



## SAR Reference Dipole Calibration Report

Ref : ACR.15.9.21.MVGB.B

Cancel and replace the report ACR.15.9.21.MVGB.A

### **JIANYAN TESTING GROUP SHENZHEN CO.,LTD.**

**No.110~116, BUILDING B, JINYUAN BUSINESS BUILDING,  
XIXIANG ROAD, BAOAN DISTRICT,  
SHENZHEN, GUANGDONG, PR CHINA**

### **MVG COMOSAR REFERENCE DIPOLE**

**FREQUENCY: 1750 MHZ**

**SERIAL NO.: SN 50/20 DIP 1G750-510**

**Calibrated at MVG**

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

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

**Calibration date: 01/14/2021**



Accreditations #2-6789 and #2-6814  
Scope available on [www.cofrac.fr](http://www.cofrac.fr)

#### *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

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|               | Name         | Function            | Date      | Signature           |
|---------------|--------------|---------------------|-----------|---------------------|
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| Approved by : | Yann Toutain | Laboratory Director | 2/8/2021  | <i>Yann Toutain</i> |

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|                | Customer Name                                 |
|----------------|-----------------------------------------------|
| Distribution : | JianYan Testing<br>Group Shenzhen<br>Co.,Ltd. |

| Issue | Name       | Date      | Modifications                |
|-------|------------|-----------|------------------------------|
| A     | Jérôme LUC | 1/15/2021 | Initial release              |
| B     | Jérôme LUC | 2/8/2021  | Change customer name/address |
|       |            |           |                              |
|       |            |           |                              |



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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 1750 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                               |
| Model                          | SID1750                           |
| Serial Number                  | SN 50/20 DIP 1G750-510            |
| Product Condition (new / used) | New                               |

## 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. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

##### 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 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.

#### 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    | 0.08 LIN                            |

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|-------------|--------------------------------|
| 0 - 300     | 0.20 mm                        |
| 300 - 450   | 0.44 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.



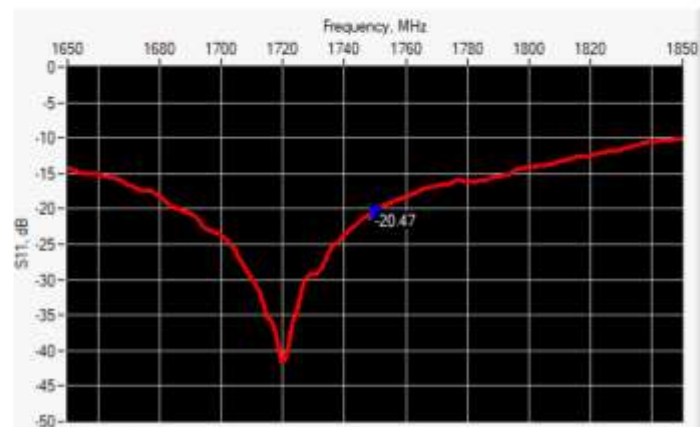
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| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
| 1 g         | 19 % (SAR)           |
| 10 g        | 19 % (SAR)           |

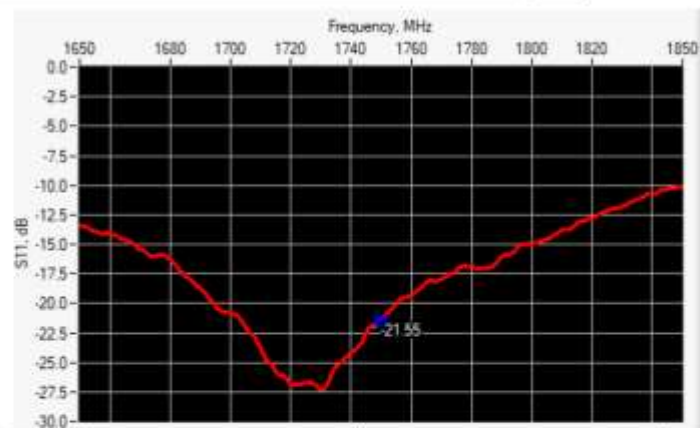
## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 1750            | -20.47           | -20              | $40.7 \Omega + 1.3 j\Omega$ |

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 1750            | -21.55           | -20              | $42.4 \Omega - 3.4 j\Omega$ |

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6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm        |          | h mm        |          | d mm       |          |
|---------------|-------------|----------|-------------|----------|------------|----------|
|               | required    | measured | required    | measured | required   | measured |
| 300           | 420.0 ±1 %. |          | 250.0 ±1 %. |          | 6.35 ±1 %. |          |
| 450           | 290.0 ±1 %. |          | 166.7 ±1 %. |          | 6.35 ±1 %. |          |
| 750           | 176.0 ±1 %. |          | 100.0 ±1 %. |          | 6.35 ±1 %. |          |
| 835           | 161.0 ±1 %. |          | 89.8 ±1 %.  |          | 3.6 ±1 %.  |          |
| 900           | 149.0 ±1 %. |          | 83.3 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1450          | 89.1 ±1 %.  |          | 51.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1500          | 80.5 ±1 %.  |          | 50.0 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1640          | 79.0 ±1 %.  |          | 45.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1750          | 75.2 ±1 %.  | 75.36    | 42.9 ±1 %.  | 42.48    | 3.6 ±1 %.  | 3.60     |
| 1800          | 72.0 ±1 %.  |          | 41.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1900          | 68.0 ±1 %.  |          | 39.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1950          | 66.3 ±1 %.  |          | 38.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2000          | 64.5 ±1 %.  |          | 37.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2100          | 61.0 ±1 %.  |          | 35.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2300          | 55.5 ±1 %.  |          | 32.6 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2450          | 51.5 ±1 %.  |          | 30.4 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2600          | 48.5 ±1 %.  |          | 28.8 ±1 %.  |          | 3.6 ±1 %.  |          |
| 3000          | 41.5 ±1 %.  |          | 25.0 ±1 %.  |          | 3.6 ±1 %.  |          |
| 3300          | -           |          | -           |          | -          |          |
| 3500          | 37.0 ±1 %.  |          | 26.4 ±1 %.  |          | 3.6 ±1 %.  |          |
| 3700          | 34.7 ±1 %.  |          | 26.4 ±1 %.  |          | 3.6 ±1 %.  |          |
| 3900          | -           |          | -           |          | -          |          |
| 4200          | -           |          | -           |          | -          |          |
| 4600          | -           |          | -           |          | -          |          |
| 4900          | -           |          | -           |          | -          |          |

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.

