 1.17 |
| HL3700 | 3700 | 1.11 |
| HL3900 | 3900 | 1.14 |
| HL4200 | 4200 | 1.29 |
| HL4600 | 4600 | 1.28 |
| HL4900 | 4900 | 1.19 |
| HL5200 | 5200 | 1.18 |
| HL5400 | 5400 | 1.14 |
| HL5600 | 5600 | 1.12 |
| HL5800 | 5800 | 1.11 |

(*) Frequency validity is +/-50MHz below 600MHz, +/-100MHz from 600MHz to 6GHz and +/-700MHz above 6GHz




## 6 VERIFICATION RESULTS

The figures below represent the measured linearity and axial isotropy for this probe. The probe specification is +/-0.2 dB for linearity and +/-0.15 dB for axial isotropy.



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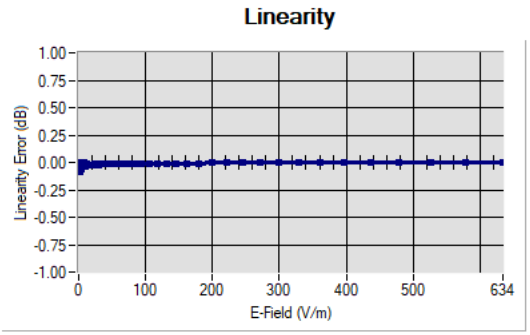
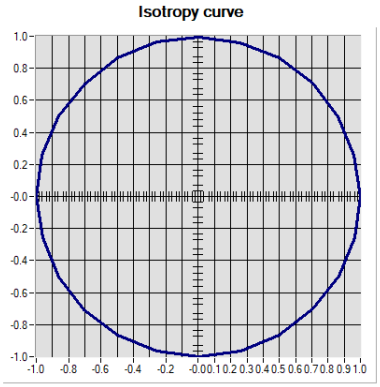



Linearity:+/-2.00% (+/-0.09dB)




Isotropy:+/-0.25% (+/-0.01dB)



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# 7 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| CALIPROBE Test Bench | Version 2 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rohde & Schwarz ZVM | 100203 | 08/2021 | 08/2026 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2027 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 183277 | 05/2022 | 05/2025 |
| 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 | 06/2026 |
| USB Sensor | Keysight U2000A | SN: MY62340002 | 10/2024 | 10/2027 |
| Directional Coupler | Krytar 158020 | 131467 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Fluoroptic Thermometer | LumaSense Luxtron 812 | 94264 | 09/2022 | 09/2025 |
| Coaxial cell | MVG | SN 32/16 COAXCELL_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG2_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_0G600_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG4_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_0G900_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG6_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_1G500_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG8_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_1G800B_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_1G800H_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG10_1 | Validated. No cal required. | Validated. No cal required. |



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| | | | | |
|---|---|---|---|---|
| Liquid transition | MVG | SN 32/16 WGLIQ_3G500_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG12_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_5G000_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG14_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_7G000_1 | Validated. No cal required. | Validated. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44235403 | 02/2024 | 02/2027 |



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# 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
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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).

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| | *Name* | *Function* | *Date* | *Signature* |
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| *Checked & approved by:* | Pedro Ruiz | Technical Manager | 2/10/2025 | |
| *Authorized by:* | Geraldine Toutain | Quality Manager | 2/10/2025 | DocuSigned by: Géraldine TOUTAIN A1C9AC91CB5441A... |

| | *Customer Name* |
|---|---|
| *Distribution :* | BTF Testing Lab (Shenzhen) Co., Ltd. |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Pedro Ruiz | 2/10/2025 | Initial release |
| | | | |
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| | | | |



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# 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



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# 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*



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# 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 °C |
| Lab Temperature | 20 +/- 1 °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 ε'+jε") are compared with the reference values for this liquid.



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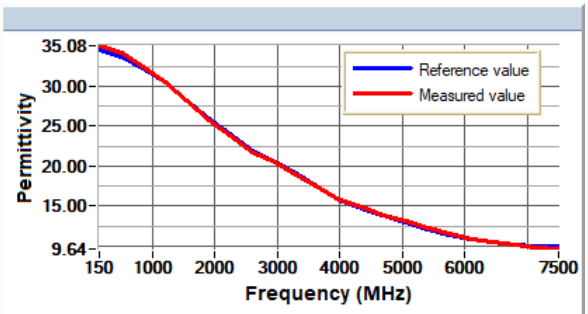
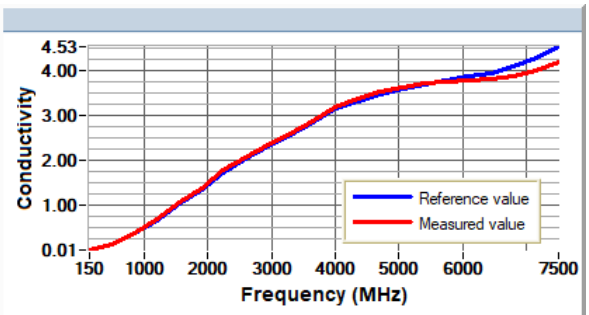



| Frequency (MHz) | Methanol Permittivity (Reference) | Methanol Permittivity (Measure) | Difference (%) | Limit (+/- %) |
|---|---|---|---|---|
| 150 | 34.52 | 35.08 | -1.6 | 10.0 |
| 500 | 33.73 | 34.18 | -1.3 | 10.0 |
| 850 | 32.20 | 32.49 | -0.9 | 10.0 |
| 1200 | 30.57 | 30.52 | 0.2 | 10.0 |
| 1550 | 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 |



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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 | 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 |



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# SAR Reference Dipole Calibration Report

Ref : ACR.148.5.25.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 COMOSAR REFERENCE DIPOLE

