



SAR Reference Dipole Calibration Report

Ref : ACR.53.29.24.BES.A

SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

BUILDING E, FENDA SCIENCE PARK, SANWEI
COMMUNITY, XIXIANG STREET,
BAO'AN DISTRICT, SHENZHEN GUANGDONG, CHINA

MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ

SERIAL NO.: SN 03/15DIP2G450-352

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon
29280 PLOUZANE - FRANCE

Calibration date: 02/21/2024



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.



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.53.29.24.BES.A

| | Name | Function | Date | Signature |
|------------------------|--------------|-------------------------|-----------|-----------|
| Prepared by: | Pedro Ruiz | Measurement Responsible | 2/22/2024 | |
| Checked & approved by: | Jérôme Luc | Technical Manager | 2/22/2024 | |
| Authorized by: | Yann Toutain | Laboratory Director | 2/27/2024 | |

Yann
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| | Customer Name |
|---------------|---|
| Distribution: | SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD. |

| Issue | Name | Date | Modifications |
|-------|------------|-----------|-----------------|
| A | Pedro Ruiz | 2/22/2024 | Initial release |
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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 | SN 03/15DIP2G450-352 |
| 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.

**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, 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.



SAR REFERENCE DIPOLE CALIBRATION REPORT

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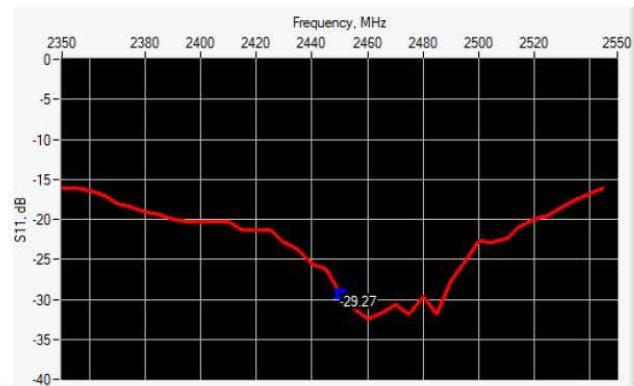
6 CALIBRATION RESULTS

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 | -29.27 | -20 | $53.6\Omega + 0.1j\Omega$ |

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.

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.

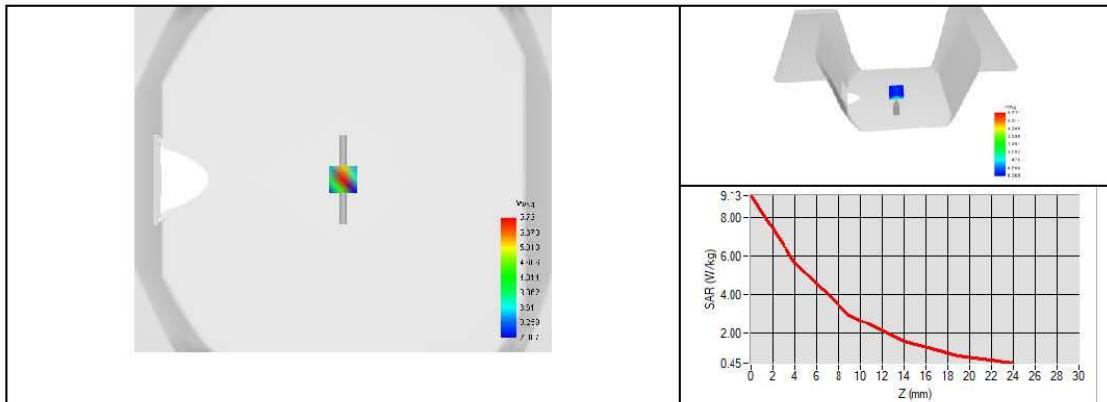


SAR REFERENCE DIPOLE CALIBRATION REPORT

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| | |
|---|--|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | 3523-EPGO-429 |
| Liquid | Head Liquid Values: $\epsilon' = 42.1$ $\sigma = 1.83$ |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | $dx = 8\text{mm}/dy = 8\text{mm}$ |
| Zoon Scan Resolution | $dx = 5\text{mm}/dy = 5\text{mm}/dz = 5\text{mm}$ |
| 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 | 5.00 | 50.05 | 52.40 | 2.38 | 23.80 | 24.00 |





SAR REFERENCE DIPOLE CALIBRATION REPORT

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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 | 08/2024 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2025 |
| Calipers | Mitutoyo | SN 0009732 | 11/2022 | 11/2025 |
| Reference Probe | MVG | 3523-EPGO-429 | 11/2023 | 11/2024 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 106589 | 03/2022 | 03/2025 |
| 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 | 06/2024 |
| Power Meter | Keysight U2000A | SN: MY62340002 | 10/2022 | 10/2025 |
| 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 |



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MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2600 MHZ

SERIAL NO.: SN 03/15DIP2G600-356

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon
29280 PLOUZANE - FRANCE

Calibration date: 02/21/2024



Accreditations #2-6789 and #2-6814
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Summary:

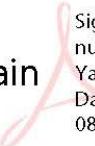
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| | Name | Function | Date | Signature |
|------------------------|--------------|-------------------------|-----------|---|
| Prepared by: | Pedro Ruiz | Measurement Responsible | 2/22/2024 |  |
| Checked & approved by: | Jérôme Luc | Technical Manager | 2/22/2024 |  |
| Authorized by: | Yann Toutain | Laboratory Director | 2/27/2024 |  |

Yann
Toutain
ID


 Signature numérique de
 Yann Toutain ID
 Date : 2024.02.27
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2 DEVICE UNDER TEST

| Device Under Test | |
|--------------------------------|-----------------------------------|
| Device Type | COMOSAR 2600 MHz REFERENCE DIPOLE |
| Manufacturer | MVG |
| Model | SID2600 |
| Serial Number | SN 03/15DIP2G600-356 |
| 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.