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## 7.1 HEAD LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 300              | 45.3 $\pm$ 10 %                         |          | 0.87 $\pm$ 10 %               |          |
| 450              | 43.5 $\pm$ 10 %                         |          | 0.87 $\pm$ 10 %               |          |
| 750              | 41.9 $\pm$ 10 %                         |          | 0.89 $\pm$ 10 %               |          |
| 835              | 41.5 $\pm$ 10 %                         |          | 0.90 $\pm$ 10 %               |          |
| 900              | 41.5 $\pm$ 10 %                         |          | 0.97 $\pm$ 10 %               |          |
| 1450             | 40.5 $\pm$ 10 %                         |          | 1.20 $\pm$ 10 %               |          |
| 1500             | 40.4 $\pm$ 10 %                         |          | 1.23 $\pm$ 10 %               |          |
| 1640             | 40.2 $\pm$ 10 %                         |          | 1.31 $\pm$ 10 %               |          |
| 1750             | 40.1 $\pm$ 10 %                         | 43.8     | 1.37 $\pm$ 10 %               | 1.30     |
| 1800             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 1900             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 1950             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 2000             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 2100             | 39.8 $\pm$ 10 %                         |          | 1.49 $\pm$ 10 %               |          |
| 2300             | 39.5 $\pm$ 10 %                         |          | 1.67 $\pm$ 10 %               |          |
| 2450             | 39.2 $\pm$ 10 %                         |          | 1.80 $\pm$ 10 %               |          |
| 2600             | 39.0 $\pm$ 10 %                         |          | 1.96 $\pm$ 10 %               |          |
| 3000             | 38.5 $\pm$ 10 %                         |          | 2.40 $\pm$ 10 %               |          |
| 3300             | 38.2 $\pm$ 10 %                         |          | 2.71 $\pm$ 10 %               |          |
| 3500             | 37.9 $\pm$ 10 %                         |          | 2.91 $\pm$ 10 %               |          |
| 3700             | 37.7 $\pm$ 10 %                         |          | 3.12 $\pm$ 10 %               |          |
| 3900             | 37.5 $\pm$ 10 %                         |          | 3.32 $\pm$ 10 %               |          |
| 4200             | 37.1 $\pm$ 10 %                         |          | 3.63 $\pm$ 10 %               |          |
| 4600             | 36.7 $\pm$ 10 %                         |          | 4.04 $\pm$ 10 %               |          |
| 4900             | 36.3 $\pm$ 10 %                         |          | 4.35 $\pm$ 10 %               |          |

## 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.



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|                                           |                                                                  |
|-------------------------------------------|------------------------------------------------------------------|
| Software                                  | OPENSAR V5                                                       |
| Phantom                                   | SN 13/09 SAM68                                                   |
| Probe                                     | SN 41/18 EPG0333                                                 |
| Liquid                                    | Head Liquid Values: $\epsilon_{\text{ps}}^*$ : 43.8 sigma : 1.30 |
| Distance between dipole center and liquid | 10.0 mm                                                          |
| Area scan resolution                      | $dx=8\text{mm}/dy=8\text{mm}$                                    |
| Zoon Scan Resolution                      | $dx=8\text{mm}/dy=8\text{mm}/dz=5\text{mm}$                      |
| Frequency                                 | 1750 MHz                                                         |
| Input power                               | 20 dBm                                                           |
| Liquid Temperature                        | 20 +/- 1 °C                                                      |
| Lab Temperature                           | 20 +/- 1 °C                                                      |
| Lab Humidity                              | 30-70 %                                                          |

| 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             |              | 3.06              |              |
| 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             | 36.50 (3.65) | 19.3              | 19.18 (1.92) |
| 1800             | 38.4             |              | 20.1              |              |
| 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              |              |
| 3300             | -                |              | -                 |              |
| 3500             | 67.1             |              | 25                |              |
| 3700             | 67.4             |              | 24.2              |              |
| 3900             | -                |              | -                 |              |
| 4200             | -                |              | -                 |              |
| 4600             | -                |              | -                 |              |
| 4900             | -                |              | -                 |              |