**FREQUENCY: 750 MHZ**

**SERIAL NO.: 0722-DIP0G750-655**

**Calibrated at MVG**

**Z.I. de la pointe du diable**

**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**

**29280 PLOUZANE - FRANCE**

**Calibration date: 05/26/2025**

Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

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*Summary:*

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

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| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Pedro Ruiz | Technical Manager | 6/2/2025 | |
| *Checked & approved by:* | Pedro Ruiz | Technical Manager | 6/2/2025 | |
| *Authorized by:* | Kim Rutkowski | Quality Manager | 6/4/2025 | Signed by: Kimberley ROTKOWSKI 2B689547AD17461... |

| | *Customer Name* |
|---|---|
| *Distribution :* | BTF Testing Lab (Shenzhen) Co., Ltd. |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Pedro Ruiz | 6/2/2025 | Initial release |
| | | | |
| | | | |
| | | | |



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# 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 Mechanical Requirements ..... 5
4.2 S11 parameter Requirements ..... 5
4.3 SAR Requirements ..... 5
5 Measurement Uncertainty ..... 5
5.1 Mechanical dimensions ..... 5
5.2 S11 Parameter ..... 5
5.3 SAR ..... 5
6 Calibration Results ..... 6
6.1 Mechanical Dimensions ..... 6
6.2 S11 parameter ..... 6
6.3 SAR ..... 7
7 List of Equipment ..... 9



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# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

# 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR 750 MHz REFERENCE DIPOLE |
| Manufacturer | MVG |
| Model | SID750 |
| Serial Number | 0722-DIP0G750-655 |
| Product Condition (new / used) | Used |

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards. The product is designed for use with the COMOSAR test bench only, however, being built in accordance to relevant standards, it can be used in others SAR test benches as long as the final user take care that the prescribed S11 and SAR target value are met.

**Figure 1** – *MVG COMOSAR Validation Dipole*



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# 4 MEASUREMENT METHOD

## 4.1 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness. A direct method is used with a ISO17025 calibrated caliper.

## 4.2 S11 PARAMETER REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a S11 of -20 dB or better. The S11 measurement shall be performed against a liquid filled flat phantom and using a prescribed spacer, with the phantom constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

## 4.3 SAR REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore-mentioned standards.

# 5 MEASUREMENT UNCERTAINTY

## 5.1 MECHANICAL DIMENSIONS

For the measurement in the range 0-300mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.20 mm with respect to measurement conditions.

For the measurement in the range 300-450mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.44 mm with respect to measurement conditions.

## 5.2 S11 PARAMETER

The estimated expanded uncertainty (k=2) in calibration for the S11 parameter in linear is +/-0.08 with respect to measurement conditions.

## 5.3 SAR

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



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The estimated expanded uncertainty (k=2) in calibration for the 1g and 10g SAR measurement in W/kg is +/-19% with respect to measurement conditions.

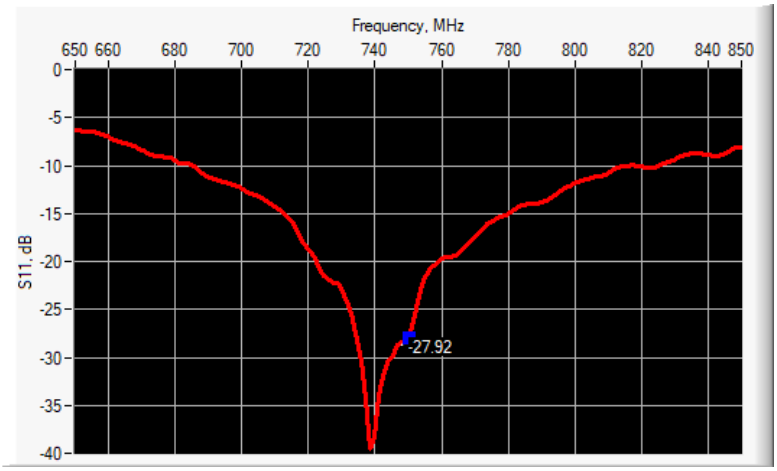
# 6 CALIBRATION RESULTS

## 6.1 MECHANICAL DIMENSIONS

| L mm | | h mm | | d mm | |
|---|---|---|---|---|---|
| **Measured** | **Required** | **Measured** | **Required** | **Measured** | **Required** |
| - | 176.00 +/- 2% | - | 100.00 +/- 2% | - | 6.35 +/- 2% |

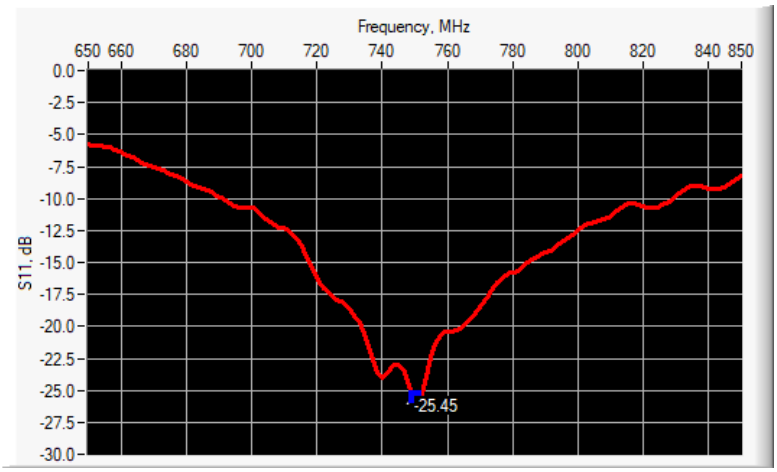
## 6.2 S11 PARAMETER

### 6.2.1 S11 parameter in Head Liquid




| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 750 | -27.92 | -20 | 53.6Ω + 1.4jΩ |

### 6.2.2 S11 parameter in Body Liquid




| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 750 | -25.45 | -20 | 50.7Ω + 5.0jΩ |



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## 6.3 SAR

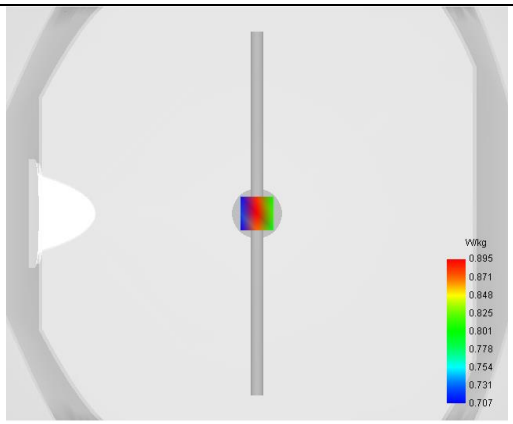
The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, 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 by using a prescribed spacer.

