# COMOSAR E-Field Probe Calibration Report

Ref : ACR.197.12.21.BES.B

Cancel and replace the report ACR.197.12.21.BES.A

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**BAO'AN DISTRICT, SHENZHEN, GUANGDONG , CHINA**

**MVG COMOSAR DOSIMETRIC E-FIELD PROBE**

**SERIAL NO.: SN 18/21 EPGO356**

**Calibrated at MVG**

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

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

**29280 PLOUZANE - FRANCE**

**Calibration date: 07/08/2022**

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

*Summary:*

This document presents the method and results from an accredited COMOSAR 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).

| | Name | Function | Date | Signature |
|---|---|---|---|---|
| *Prepared by :* | Jérôme Le Gall | Measurement Responsible | 7/10/2022 | |
| *Checked by :* | Jérôme Luc | Technical Manager | 7/10/2022 | |
| *Approved by :* | Yann Toutain | Laboratory Director | 7/14/2022 | Yann TOUTAIN 2022.07.14 10:05:50 +03'00' |

| | Customer Name |
|---|---|
| *Distribution :* | Waltek Testing Group (Shenzhen) Co., Ltd |

| Issue | Name | Date | Modifications |
|---|---|---|---|
| A | Jérôme Luc | 7/10/2022 | Initial release |
| | | | |
| | | | |
| | | | |

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# 1 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | MVG |
| Model | SSE2 |
| Serial Number | SN 18/21 EPGO356 |
| Product Condition (new / used) | New |
| Frequency Range of Probe | 0.15 GHz-6GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.221 MΩ<br>Dipole 2: R2=0.197 MΩ<br>Dipole 3: R3=0.195 MΩ |

# 2 PRODUCT DESCRIPTION

## 2.1 GENERAL INFORMATION

MVG's COMOSAR E field Probes are built in accordance to the IEEE 1528, FCC KDB865664 D01, CENELEC EN62209 and CEI/IEC 62209 standards.

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

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

# 3 MEASUREMENT METHOD

The IEEE 1528, FCC KDB865664 D01, CENELEC EN62209 and CEI/IEC 62209 standards provide recommended practices for the probe calibrations, including the performance characteristics of interest and methods by which to assess their affect. All calibrations / measurements performed meet the fore mentioned standards.

## 3.1 LINEARITY

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

## 3.2 SENSITIVITY

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

## 3.3 LOWER DETECTION LIMIT

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

## 3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 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°).

## 3.1 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:

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

where

| | |
|---|---|
| $SAR_{uncertainty}$ | 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; |
| $\Delta SAR_{be}$ | 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%).

## 4 MEASUREMENT UNCERTAINTY

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

| **Uncertainty analysis of the probe calibration in waveguide** | | | | | |
|---|---|---|---|---|---|
| **ERROR SOURCES** | **Uncertainty value (%)** | **Probability Distribution** | **Divisor** | **ci** | **Standard Uncertainty (%)** |
| **Expanded uncertainty** 95 % confidence level k = 2 | | | | | 14 % |

## 5 CALIBRATION MEASUREMENT RESULTS

| **Calibration Parameters** | |
|---|---|
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