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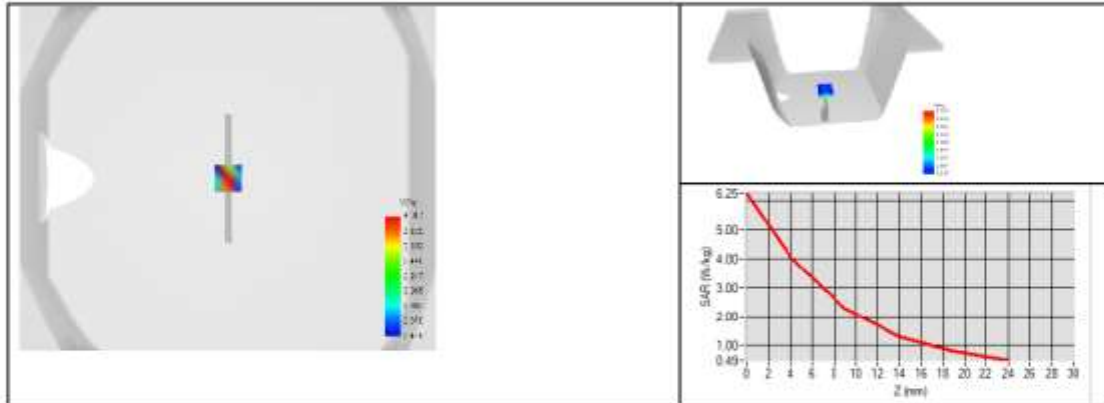
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### 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 $\pm$ 10 %                         |          | 0.80 $\pm$ 10 %               |          |
| 300              | 58.2 $\pm$ 10 %                         |          | 0.92 $\pm$ 10 %               |          |
| 450              | 56.7 $\pm$ 10 %                         |          | 0.94 $\pm$ 10 %               |          |
| 750              | 55.5 $\pm$ 10 %                         |          | 0.96 $\pm$ 10 %               |          |
| 835              | 55.2 $\pm$ 10 %                         |          | 0.97 $\pm$ 10 %               |          |
| 900              | 55.0 $\pm$ 10 %                         |          | 1.05 $\pm$ 10 %               |          |
| 915              | 55.0 $\pm$ 10 %                         |          | 1.06 $\pm$ 10 %               |          |
| 1450             | 54.0 $\pm$ 10 %                         |          | 1.30 $\pm$ 10 %               |          |
| 1610             | 53.8 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 1750             | 53.4 $\pm$ 10 %                         | 55.6     | 1.49 $\pm$ 10 %               | 1.45     |
| 1800             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 1900             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 2000             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 2100             | 53.2 $\pm$ 10 %                         |          | 1.62 $\pm$ 10 %               |          |
| 2300             | 52.9 $\pm$ 10 %                         |          | 1.81 $\pm$ 10 %               |          |
| 2450             | 52.7 $\pm$ 10 %                         |          | 1.95 $\pm$ 10 %               |          |
| 2600             | 52.5 $\pm$ 10 %                         |          | 2.16 $\pm$ 10 %               |          |
| 3000             | 52.0 $\pm$ 10 %                         |          | 2.73 $\pm$ 10 %               |          |
| 3300             | 51.6 $\pm$ 10 %                         |          | 3.08 $\pm$ 10 %               |          |
| 3500             | 51.3 $\pm$ 10 %                         |          | 3.31 $\pm$ 10 %               |          |
| 3700             | 51.0 $\pm$ 10 %                         |          | 3.55 $\pm$ 10 %               |          |
| 3900             | 50.8 $\pm$ 10 %                         |          | 3.78 $\pm$ 10 %               |          |
| 4200             | 50.4 $\pm$ 10 %                         |          | 4.13 $\pm$ 10 %               |          |
| 4600             | 49.8 $\pm$ 10 %                         |          | 4.60 $\pm$ 10 %               |          |
| 4900             | 49.4 $\pm$ 10 %                         |          | 4.95 $\pm$ 10 %               |          |
| 5200             | 49.0 $\pm$ 10 %                         |          | 5.30 $\pm$ 10 %               |          |
| 5300             | 48.9 $\pm$ 10 %                         |          | 5.42 $\pm$ 10 %               |          |
| 5400             | 48.7 $\pm$ 10 %                         |          | 5.53 $\pm$ 10 %               |          |
| 5500             | 48.6 $\pm$ 10 %                         |          | 5.65 $\pm$ 10 %               |          |
| 5600             | 48.5 $\pm$ 10 %                         |          | 5.77 $\pm$ 10 %               |          |
| 5800             | 48.2 $\pm$ 10 %                         |          | 6.00 $\pm$ 10 %               |          |



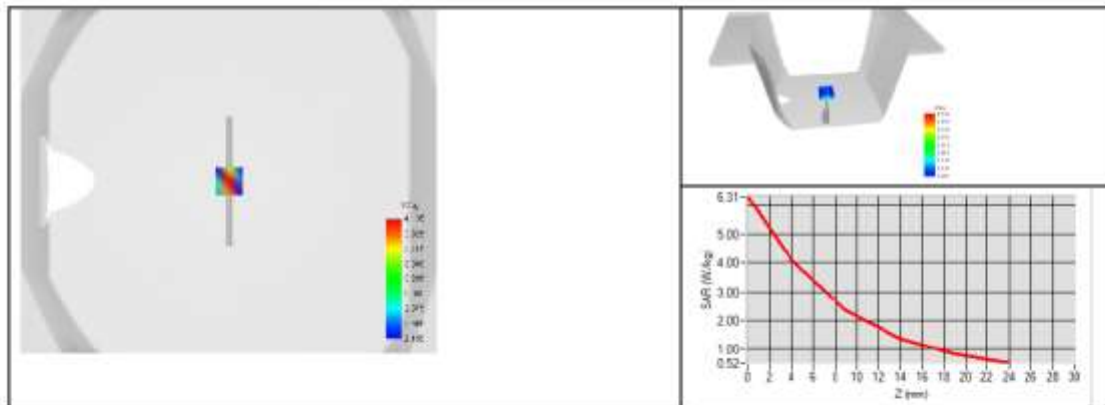
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Ref: ACR.15.9.21.MVGB.B

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                                             |
|-------------------------------------------|-------------------------------------------------------------|
| Software                                  | OPENSAR V5                                                  |
| Phantom                                   | SN 13/09 SAM68                                              |
| Probe                                     | SN 41/18 EPG0333                                            |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}' : 55.6$ $\sigma : 1.45$ |
| 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                                 | 1750 MHz                                                    |
| Input power                               | 20 dBm                                                      |
| Liquid Temperature                        | 20 +/- 1 °C                                                 |
| Lab Temperature                           | 20 +/- 1 °C                                                 |
| Lab Humidity                              | 30-70 %                                                     |

| Frequency<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 1750             | 37.02 (3.70)     | 19.36 (1.94)      |





## 8 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             | 05/2019                                       | 05/2022                                       |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223             | 05/2019                                       | 05/2022                                       |
| Calipers                           | Mitutoyo                | SN 0009732         | 10/2019                                       | 10/2022                                       |
| Reference Probe                    | MVG                     | EPGO333 SN 41/18   | 05/2020                                       | 05/2021                                       |
| Multimeter                         | Keithley 2000           | 1160271            | 02/2020                                       | 02/2023                                       |
| Signal Generator                   | Rohde & Schwarz SMB     | 106589             | 04/2019                                       | 04/2022                                       |
| Amplifier                          | Aethercomm              | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                        | NI-USB 5680             | 170100013          | 05/2019                                       | 05/2022                                       |
| Directional Coupler                | Narda 4216-20           | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor      | Testo 184 H1            | 44220687           | 05/2020                                       | 05/2023                                       |