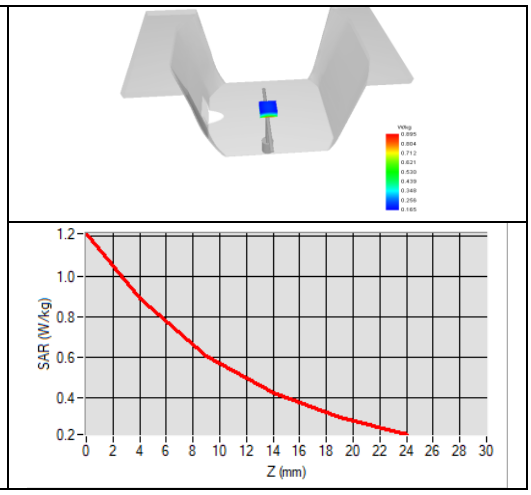
### 6.3.1 SAR with Head Liquid

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | 4424-EPGO-443 |
| Liquid | Head Liquid Values: eps' : 44.6 sigma : 0.88 |
| 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 | 750 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| **Frequency** | **1g SAR (W/kg)** | | | **10g SAR (W/kg)** | | |
|---|---|---|---|---|---|---|
| | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** |
| 750 MHz | 0.84 | 8.41 | 8.49 | 0.55 | 5.55 | 5.55 |



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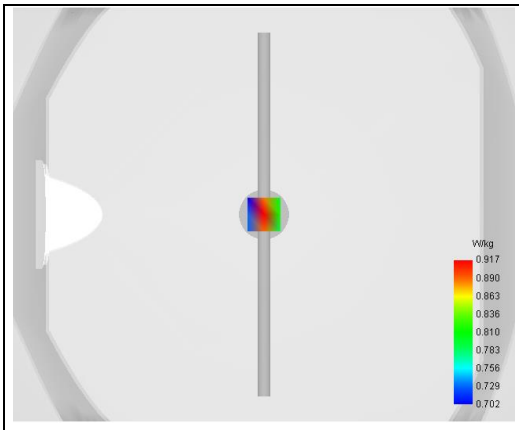
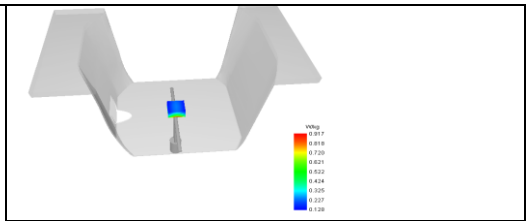
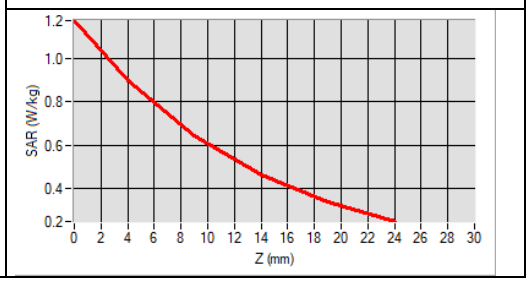
### 6.3.2 SAR with Body Liquid

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | SN 4424-EPGO-443 |
| Liquid | Body Liquid Values: eps' : 56.1 sigma : 0.93 |
| 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 | 750 |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| **Frequency** | **1g SAR (W/kg)** | | | **10g SAR (W/kg)** | | |
|---|---|---|---|---|---|---|
| | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** |
| 750 MHz | 0.85 | 8.48 | 8.60 | 0.57 | 5.68 | 5.70 |





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# 7 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 | 08/2026 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2027 |
| Calipers | Mitutoyo | SN 0009732 | 11/2022 | 11/2025 |
| Reference Probe | MVG | 4424-EPGO-443 | 05/2025 | 05/2026 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 183277 | 05/2022 | 05/2026 |
| 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 | 06/2026 |
| Power Meter | Keysight U2000A | SN: MY62340002 | 10/2024 | 10/2027 |
| 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 | 44235403 | 10/2024 | 10/2027 |



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# SAR Reference Dipole Calibration Report

Ref : ACR.148.7.25.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 COMOSAR REFERENCE DIPOLE

**FREQUENCY: 1800 MHZ**

**SERIAL NO.: 0722-DIP1G800-657**

## Calibrated at MVG

**Z.I. de la pointe du diable**

**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**

**29280 PLOUZANE - FRANCE**

## Calibration date: 05/26/2025

Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

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*Summary:*

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

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| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Pedro Ruiz | Technical Manager | 6/2/2025 | |
| *Checked & approved by:* | Pedro Ruiz | Technical Manager | 6/2/2025 | |
| *Authorized by:* | Kim Rutkowski | Quality Manager | 6/4/2025 | Signed by: Kimberley ROTKOWSKI 2B689547AD17461... |

| | *Customer Name* |
|---|---|
| *Distribution :* | BTF Testing Lab (Shenzhen) Co., Ltd. |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Pedro Ruiz | 6/2/2025 | Initial release |
| | | | |
| | | | |
| | | | |



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# 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 Mechanical Requirements ..... 5
4.2 S11 parameter Requirements ..... 5
4.3 SAR Requirements ..... 5
5 Measurement Uncertainty ..... 5
5.1 Mechanical dimensions ..... 5
5.2 S11 Parameter ..... 5
5.3 SAR ..... 5
6 Calibration Results ..... 6
6.1 Mechanical Dimensions ..... 6
6.2 S11 parameter ..... 6
6.3 SAR ..... 7
7 List of Equipment ..... 9



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# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

# 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR 1800 MHz REFERENCE DIPOLE |
| Manufacturer | MVG |
| Model | SID1800 |
| Serial Number | 0722-DIP1G800-657 |
| Product Condition (new / used) | Used |

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards. The product is designed for use with the COMOSAR test bench only, however, being built in accordance to relevant standards, it can be used in others SAR test benches as long as the final user take care that the prescribed S11 and SAR target value are met.

**Figure 1** – *MVG COMOSAR Validation Dipole*



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# 4 MEASUREMENT METHOD

## 4.1 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness. A direct method is used with a ISO17025 calibrated caliper.

