



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.4.42.BES.A

|                               |              |                           |                             |                             |
|-------------------------------|--------------|---------------------------|-----------------------------|-----------------------------|
| Liquid transition             | MVG          | SN 32/16<br>WGLIQ_5G000_1 | Validated. No cal required. | Validated. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44225320                  | 06/2024                     | 06/2027                     |

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*Template\_ACR.DDD.N.YY.MVGB.ISSUE\_COMOSAR Probe vK*

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## SAR Reference Dipole Calibration Report

Ref : ACR.273.1.18.SATU.A

### GUANGDONG ASIA HONGKE TEST TECHNOLOGY CO., LTD

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GUANGDONG 518055, P.R.CHINA

### MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 450 MHZ

SERIAL NO.: SN 38/18 DIP 0G450-465

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 09/22/2024

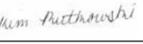
#### Summary:

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.



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|               | Name          | Function        | Date       | Signature   |
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| Approved by : | Kim RUTKOWSKI | Quality Manager | 09/28/2024 |  |

|                | Customer Name           |
|----------------|-------------------------|
| Distribution : | Shenzhen<br>Asia Hongke |

| Issue | Date       | Modifications   |
|-------|------------|-----------------|
| A     | 09/28/2024 | Initial release |
|       |            |                 |
|       |            |                 |
|       |            |                 |

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**1 INTRODUCTION**

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs and CEI/IEC 62209 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 450 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                              |
| Model                          | SID450                           |
| Serial Number                  | SN 38/18 DIP 0G450-465           |
| Product Condition (new / used) | Used                             |

A yearly calibration interval is recommended.

**3 PRODUCT DESCRIPTION****3.1 GENERAL INFORMATION**

MVG's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.



**Figure 1 – MVG COMOSAR Validation Dipole**



#### 4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 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.

##### 4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards.

##### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions 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.

#### 5 MEASUREMENT UNCERTAINTY

All uncertainties listed below represent an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of  $k=2$ , traceable to the Internationally Accepted Guides to Measurement Uncertainty.

##### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

| Frequency band | Expanded Uncertainty on Return Loss |
|----------------|-------------------------------------|
| 400-6000MHz    | 0.1 dB                              |

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|-------------|--------------------------------|
| 3 - 300     | 0.05 mm                        |

##### 5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
| 1 g         | 20.3 %               |

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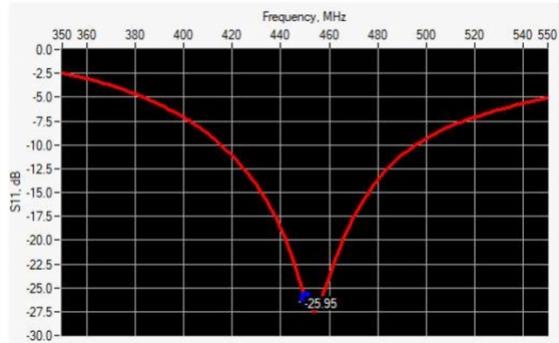
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|      |        |
|------|--------|
| 10 g | 20.1 % |
|------|--------|

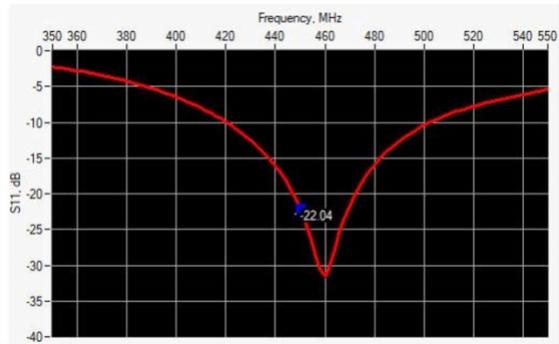
## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 450             | -25.95           | -20              | $45.0 \Omega - 0.5 j\Omega$ |

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 450             | -22.04           | -20              | $42.9 \Omega + 3.4 j\Omega$ |

### 6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm             |          | h mm             |          | d mm            |          |
|---------------|------------------|----------|------------------|----------|-----------------|----------|
|               | required         | measured | required         | measured | required        | measured |
| 300           | $420.0 \pm 1 \%$ |          | $250.0 \pm 1 \%$ |          | $6.35 \pm 1 \%$ |          |