## Dipole Impedance and Return Loss calibration Report

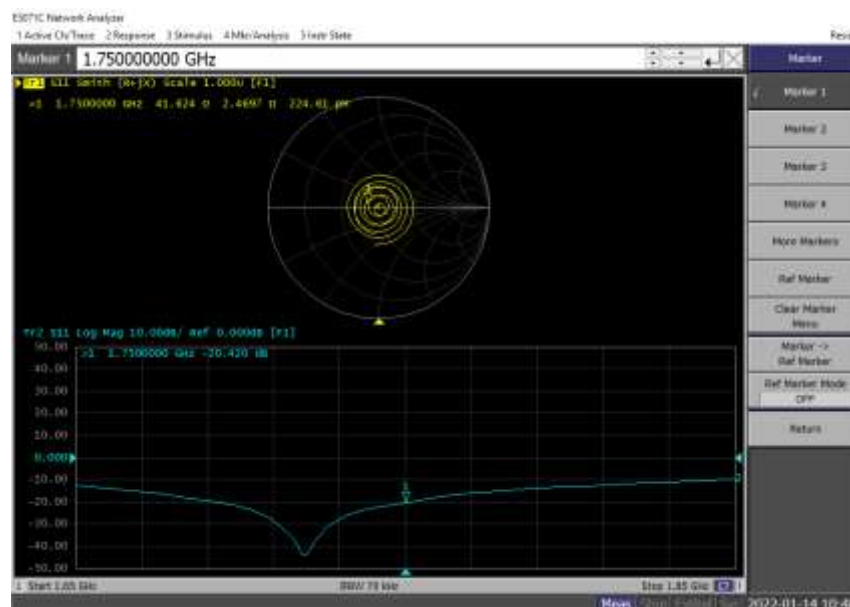
**Object:** SID1750 - SN 50/20 DIP 1G750-510  
**Calibration Date:** January 14, 2022  
**Calibration reference:** IEEE Std 1528:2013, IEC 62209-1:2016, FCC KDB 865664 D01  
**Calibrated By:** *Janet Wei* (Janet Wei, SAR project engineer)  
**Reviewed By:** *Winner Zhang* (Winner Zhang, Technical manager)

### Environment of Test Site

|                       |           |
|-----------------------|-----------|
| Temperature:          | 18 ~ 25°C |
| Humidity:             | 50~60% RH |
| Atmospheric Pressure: | 1011 mbar |

### Test Data

Measurement Plot for Head TSL In 2022



### Comparison with Original report

| Items                    | Calibrated By MVG | Calibrated By JYT In 2022 | Deviation    | Limit                    |
|--------------------------|-------------------|---------------------------|--------------|--------------------------|
| Impedence for Head TSL   | 40.7Ω+1.3jΩ       | 41.62Ω+2.47jΩ             | 0.92Ω+1.17jΩ | ±5Ω                      |
| Return Loss for Head TSL | -20.47dB          | -20.42dB                  | -0.24%       | ±20%(No less than 20 dB) |

### Result

Compliance



## SAR Reference Dipole Calibration Report

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XIXIANG ROAD, BAOAN DISTRICT,  
SHENZHEN, GUANGDONG, PR CHINA  
**MVG COMOSAR REFERENCE DIPOLE**  
FREQUENCY: 1900 MHZ  
SERIAL NO.: SN 50/20 DIP 1G900-511

**Calibrated at MVG**  
**Z.I. de la pointe du diable**  
**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**  
**29280 PLOUZANE - FRANCE**

**Calibration date: 01/14/2021**



Accreditations #2-6789 and #2-6814  
Scope available on [www.cofrac.fr](http://www.cofrac.fr)

### *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.15.10.21.MVGB.B

|               | Name         | Function            | Date      | Signature           |
|---------------|--------------|---------------------|-----------|---------------------|
| Prepared by : | Jérôme LUC   | Technical Manager   | 1/15/2021 | <i>JLS</i>          |
| Checked by :  | Jérôme LUC   | Technical Manager   | 1/15/2021 | <i>JLS</i>          |
| Approved by : | Yann Toutain | Laboratory Director | 2/8/2021  | <i>Yann Toutain</i> |

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|                | Customer Name                                 |
|----------------|-----------------------------------------------|
| Distribution : | JianYan Testing<br>Group Shenzhen<br>Co.,Ltd. |

| Issue | Name       | Date      | Modifications                |
|-------|------------|-----------|------------------------------|
| A     | Jérôme LUC | 1/15/2021 | Initial release              |
| B     | Jérôme LUC | 2/8/2021  | Change customer name/address |
|       |            |           |                              |
|       |            |           |                              |



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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 1900 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                               |
| Model                          | SID1900                           |
| Serial Number                  | SN 50/20 DIP 1G900-511            |
| Product Condition (new / used) | New                               |

## 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. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

##### 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 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.

#### 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    | 0.08 LIN                            |

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|-------------|--------------------------------|
| 0 - 300     | 0.20 mm                        |
| 300 - 450   | 0.44 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.

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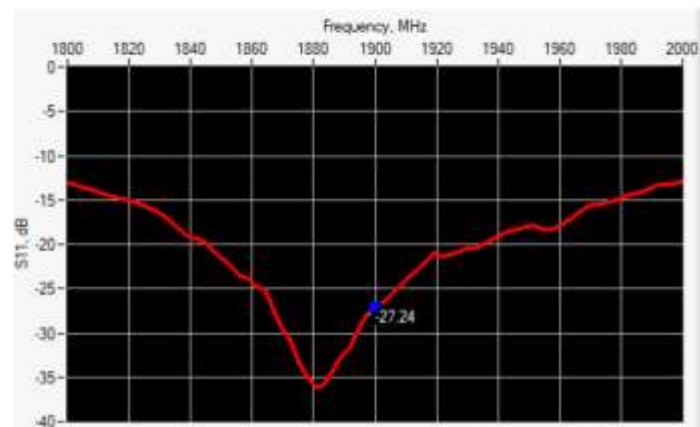
**SAR REFERENCE DIPOLE CALIBRATION REPORT**