## 4.2 S11 PARAMETER REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a S11 of -20 dB or better. The S11 measurement shall be performed against a liquid filled flat phantom and using a prescribed spacer, with the phantom constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

## 4.3 SAR REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore-mentioned standards.

# 5 MEASUREMENT UNCERTAINTY

## 5.1 MECHANICAL DIMENSIONS

For the measurement in the range 0-300mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.20 mm with respect to measurement conditions.

For the measurement in the range 300-450mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.44 mm with respect to measurement conditions.

## 5.2 S11 PARAMETER

The estimated expanded uncertainty (k=2) in calibration for the S11 parameter in linear is +/-0.08 with respect to measurement conditions.

## 5.3 SAR

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

The estimated expanded uncertainty (k=2) in calibration for the 1g and 10g SAR measurement in W/kg is +/-19% with respect to measurement conditions.



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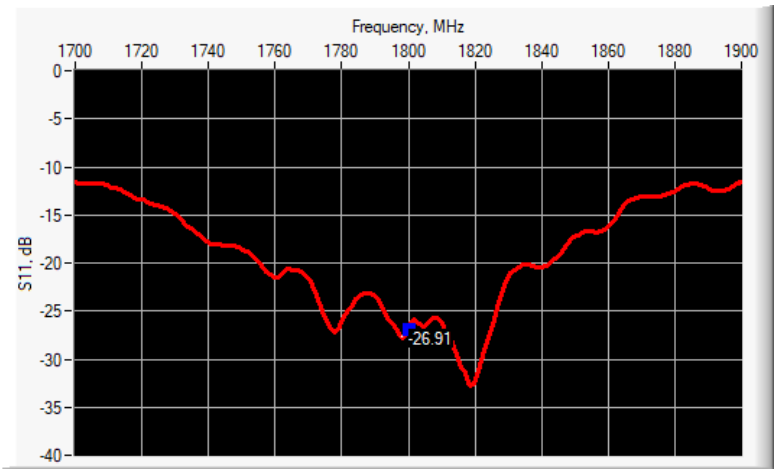
# 6 CALIBRATION RESULTS

## 6.1 MECHANICAL DIMENSIONS

| L mm | | h mm | | d mm | |
|---|---|---|---|---|---|
| **Measured** | **Required** | **Measured** | **Required** | **Measured** | **Required** |
| - | 72.00 +/- 2% | - | 41.70 +/- 2% | - | 3.60 +/- 2% |

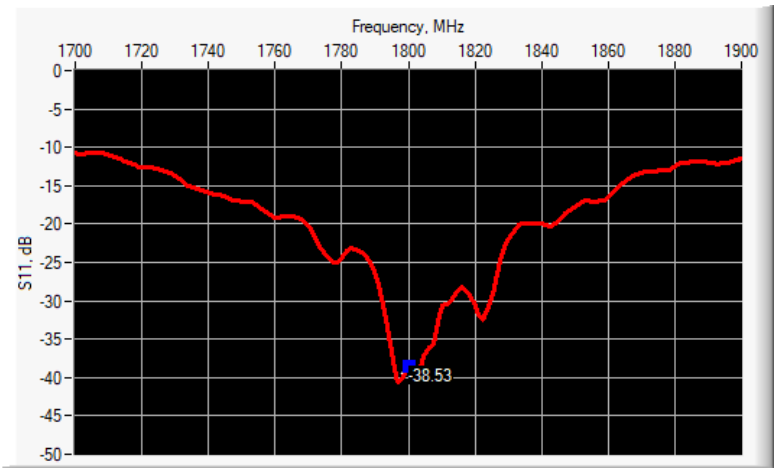
## 6.2 S11 PARAMETER

### 6.2.1 S11 parameter in Head Liquid




| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1800 | -26.91 | -20 | 50.8Ω + 4.3jΩ |

### 6.2.2 S11 parameter in Body Liquid




| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1800 | -38.53 | -20 | 51.1Ω - 0.3jΩ |



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## 6.3 SAR

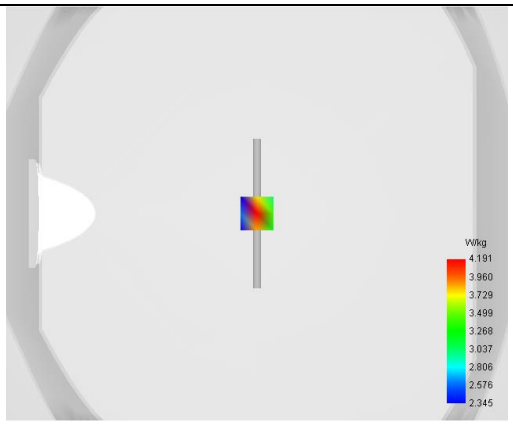
The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, 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 by using a prescribed spacer.

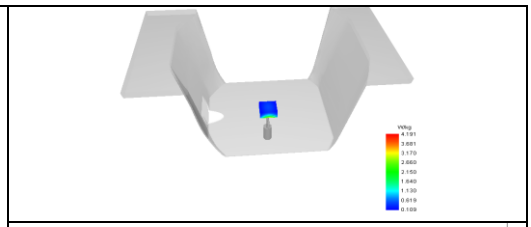
### 6.3.1 SAR with Head Liquid

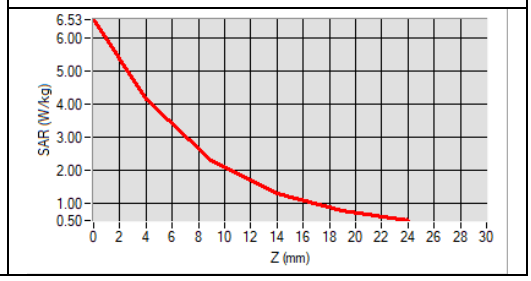
The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | 4424-EPGO-443 |
| Liquid | Head Liquid Values: eps' : 42.2 sigma : 1.39 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8mm/dz=5mm |
| Frequency | 1800 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| **Frequency** | **1g SAR (W/kg)** | | | **10g SAR (W/kg)** | | |
|---|---|---|---|---|---|---|
| | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** |
| 1800 MHz | 3.79 | 37.93 | 38.40 | 1.98 | 19.83 | 20.10 |