**Figure 1 – MVG COMOSAR Validation Dipole**

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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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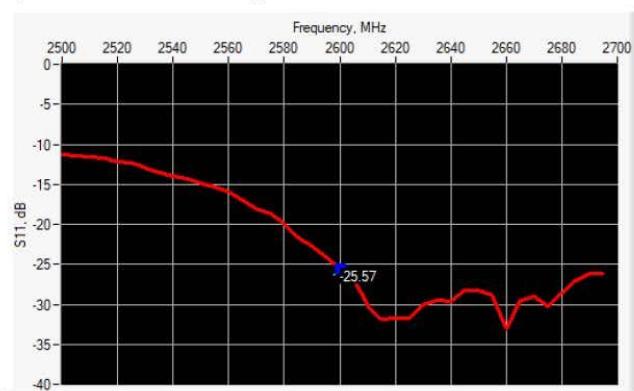
6 CALIBRATION RESULTS

6.1 MECHANICAL DIMENSIONS

| L mm | | h mm | | d mm | |
|----------|--------------|----------|--------------|----------|-------------|
| Measured | Required | Measured | Required | Measured | Required |
| - | 48.50 +/- 2% | - | 28.80 +/- 2% | - | 3.60 +/- 2% |

6.2 S11 PARAMETER

6.2.1 S11 parameter in Head Liquid



| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|-----------------|--------------------|------------------|---------------------------|
| 2600 | -25.57 | -20 | $54.5\Omega - 3.2j\Omega$ |

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.

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.

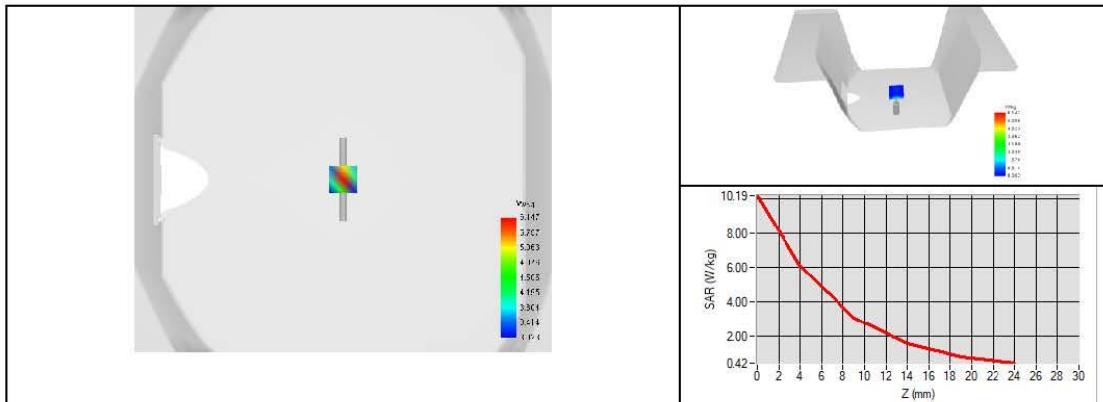


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Ref: ACR.53.30.24.BES.A

| | |
|---|--|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | 3523-EPGO-429 |
| Liquid | Head Liquid Values: $\epsilon' = 41.3$ $\sigma = 1.95$ |
| Distance between dipole center and liquid | 10.0 mm |
| Area scan resolution | $dx = 8\text{mm}/dy = 8\text{mm}$ |
| Zoon Scan Resolution | $dx = 5\text{mm}/dy = 5\text{mm}/dz = 5\text{mm}$ |
| Frequency | 2600 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 |
| 2600 MHz | 5.42 | 54.16 | 55.30 | 2.49 | 24.85 | 24.60 |





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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 | 08/2024 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2025 |
| Calipers | Mitutoyo | SN 0009732 | 11/2022 | 11/2025 |
| Reference Probe | MVG | 3523-EPGO-429 | 11/2023 | 11/2024 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 106589 | 03/2022 | 03/2025 |
| 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 | 06/2024 |
| Power Meter | Keysight U2000A | SN: MY62340002 | 10/2022 | 10/2025 |
| 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 |

<Justification of the extended calibration>

If dipoles are verified in return loss (<-20dB, within 20% of prior calibration for below 3GHz, and <-8dB, within 20% of prior calibration for 5GHz to 6GHz), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Head 835MHz>

| S11 parameter (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|--------------------|-----------|-----------|------------|---------------------|
| -42.84 | - | 50.50 | - | Feb. 21, 2024 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

<Head 1800MHz>

| S11 parameter (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|--------------------|-----------|-----------|------------|---------------------|
| -24.53 | - | 44.80 | - | Feb. 21, 2024 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

<Head 1900MHz>

| S11 parameter (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|--------------------|-----------|-----------|------------|---------------------|
| -23.28 | - | 46.20 | - | Feb. 21, 2024 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

<Head 2450MHz>

| S11 parameter (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|--------------------|-----------|-----------|------------|---------------------|
| -29.27 | - | 53.60 | - | Feb. 21, 2024 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

<Head 2600MHz>

| S11 parameter (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|--------------------|-----------|-----------|------------|---------------------|
| -25.57 | - | 54.50 | - | Feb. 21, 2024 |

The return loss is <-20dB, within 20% of prior calibration; the impedance is within 5 ohm of prior calibration. Therefore the verification result should support extended calibration.

END