Ref: ACR 15.10.21 MVGB B

| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
| 1 g         | 19 % (SAR)           |
| 10 g        | 19 % (SAR)           |

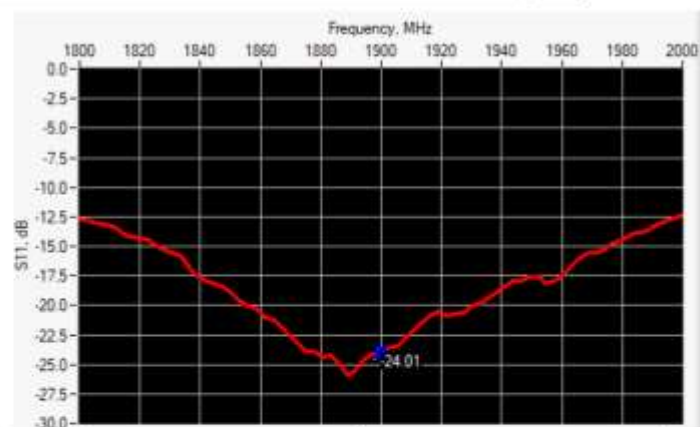
## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 1900            | -27.24           | -20              | $51.2 \Omega + 4.2 j\Omega$ |

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 1900            | -24.01           | -20              | $46.6 \Omega + 5.3 j\Omega$ |

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## 6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm       |          | h mm       |          | d mm      |          |
|---------------|------------|----------|------------|----------|-----------|----------|
|               | required   | measured | required   | measured | required  | measured |
| 300           | 420.0 ±1 % |          | 250.0 ±1 % |          | 6.35 ±1 % |          |
| 450           | 290.0 ±1 % |          | 166.7 ±1 % |          | 6.35 ±1 % |          |
| 750           | 176.0 ±1 % |          | 100.0 ±1 % |          | 6.35 ±1 % |          |
| 835           | 161.0 ±1 % |          | 89.8 ±1 %  |          | 3.6 ±1 %  |          |
| 900           | 149.0 ±1 % |          | 83.3 ±1 %  |          | 3.6 ±1 %  |          |
| 1450          | 89.1 ±1 %  |          | 51.7 ±1 %  |          | 3.6 ±1 %  |          |
| 1500          | 80.5 ±1 %  |          | 50.0 ±1 %  |          | 3.6 ±1 %  |          |
| 1640          | 79.0 ±1 %  |          | 45.7 ±1 %  |          | 3.6 ±1 %  |          |
| 1750          | 75.2 ±1 %  |          | 42.9 ±1 %  |          | 3.6 ±1 %  |          |
| 1800          | 72.0 ±1 %  |          | 41.7 ±1 %  |          | 3.6 ±1 %  |          |
| 1900          | 68.0 ±1 %  | 68.23    | 39.5 ±1 %  | 39.22    | 3.6 ±1 %  | 3.59     |
| 1950          | 66.3 ±1 %  |          | 38.5 ±1 %  |          | 3.6 ±1 %  |          |
| 2000          | 64.5 ±1 %  |          | 37.5 ±1 %  |          | 3.6 ±1 %  |          |
| 2100          | 61.0 ±1 %  |          | 35.7 ±1 %  |          | 3.6 ±1 %  |          |
| 2300          | 55.5 ±1 %  |          | 32.6 ±1 %  |          | 3.6 ±1 %  |          |
| 2450          | 51.5 ±1 %  |          | 30.4 ±1 %  |          | 3.6 ±1 %  |          |
| 2600          | 48.5 ±1 %  |          | 28.8 ±1 %  |          | 3.6 ±1 %  |          |
| 3000          | 41.5 ±1 %  |          | 25.0 ±1 %  |          | 3.6 ±1 %  |          |
| 3300          | -          |          | -          |          | -         |          |
| 3500          | 37.0 ±1 %  |          | 26.4 ±1 %  |          | 3.6 ±1 %  |          |
| 3700          | 34.7 ±1 %  |          | 26.4 ±1 %  |          | 3.6 ±1 %  |          |
| 3900          | -          |          | -          |          | -         |          |
| 4200          | -          |          | -          |          | -         |          |
| 4600          | -          |          | -          |          | -         |          |
| 4900          | -          |          | -          |          | -         |          |

## 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.

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## 7.1 HEAD LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 300              | 45.3 $\pm$ 10 %                         |          | 0.87 $\pm$ 10 %               |          |
| 450              | 43.5 $\pm$ 10 %                         |          | 0.87 $\pm$ 10 %               |          |
| 750              | 41.9 $\pm$ 10 %                         |          | 0.89 $\pm$ 10 %               |          |
| 835              | 41.5 $\pm$ 10 %                         |          | 0.90 $\pm$ 10 %               |          |
| 900              | 41.5 $\pm$ 10 %                         |          | 0.97 $\pm$ 10 %               |          |
| 1450             | 40.5 $\pm$ 10 %                         |          | 1.20 $\pm$ 10 %               |          |
| 1500             | 40.4 $\pm$ 10 %                         |          | 1.23 $\pm$ 10 %               |          |
| 1640             | 40.2 $\pm$ 10 %                         |          | 1.31 $\pm$ 10 %               |          |
| 1750             | 40.1 $\pm$ 10 %                         |          | 1.37 $\pm$ 10 %               |          |
| 1800             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 1900             | 40.0 $\pm$ 10 %                         | 43.3     | 1.40 $\pm$ 10 %               | 1.41     |
| 1950             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 2000             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 2100             | 39.8 $\pm$ 10 %                         |          | 1.49 $\pm$ 10 %               |          |
| 2300             | 39.5 $\pm$ 10 %                         |          | 1.67 $\pm$ 10 %               |          |
| 2450             | 39.2 $\pm$ 10 %                         |          | 1.80 $\pm$ 10 %               |          |
| 2600             | 39.0 $\pm$ 10 %                         |          | 1.96 $\pm$ 10 %               |          |
| 3000             | 38.5 $\pm$ 10 %                         |          | 2.40 $\pm$ 10 %               |          |
| 3300             | 38.2 $\pm$ 10 %                         |          | 2.71 $\pm$ 10 %               |          |
| 3500             | 37.9 $\pm$ 10 %                         |          | 2.91 $\pm$ 10 %               |          |
| 3700             | 37.7 $\pm$ 10 %                         |          | 3.12 $\pm$ 10 %               |          |
| 3900             | 37.5 $\pm$ 10 %                         |          | 3.32 $\pm$ 10 %               |          |
| 4200             | 37.1 $\pm$ 10 %                         |          | 3.63 $\pm$ 10 %               |          |
| 4600             | 36.7 $\pm$ 10 %                         |          | 4.04 $\pm$ 10 %               |          |
| 4900             | 36.3 $\pm$ 10 %                         |          | 4.35 $\pm$ 10 %               |          |