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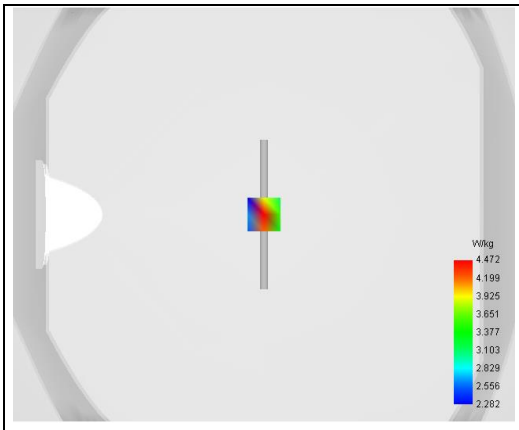
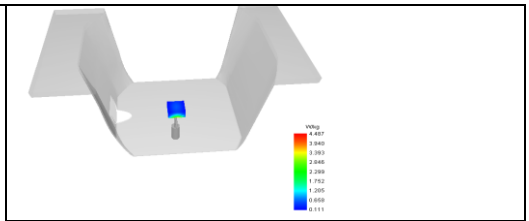
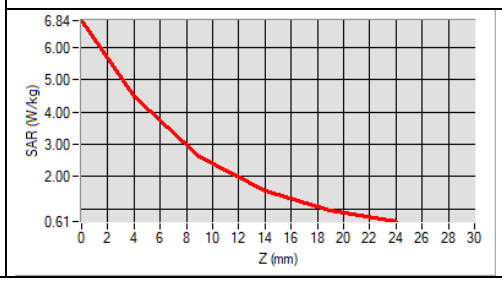
### 6.3.2 SAR with Body Liquid

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | SN 4424-EPGO-443 |
| Liquid | Body Liquid Values: eps' : 53.9 sigma : 1.49 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8mm/dz=5mm |
| Frequency | 1800 |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| **Frequency** | **1g SAR (W/kg)** | | | **10g SAR (W/kg)** | | |
|---|---|---|---|---|---|---|
| | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** |
| 1800 MHz | 4.07 | 40.68 | 38.50 | 2.15 | 21.48 | 20.30 |





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# 7 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 | 08/2026 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2027 |
| Calipers | Mitutoyo | SN 0009732 | 11/2022 | 11/2025 |
| Reference Probe | MVG | 4424-EPGO-443 | 05/2025 | 05/2026 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 183277 | 05/2022 | 05/2026 |
| 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 | 06/2026 |
| Power Meter | Keysight U2000A | SN: MY62340002 | 10/2024 | 10/2027 |
| 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 | 44235403 | 10/2024 | 10/2027 |



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# SAR Reference Dipole Calibration Report

Ref : ACR.148.8.25.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 COMOSAR REFERENCE DIPOLE

**FREQUENCY: 1900 MHZ**

**SERIAL NO.: 4721-DIP1G900-658**

## Calibrated at MVG

**Z.I. de la pointe du diable**

**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**

**29280 PLOUZANE - FRANCE**

## Calibration date: 05/26/2025

Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

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*Summary:*

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

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| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Pedro Ruiz | Technical Manager | 5/28/2025 | |
| *Checked & approved by:* | Pedro Ruiz | Technical Manager | 5/28/2025 | |
| *Authorized by:* | Kim Rutkowski | Quality Manager | 6/4/2025 | Signed by: Kimberley ROTKOWSKI 2B689547AD17461... |

| | *Customer Name* |
|---|---|
| *Distribution :* | BTF Testing Lab (Shenzhen) Co., Ltd. |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Pedro Ruiz | 5/28/2025 | Initial release |
| | | | |
| | | | |
| | | | |



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# 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 Mechanical Requirements ..... 5
4.2 S11 parameter Requirements ..... 5
4.3 SAR Requirements ..... 5
5 Measurement Uncertainty ..... 5
5.1 Mechanical dimensions ..... 5
5.2 S11 Parameter ..... 5
5.3 SAR ..... 5
6 Calibration Results ..... 6
6.1 Mechanical Dimensions ..... 6
6.2 S11 parameter ..... 6
6.3 SAR ..... 7
7 List of Equipment ..... 9



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# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

# 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR 1900 MHz REFERENCE DIPOLE |
| Manufacturer | MVG |
| Model | SID1900 |
| Serial Number | 4721-DIP1G900-658 |
| Product Condition (new / used) | Used |

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards. The product is designed for use with the COMOSAR test bench only, however, being built in accordance to relevant standards, it can be used in others SAR test benches as long as the final user take care that the prescribed S11 and SAR target value are met.

**Figure 1** – *MVG COMOSAR Validation Dipole*



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# 4 MEASUREMENT METHOD

## 4.1 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness. A direct method is used with a ISO17025 calibrated caliper.

## 4.2 S11 PARAMETER REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a S11 of -20 dB or better. The S11 measurement shall be performed against a liquid filled flat phantom and using a prescribed spacer, with the phantom constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

## 4.3 SAR REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore-mentioned standards.

# 5 MEASUREMENT UNCERTAINTY

## 5.1 MECHANICAL DIMENSIONS

For the measurement in the range 0-300mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.20 mm with respect to measurement conditions.

For the measurement in the range 300-450mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.44 mm with respect to measurement conditions.

## 5.2 S11 PARAMETER

The estimated expanded uncertainty (k=2) in calibration for the S11 parameter in linear is +/-0.08 with respect to measurement conditions.

## 5.3 SAR

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

The estimated expanded uncertainty (k=2) in calibration for the 1g and 10g SAR measurement in W/kg is +/-19% with respect to measurement conditions.