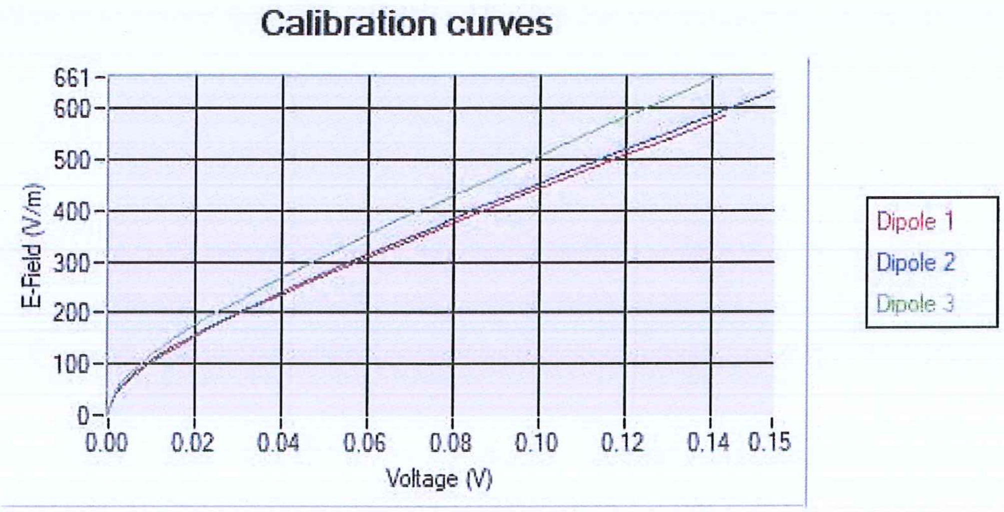
### 5.1 SENSITIVITY IN AIR

| Normx dipole 1 ($\mu V/(V/m)^2$) | Normy dipole 2 ($\mu V/(V/m)^2$) | Normz dipole 3 ($\mu V/(V/m)^2$) |
|---|---|---|
| 0.98 | 0.94 | 0.75 |

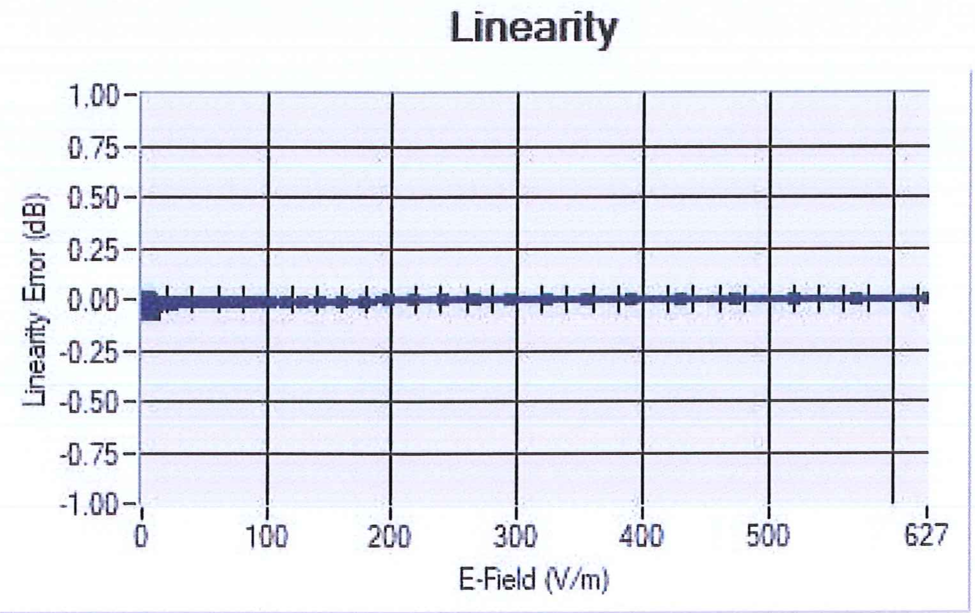
| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|---|---|---|
| 105 | 107 | 104 |

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

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




## 5.2 LINEARITY




Linearity:+/-1.73% (+/-0.08dB)