## 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.



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.15.10.21.MVGB.B

|                                           |                                                         |
|-------------------------------------------|---------------------------------------------------------|
| Software                                  | OPENSAR V5                                              |
| Phantom                                   | SN 13/09 SAM68                                          |
| Probe                                     | SN 41/18 EPG0333                                        |
| Liquid                                    | Head Liquid Values: $\epsilon_p$ : 43.3 $\sigma$ : 1.41 |
| 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<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             |              | 3.06              |              |
| 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              |              |
| 1900             | 39.7             | 39.60 (3.96) | 20.5              | 20.33 (2.03) |
| 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              |              |
| 3300             | -                |              | -                 |              |
| 3500             | 67.1             |              | 25                |              |
| 3700             | 67.4             |              | 24.2              |              |
| 3900             | -                |              | -                 |              |
| 4200             | -                |              | -                 |              |
| 4600             | -                |              | -                 |              |
| 4900             | -                |              | -                 |              |

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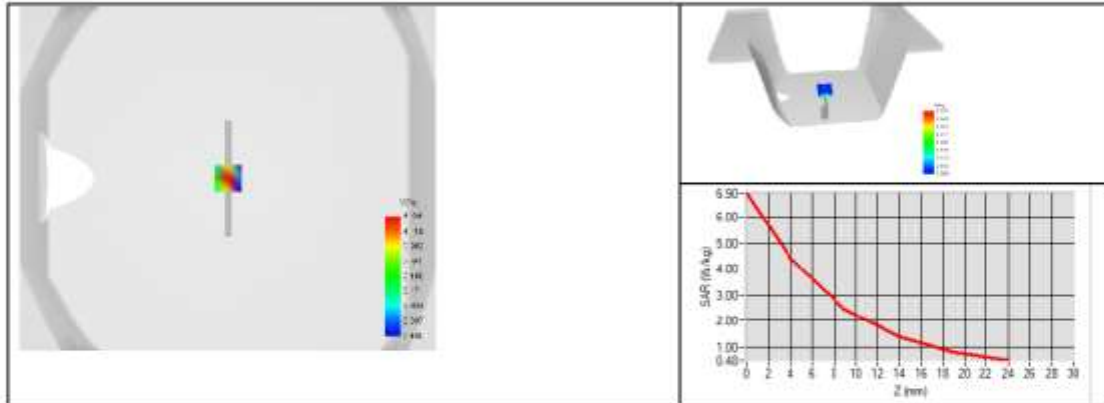
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7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 $\pm$ 10 %                         |          | 0.80 $\pm$ 10 %               |          |
| 300              | 58.2 $\pm$ 10 %                         |          | 0.92 $\pm$ 10 %               |          |
| 450              | 56.7 $\pm$ 10 %                         |          | 0.94 $\pm$ 10 %               |          |
| 750              | 55.5 $\pm$ 10 %                         |          | 0.96 $\pm$ 10 %               |          |
| 835              | 55.2 $\pm$ 10 %                         |          | 0.97 $\pm$ 10 %               |          |
| 900              | 55.0 $\pm$ 10 %                         |          | 1.05 $\pm$ 10 %               |          |
| 915              | 55.0 $\pm$ 10 %                         |          | 1.06 $\pm$ 10 %               |          |
| 1450             | 54.0 $\pm$ 10 %                         |          | 1.30 $\pm$ 10 %               |          |
| 1610             | 53.8 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 1800             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 1900             | 53.3 $\pm$ 10 %                         | 55.0     | 1.52 $\pm$ 10 %               | 1.57     |
| 2000             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 2100             | 53.2 $\pm$ 10 %                         |          | 1.62 $\pm$ 10 %               |          |
| 2300             | 52.9 $\pm$ 10 %                         |          | 1.81 $\pm$ 10 %               |          |
| 2450             | 52.7 $\pm$ 10 %                         |          | 1.95 $\pm$ 10 %               |          |
| 2600             | 52.5 $\pm$ 10 %                         |          | 2.16 $\pm$ 10 %               |          |
| 3000             | 52.0 $\pm$ 10 %                         |          | 2.73 $\pm$ 10 %               |          |
| 3300             | 51.6 $\pm$ 10 %                         |          | 3.08 $\pm$ 10 %               |          |
| 3500             | 51.3 $\pm$ 10 %                         |          | 3.31 $\pm$ 10 %               |          |
| 3700             | 51.0 $\pm$ 10 %                         |          | 3.55 $\pm$ 10 %               |          |
| 3900             | 50.8 $\pm$ 10 %                         |          | 3.78 $\pm$ 10 %               |          |
| 4200             | 50.4 $\pm$ 10 %                         |          | 4.13 $\pm$ 10 %               |          |
| 4600             | 49.8 $\pm$ 10 %                         |          | 4.60 $\pm$ 10 %               |          |
| 4900             | 49.4 $\pm$ 10 %                         |          | 4.95 $\pm$ 10 %               |          |
| 5200             | 49.0 $\pm$ 10 %                         |          | 5.30 $\pm$ 10 %               |          |
| 5300             | 48.9 $\pm$ 10 %                         |          | 5.42 $\pm$ 10 %               |          |
| 5400             | 48.7 $\pm$ 10 %                         |          | 5.53 $\pm$ 10 %               |          |
| 5500             | 48.6 $\pm$ 10 %                         |          | 5.65 $\pm$ 10 %               |          |
| 5600             | 48.5 $\pm$ 10 %                         |          | 5.77 $\pm$ 10 %               |          |
| 5800             | 48.2 $\pm$ 10 %                         |          | 6.00 $\pm$ 10 %               |          |