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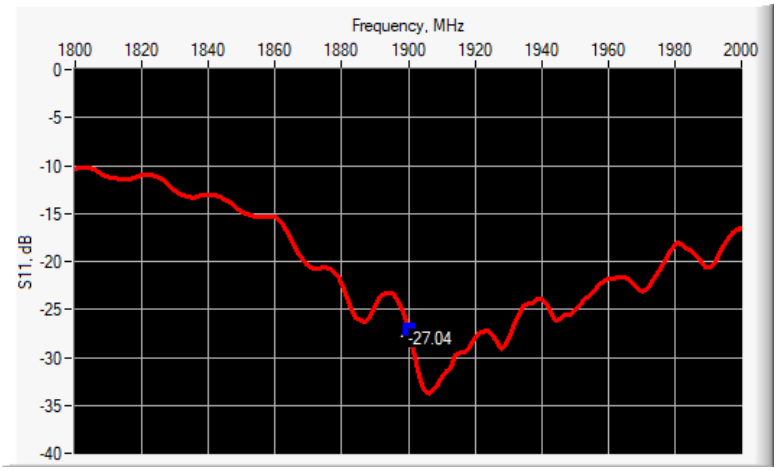
# 6 CALIBRATION RESULTS

## 6.1 MECHANICAL DIMENSIONS

| L mm | | h mm | | d mm | |
|---|---|---|---|---|---|
| **Measured** | **Required** | **Measured** | **Required** | **Measured** | **Required** |
| - | 68.00 +/- 2% | - | 39.50 +/- 2% | - | 3.60 +/- 2% |

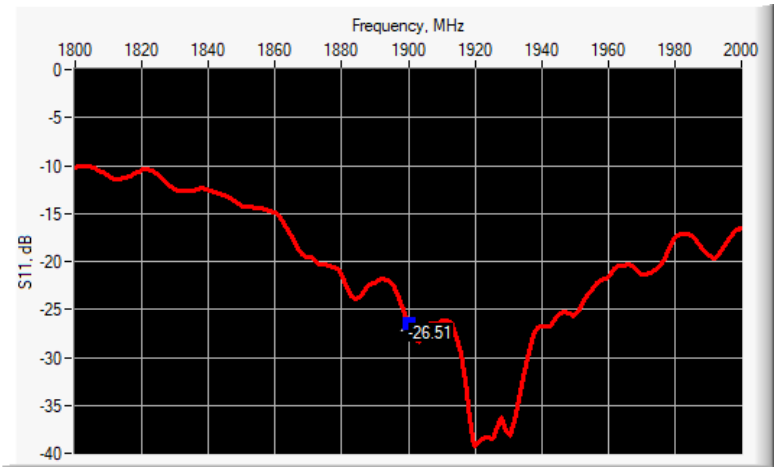
## 6.2 S11 PARAMETER

### 6.2.1 S11 parameter in Head Liquid




| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1900 | -27.04 | -20 | 50.8Ω - 4.3jΩ |

### 6.2.2 S11 parameter in Body Liquid




| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 1900 | -26.51 | -20 | 47.3Ω - 3.6jΩ |



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## 6.3 SAR

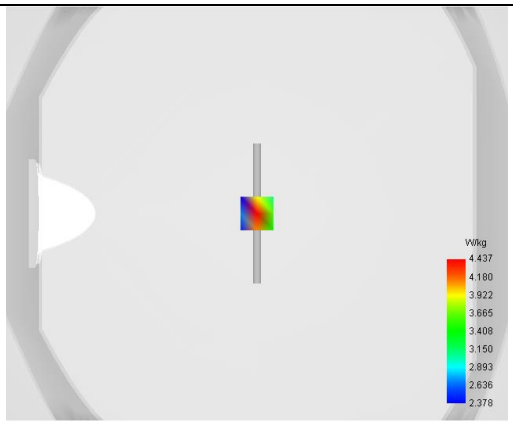
The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, 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 by using a prescribed spacer.

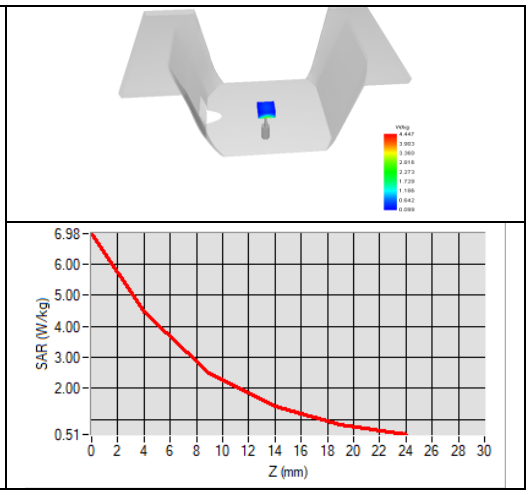
### 6.3.1 SAR with Head Liquid

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | 4424-EPGO-443 |
| Liquid | Head Liquid Values: eps' : 42.4 sigma : 1.39 |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | dx=8mm/dy=8mm |
| Zoon Scan Resolution | dx=8mm/dy=8mm/dz=5mm |
| Frequency | 1900 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| **Frequency** | **1g SAR (W/kg)** | | | **10g SAR (W/kg)** | | |
|---|---|---|---|---|---|---|
| | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** |
| 1900 MHz | 4.03 | 40.29 | 39.70 | 2.08 | 20.82 | 20.50 |



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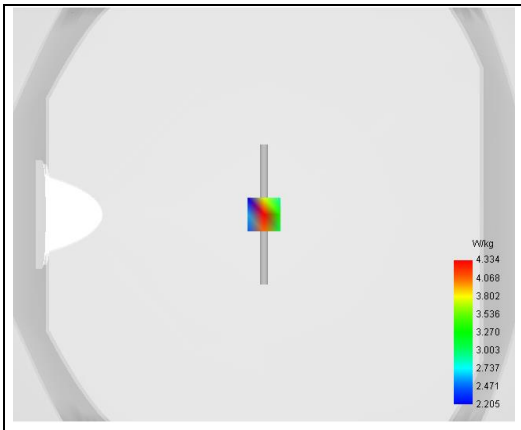
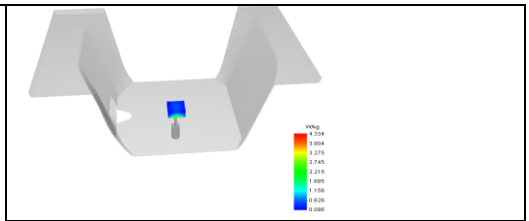
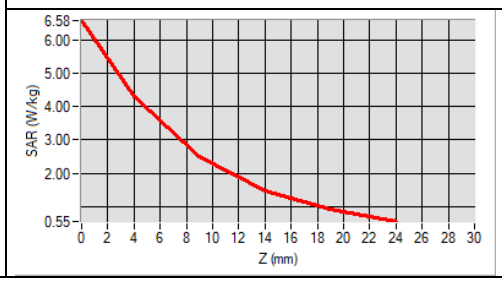
### 6.3.2 SAR with Body Liquid