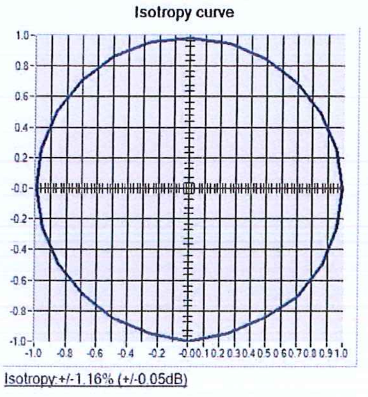
## 5.3 SENSITIVITY IN LIQUID

| Liquid | Frequency (MHz +/- 100MHz) | ConvF |
|---|---|---|
| HL750 | 750 | 1.66 |
| BL750 | 750 | 1.76 |
| HL850 | 835 | 1.71 |
| BL850 | 835 | 1.78 |
| HL900 | 900 | 1.88 |
| BL900 | 900 | 1.85 |
| HL1800 | 1800 | 2.11 |
| BL1800 | 1800 | 2.15 |
| HL1900 | 1900 | 2.21 |
| BL1900 | 1900 | 2.30 |
| HL2000 | 2000 | 2.41 |
| BL2000 | 2000 | 2.39 |
| HL2450 | 2450 | 2.29 |
| BL2450 | 2450 | 2.60 |
| HL2600 | 2600 | 2.22 |
| BL2600 | 2600 | 2.41 |
| HL3300 | 3300 | 2.64 |
| BL3300 | 3300 | 2.16 |
| HL3500 | 3500 | 2.05 |
| BL3500 | 3500 | 2.20 |
| HL3700 | 3700 | 2.27 |
| BL3700 | 3700 | 2.24 |
| HL3900 | 3900 | 2.38 |
| BL3900 | 3900 | 2.45 |
| HL4200 | 4200 | 2.42 |
| BL4200 | 4200 | 2.53 |
| HL4600 | 4600 | 2.41 |
| BL4600 | 4600 | 2.64 |
| HL4900 | 4900 | 2.21 |
| BL4900 | 4900 | 2.46 |
| HL5200 | 5200 | 1.91 |
| BL5200 | 5200 | 1.84 |
| HL5400 | 5400 | 2.12 |
| BL5400 | 5400 | 2.02 |
| HL5600 | 5600 | 2.25 |
| BL5600 | 5600 | 2.20 |
| HL5800 | 5800 | 2.14 |
| BL5800 | 5800 | 2.11 |

LOWER DETECTION LIMIT: 8mW/kg

## 5.4 ISOTROPY

**HL1800 MHz**



## 6 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|---|---|---|---|---|
| **Equipment Description** | **Manufacturer / Model** | **Identification No.** | **Current Calibration Date** | **Next Calibration Date** |
| Flat Phantom | MVG | SN-20/09-SAM71 | Validated. No cal required. | Validated. No cal required. |
| COMOSAR Test Bench | Version 3 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rohde & Schwarz ZVM | 100203 | 05/2022 | 05/2024 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 05/2022 | 05/2024 |
| Multimeter | Keithley 2000 | 1160271 | 02/2020 | 02/2023 |
| Signal Generator | Rohde & Schwarz SMB | 106589 | 04/2022 | 04/2024 |
| Amplifier | Aethercomm | SN 046 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | NI-USB 5680 | 170100013 | 05/2022 | 05/2024 |
| Directional Coupler | Narda 4216-20 | 01386 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Waveguide | Mega Industries | 069Y7-158-13-712 | Validated. No cal required. | Validated. No cal required. |
| Waveguide Transition | Mega Industries | 069Y7-158-13-701 | Validated. No cal required. | Validated. No cal required. |
| Waveguide Termination | Mega Industries | 069Y7-158-13-701 | Validated. No cal required. | Validated. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44220687 | 05/2020 | 05/2023 |

# SAR Reference Dipole Calibration Report

Ref : ACR.94.2.20.SATU.A

# WALTEK TESTING GROUP CO., LTD.

**NO.77, HOUJIE SECTION, GUANTAI ROAD, HOUJIE TOWN,**

**DONGGUAN GUANGDONG 518105 , CHINA**

## MVG COMOSAR REFERENCE DIPOLE

**FREQUENCY: 750 MHZ**
**SERIAL NO.: SN 09/15 DIP 0G750-357**

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

**Calibration Date: 08/29/20**


*Summary:*

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