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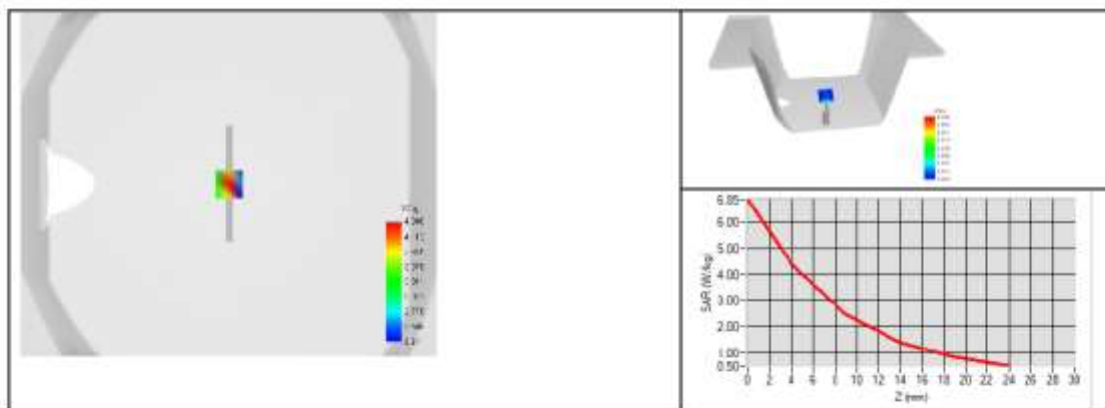
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Ref: ACR.15.10.21.MVGB.B

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                                             |
|-------------------------------------------|-------------------------------------------------------------|
| Software                                  | OPENSAR V5                                                  |
| Phantom                                   | SN 13/09 SAM68                                              |
| Probe                                     | SN 41/18 EPG0333                                            |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}' : 55.0$ $\sigma : 1.57$ |
| 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<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 1900             | 39.85 (3.99)     | 20.29 (2.03)      |





## 8 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             | 05/2019                                       | 05/2022                                       |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223             | 05/2019                                       | 05/2022                                       |
| Calipers                           | Mitutoyo                | SN 0009732         | 10/2019                                       | 10/2022                                       |
| Reference Probe                    | MVG                     | EPGO333 SN 41/18   | 05/2020                                       | 05/2021                                       |
| Multimeter                         | Keithley 2000           | 1160271            | 02/2020                                       | 02/2023                                       |
| Signal Generator                   | Rohde & Schwarz SMB     | 106589             | 04/2019                                       | 04/2022                                       |
| Amplifier                          | Aethercomm              | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                        | NI-USB 5680             | 170100013          | 05/2019                                       | 05/2022                                       |
| Directional Coupler                | Narda 4216-20           | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor      | Testo 184 H1            | 44220687           | 05/2020                                       | 05/2023                                       |

## Dipole Impedance and Return Loss calibration Report

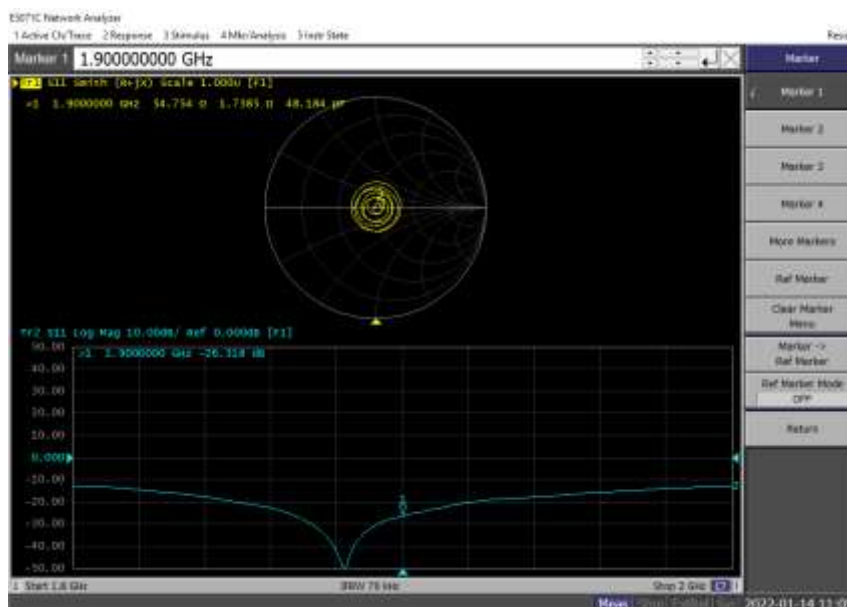
**Object:** SID1900 - SN 50/20 DIP 1G900-511  
**Calibration Date:** January 14, 2022  
**Calibration reference:** IEEE Std 1528:2013, IEC 62209-1:2016, FCC KDB 865664 D01  
**Calibrated By:** *Janet Wei* (Janet Wei, SAR project engineer)  
**Reviewed By:** *Winner Zhang* (Winner Zhang, Technical manager)

### Environment of Test Site

|                       |           |
|-----------------------|-----------|
| Temperature:          | 18 ~ 25°C |
| Humidity:             | 50~60% RH |
| Atmospheric Pressure: | 1011 mbar |

### Test Data

Measurement Plot for Head TSL In 2022



### Comparison with Original report

| Items                    | Calibrated By MVG | Calibrated By JYT In 2022 | Deviation    | Limit                    |
|--------------------------|-------------------|---------------------------|--------------|--------------------------|
| Impendence for Head TSL  | 51.2Ω+4.2jΩ       | 54.75Ω+1.74jΩ             | 3.55Ω-2.46jΩ | ±5Ω                      |
| Return Loss for Head TSL | -27.24dB          | -26.32dB                  | -3.38%       | ±20%(No less than 20 dB) |