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | SN 4424-EPGO-443 |
| Liquid | Body Liquid Values: eps' : 54.0 sigma : 1.50 |
| 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 |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| **Frequency** | **1g SAR (W/kg)** | | | **10g SAR (W/kg)** | | |
|---|---|---|---|---|---|---|
| | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** |
| 1900 MHz | 3.89 | 38.93 | 39.80 | 2.03 | 20.29 | 20.80 |





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# 7 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 | 08/2026 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2027 |
| Calipers | Mitutoyo | SN 0009732 | 11/2022 | 11/2025 |
| Reference Probe | MVG | 4424-EPGO-443 | 05/2025 | 05/2026 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 183277 | 05/2022 | 05/2026 |
| 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 | 06/2026 |
| Power Meter | Keysight U2000A | SN: MY62340002 | 10/2024 | 10/2027 |
| 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 | 44235403 | 10/2024 | 10/2027 |



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# SAR Reference Dipole Calibration Report

Ref : ACR.148.12.25.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 COMOSAR REFERENCE DIPOLE

**FREQUENCY: 2450 MHZ**

**SERIAL NO.: 0722-DIP2G450-662**

## Calibrated at MVG

**Z.I. de la pointe du diable**

**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**

**29280 PLOUZANE - FRANCE**

## Calibration date: 05/26/2025

Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

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*Summary:*

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

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| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Pedro Ruiz | Technical Manager | 5/28/2025 | |
| *Checked & approved by:* | Pedro Ruiz | Technical Manager | 5/28/2025 | |
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| | *Customer Name* |
|---|---|
| *Distribution :* | BTF Testing Lab (Shenzhen) Co., Ltd. |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Pedro Ruiz | 5/28/2025 | Initial release |
| | | | |
| | | | |
| | | | |



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# 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 Mechanical Requirements ..... 5
4.2 S11 parameter Requirements ..... 5
4.3 SAR Requirements ..... 5
5 Measurement Uncertainty ..... 5
5.1 Mechanical dimensions ..... 5
5.2 S11 Parameter ..... 5
5.3 SAR ..... 5
6 Calibration Results ..... 6
6.1 Mechanical Dimensions ..... 6
6.2 S11 parameter ..... 6
6.3 SAR ..... 7
7 List of Equipment ..... 9



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# 1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

# 2 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR 2450 MHz REFERENCE DIPOLE |
| Manufacturer | MVG |
| Model | SID2450 |
| Serial Number | 0722-DIP2G450-662 |
| Product Condition (new / used) | Used |

# 3 PRODUCT DESCRIPTION

## 3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards. The product is designed for use with the COMOSAR test bench only, however, being built in accordance to relevant standards, it can be used in others SAR test benches as long as the final user take care that the prescribed S11 and SAR target value are met.

**Figure 1** – *MVG COMOSAR Validation Dipole*



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# 4 MEASUREMENT METHOD

## 4.1 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness. A direct method is used with a ISO17025 calibrated caliper.

## 4.2 S11 PARAMETER REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a S11 of -20 dB or better. The S11 measurement shall be performed against a liquid filled flat phantom and using a prescribed spacer, with the phantom constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

## 4.3 SAR REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards provide requirements for reference dipoles used for system validation measurements. The following measurements were performed to verify that the product complies with the fore-mentioned standards.

# 5 MEASUREMENT UNCERTAINTY

## 5.1 MECHANICAL DIMENSIONS

For the measurement in the range 0-300mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.20 mm with respect to measurement conditions.

For the measurement in the range 300-450mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.44 mm with respect to measurement conditions.

## 5.2 S11 PARAMETER

The estimated expanded uncertainty (k=2) in calibration for the S11 parameter in linear is +/-0.08 with respect to measurement conditions.

## 5.3 SAR

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



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The estimated expanded uncertainty (k=2) in calibration for the 1g and 10g SAR measurement in W/kg is +/-19% with respect to measurement conditions.

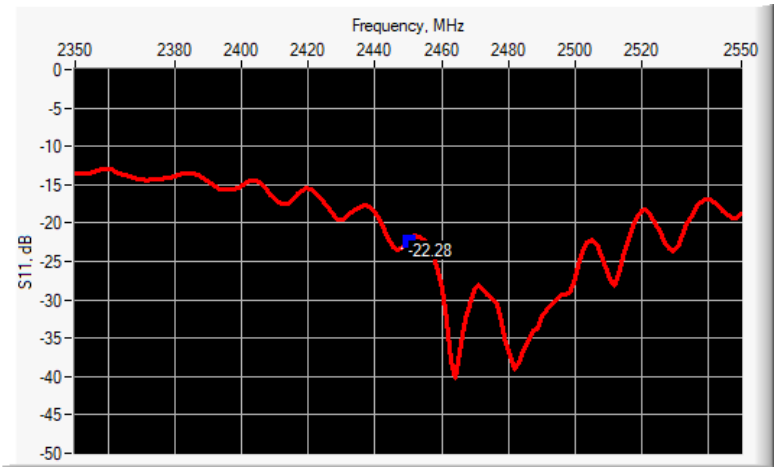
# 6 CALIBRATION RESULTS

## 6.1 MECHANICAL DIMENSIONS

| L mm | | h mm | | d mm | |
|---|---|---|---|---|---|
| **Measured** | **Required** | **Measured** | **Required** | **Measured** | **Required** |
| - | 51.50 +/- 2% | - | 30.40 +/- 2% | - | 3.60 +/- 2% |