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|      |                  |      |                  |      |                 |      |
|------|------------------|------|------------------|------|-----------------|------|
| 450  | 290.0 $\pm$ 1 %. | PASS | 166.7 $\pm$ 1 %. | PASS | 6.35 $\pm$ 1 %. | PASS |
| 750  | 176.0 $\pm$ 1 %. |      | 100.0 $\pm$ 1 %. |      | 6.35 $\pm$ 1 %. |      |
| 835  | 161.0 $\pm$ 1 %. |      | 89.8 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 900  | 149.0 $\pm$ 1 %. |      | 83.3 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 1450 | 89.1 $\pm$ 1 %.  |      | 51.7 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 1500 | 80.5 $\pm$ 1 %.  |      | 50.0 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 1640 | 79.0 $\pm$ 1 %.  |      | 45.7 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 1750 | 75.2 $\pm$ 1 %.  |      | 42.9 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 1800 | 72.0 $\pm$ 1 %.  |      | 41.7 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 1900 | 68.0 $\pm$ 1 %.  |      | 39.5 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 1950 | 66.3 $\pm$ 1 %.  |      | 38.5 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 2000 | 64.5 $\pm$ 1 %.  |      | 37.5 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 2100 | 61.0 $\pm$ 1 %.  |      | 35.7 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 2300 | 55.5 $\pm$ 1 %.  |      | 32.6 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 2450 | 51.5 $\pm$ 1 %.  |      | 30.4 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 2600 | 48.5 $\pm$ 1 %.  |      | 28.8 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 3000 | 41.5 $\pm$ 1 %.  |      | 25.0 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 3500 | 37.0 $\pm$ 1 %.  |      | 26.4 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |
| 3700 | 34.7 $\pm$ 1 %.  |      | 26.4 $\pm$ 1 %.  |      | 3.6 $\pm$ 1 %.  |      |

## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|--|----------|-------------------------------|----------|
|                  | required                               | measured | required                      | measured |
| 300              | 45.3 $\pm$ 5 %                         |          | 0.87 $\pm$ 5 %                |          |
| 450              | 43.5 $\pm$ 5 %                         | PASS     | 0.87 $\pm$ 5 %                | PASS     |
| 750              | 41.9 $\pm$ 5 %                         |          | 0.89 $\pm$ 5 %                |          |
| 835              | 41.5 $\pm$ 5 %                         |          | 0.90 $\pm$ 5 %                |          |
| 900              | 41.5 $\pm$ 5 %                         |          | 0.97 $\pm$ 5 %                |          |
| 1450             | 40.5 $\pm$ 5 %                         |          | 1.20 $\pm$ 5 %                |          |
| 1500             | 40.4 $\pm$ 5 %                         |          | 1.23 $\pm$ 5 %                |          |
| 1640             | 40.2 $\pm$ 5 %                         |          | 1.31 $\pm$ 5 %                |          |
| 1750             | 40.1 $\pm$ 5 %                         |          | 1.37 $\pm$ 5 %                |          |

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|      |                |  |                |  |
|------|----------------|--|----------------|--|
| 1800 | 40.0 $\pm$ 5 % |  | 1.40 $\pm$ 5 % |  |
| 1900 | 40.0 $\pm$ 5 % |  | 1.40 $\pm$ 5 % |  |
| 1950 | 40.0 $\pm$ 5 % |  | 1.40 $\pm$ 5 % |  |
| 2000 | 40.0 $\pm$ 5 % |  | 1.40 $\pm$ 5 % |  |
| 2100 | 39.8 $\pm$ 5 % |  | 1.49 $\pm$ 5 % |  |
| 2300 | 39.5 $\pm$ 5 % |  | 1.67 $\pm$ 5 % |  |
| 2450 | 39.2 $\pm$ 5 % |  | 1.80 $\pm$ 5 % |  |
| 2600 | 39.0 $\pm$ 5 % |  | 1.96 $\pm$ 5 % |  |
| 3000 | 38.5 $\pm$ 5 % |  | 2.40 $\pm$ 5 % |  |
| 3500 | 37.9 $\pm$ 5 % |  | 2.91 $\pm$ 5 % |  |

### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 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 V4                                   |
| Phantom                                   | SN 20/09 SAM71                               |
| Probe                                     | SN 18/11 EPG122                              |
| Liquid                                    | Head Liquid Values: cps' : 42.2 sigma : 0.86 |
| 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                                 | 450 MHz                                      |
| Input power                               | 20 dBm                                       |
| Liquid Temperature                        | 21 °C  |
| Lab Temperature                           | 21 °C  |
| Lab Humidity                              | 45 %   |

| Frequency<br>MHz | 1 g SAR (W/kg/W) |             | 10 g SAR (W/kg/W) |             |
|------------------|------------------|-------------|-------------------|-------------|
|                  | required         | measured    | required          | measured    |
| 300              | 2.85             |             | 1.94              |             |
| 450              | 4.58             | 4.70 (0.47) | 3.06              | 3.01 (0.30) |
| 750              | 8.49             |             | 5.55              |             |
| 835              | 9.56             |             | 6.22              |             |
| 900              | 10.9             |             | 6.99              |             |
| 1450             | 29               |             | 16                |             |
| 1500             | 30.5             |             | 16.8              |             |
| 1640             | 34.2             |             | 18.4              |             |
| 1750             | 36.4             |             | 19.3              |             |
| 1800             | 38.4             |             | 20.1              |             |

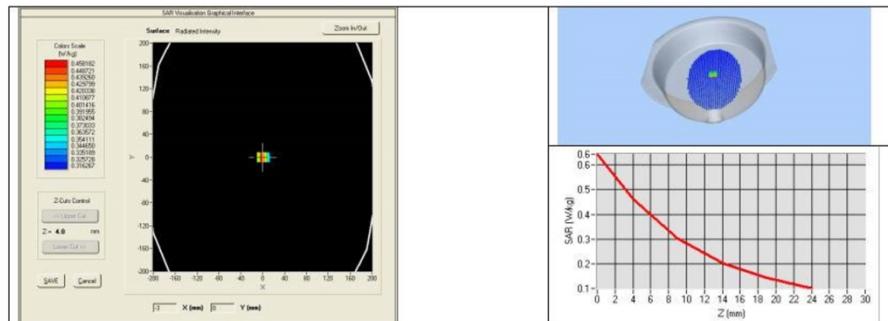
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|      |      |  |      |  |
|------|------|--|------|--|
| 1900 | 39.7 |  | 20.5 |  |
| 1950 | 40.5 |  | 20.9 |  |
| 2000 | 41.1 |  | 21.1 |  |
| 2100 | 43.6 |  | 21.9 |  |
| 2300 | 48.7 |  | 23.3 |  |
| 2450 | 52.4 |  | 24   |  |
| 2600 | 55.3 |  | 24.6 |  |
| 3000 | 63.8 |  | 25.7 |  |
| 3500 | 67.1 |  | 25   |  |
| 3700 | 67.4 |  | 24.2 |  |


**7.3 BODY LIQUID MEASUREMENT**

| Frequency<br>MHz | Relative permittivity ( $\epsilon'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|---------------------------------------|----------|-------------------------------|----------|
|                  | required                              | measured | required                      | measured |
| 150              | 61.9 $\pm$ 5 %                        |          | 0.80 $\pm$ 5 %                |          |
| 300              | 58.2 $\pm$ 5 %                        |          | 0.92 $\pm$ 5 %                |          |
| 450              | 56.7 $\pm$ 5 %                        | PASS     | 0.94 $\pm$ 5 %                | PASS     |
| 750              | 55.5 $\pm$ 5 %                        |          | 0.96 $\pm$ 5 %                |          |
| 835              | 55.2 $\pm$ 5 %                        |          | 0.97 $\pm$ 5 %                |          |
| 900              | 55.0 $\pm$ 5 %                        |          | 1.05 $\pm$ 5 %                |          |
| 915              | 55.0 $\pm$ 5 %                        |          | 1.06 $\pm$ 5 %                |          |
| 1450             | 54.0 $\pm$ 5 %                        |          | 1.30 $\pm$ 5 %                |          |
| 1610             | 53.8 $\pm$ 5 %                        |          | 1.40 $\pm$ 5 %                |          |
| 1800             | 53.3 $\pm$ 5 %                        |          | 1.52 $\pm$ 5 %                |          |
| 1900             | 53.3 $\pm$ 5 %                        |          | 1.52 $\pm$ 5 %                |          |
| 2000             | 53.3 $\pm$ 5 %                        |          | 1.52 $\pm$ 5 %                |          |
| 2100             | 53.2 $\pm$ 5 %                        |          | 1.62 $\pm$ 5 %                |          |

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