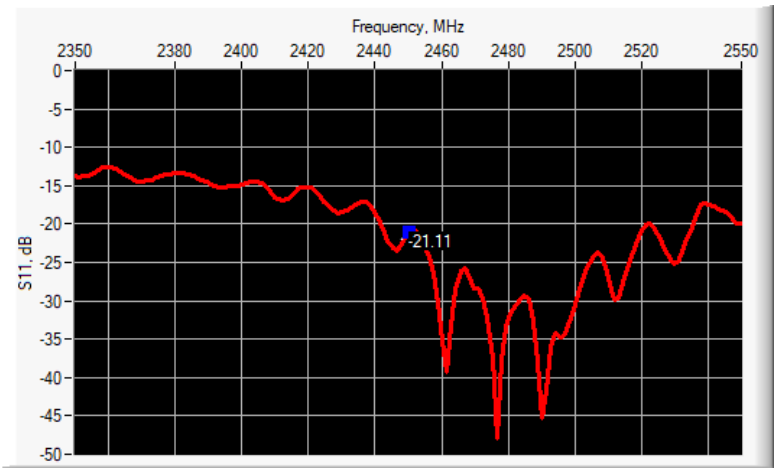
## 6.2 S11 PARAMETER

### 6.2.1 S11 parameter in Head Liquid




| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 2450 | -22.28 | -20 | 49.2Ω + 7.4jΩ |

### 6.2.2 S11 parameter in Body Liquid




| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 2450 | -21.11 | -20 | 52.5Ω + 8.4jΩ |



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## 6.3 SAR

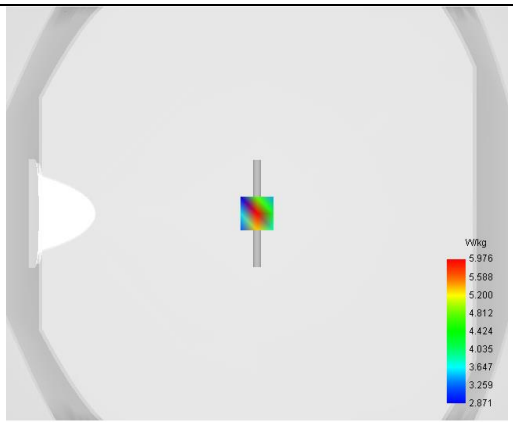
The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, 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 by using a prescribed spacer.

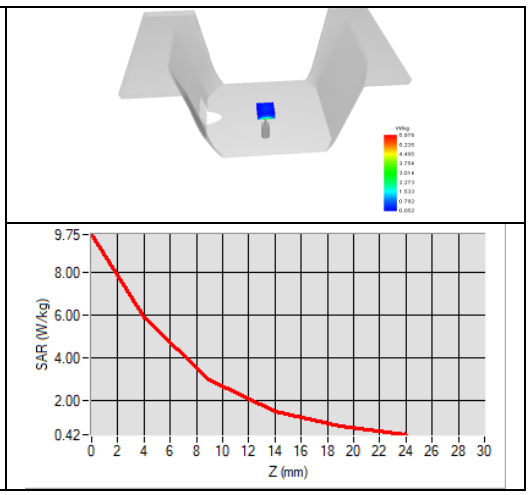
### 6.3.1 SAR with Head Liquid

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | 4424-EPGO-443 |
| Liquid | Head Liquid Values: eps' : 41.6 sigma : 1.88 |
| 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 | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| **Frequency** | **1g SAR (W/kg)** | | | **10g SAR (W/kg)** | | |
|---|---|---|---|---|---|---|
| | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** |
| 2450 MHz | 5.27 | 52.72 | 52.40 | 2.45 | 24.55 | 24.00 |



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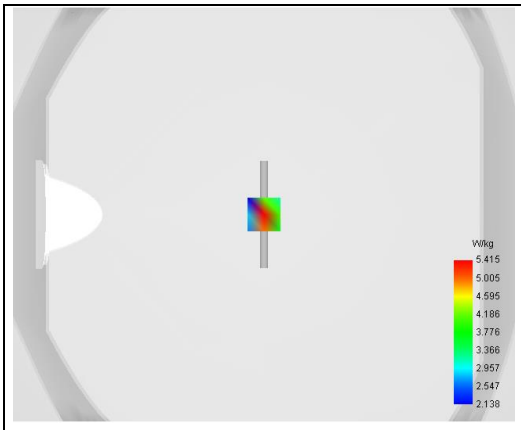
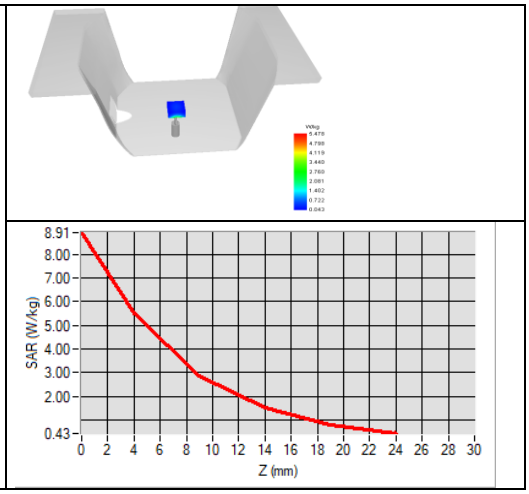
### 6.3.2 SAR with Body Liquid

| | |
|---|---|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | SN 4424-EPGO-443 |
| Liquid | Body Liquid Values: eps' : 53.4 sigma : 2.08 |
| 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 |
| Input power | 20 dBm |
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

| **Frequency** | **1g SAR (W/kg)** | | | **10g SAR (W/kg)** | | |
|---|---|---|---|---|---|---|
| | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** | **Measured** | **Measured normalized to 1W** | **Target normalized to 1W** |
| 2450 MHz | 5.02 | 50.15 | 51.20 | 2.31 | 23.11 | 23.70 |



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# 7 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 | 08/2026 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2027 |
| Calipers | Mitutoyo | SN 0009732 | 11/2022 | 11/2025 |
| Reference Probe | MVG | 4424-EPGO-443 | 05/2025 | 05/2026 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 183277 | 05/2022 | 05/2026 |
| 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 | 06/2026 |
| Power Meter | Keysight U2000A | SN: MY62340002 | 10/2024 | 10/2027 |
| 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 | 44235403 | 10/2024 | 10/2027 |



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