### Result

Compliance



## SAR Reference Dipole Calibration Report

Ref : ACR.15.13.21.MVGB.B

Cancel and replace the report ACR.15.13.21.MVGB.A

### JIANYAN TESTING GROUP SHENZHEN CO.,LTD.

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SHENZHEN, GUANGDONG, PR CHINA

### MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ

SERIAL NO.: SN 50/20 DIP 2G450-514

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 01/14/2021



Accreditations #2-6789 and #2-6814  
Scope available on [www.cofrac.fr](http://www.cofrac.fr)

#### 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.15.13.21.MVGB.B

|               | Name         | Function            | Date      | Signature           |
|---------------|--------------|---------------------|-----------|---------------------|
| Prepared by : | Jérôme LUC   | Technical Manager   | 1/15/2021 | <i>JLS</i>          |
| Checked by :  | Jérôme LUC   | Technical Manager   | 1/15/2021 | <i>JLS</i>          |
| Approved by : | Yann Toutain | Laboratory Director | 2/8/2021  | <i>Yann Toutain</i> |

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|                | Customer Name                                 |
|----------------|-----------------------------------------------|
| Distribution : | JianYan Testing<br>Group Shenzhen<br>Co.,Ltd. |

| Issue | Name       | Date      | Modifications                |
|-------|------------|-----------|------------------------------|
| A     | Jérôme LUC | 1/15/2021 | Initial release              |
| B     | Jérôme LUC | 2/8/2021  | Change customer name/address |
|       |            |           |                              |
|       |            |           |                              |



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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 2450 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                               |
| Model                          | SID2450                           |
| Serial Number                  | SN 50/20 DIP 2G450-514            |
| Product Condition (new / used) | New                               |

## 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. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

##### 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 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.

#### 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    | 0.08 LIN                            |

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|-------------|--------------------------------|
| 0 - 300     | 0.20 mm                        |
| 300 - 450   | 0.44 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.



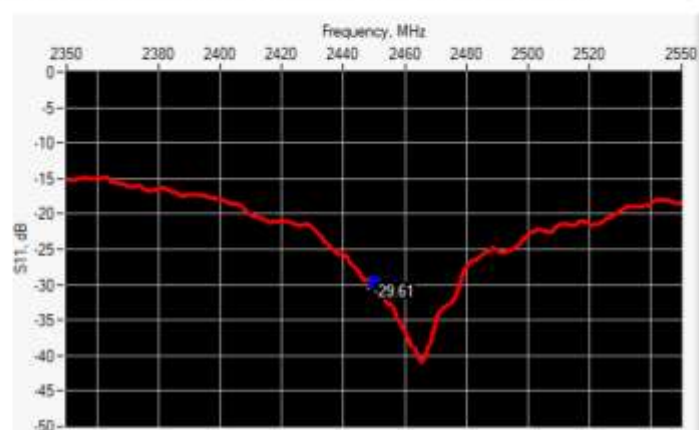
SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.15.13.21.MVGB.B

| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
| 1 g         | 19 % (SAR)           |
| 10 g        | 19 % (SAR)           |

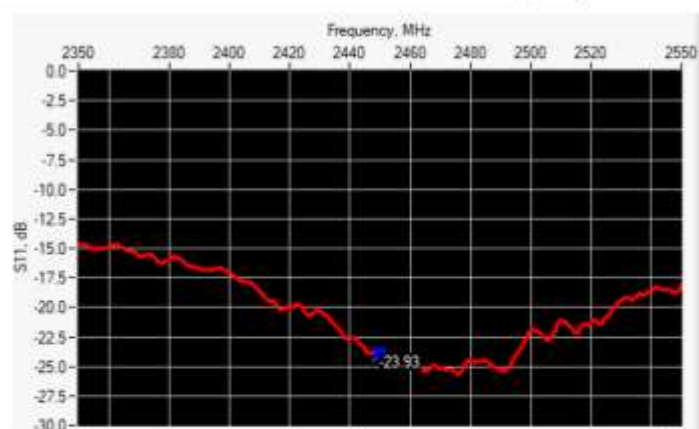
## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 2450            | -29.61           | -20              | $51.2 \Omega + 3.1 j\Omega$ |

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 2450            | -23.93           | -20              | $55.8 \Omega + 2.7 j\Omega$ |

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6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm       |          | h mm       |          | d mm      |          |
|---------------|------------|----------|------------|----------|-----------|----------|
|               | required   | measured | required   | measured | required  | measured |
| 300           | 420.0 ±1 % |          | 250.0 ±1 % |          | 6.35 ±1 % |          |
| 450           | 290.0 ±1 % |          | 166.7 ±1 % |          | 6.35 ±1 % |          |
| 750           | 176.0 ±1 % |          | 100.0 ±1 % |          | 6.35 ±1 % |          |
| 835           | 161.0 ±1 % |          | 89.8 ±1 %  |          | 3.6 ±1 %  |          |
| 900           | 149.0 ±1 % |          | 83.3 ±1 %  |          | 3.6 ±1 %  |          |
| 1450          | 89.1 ±1 %  |          | 51.7 ±1 %  |          | 3.6 ±1 %  |          |
| 1500          | 80.5 ±1 %  |          | 50.0 ±1 %  |          | 3.6 ±1 %  |          |
| 1640          | 79.0 ±1 %  |          | 45.7 ±1 %  |          | 3.6 ±1 %  |          |
| 1750          | 75.2 ±1 %  |          | 42.9 ±1 %  |          | 3.6 ±1 %  |          |
| 1800          | 72.0 ±1 %  |          | 41.7 ±1 %  |          | 3.6 ±1 %  |          |
| 1900          | 68.0 ±1 %  |          | 39.5 ±1 %  |          | 3.6 ±1 %  |          |
| 1950          | 66.3 ±1 %  |          | 38.5 ±1 %  |          | 3.6 ±1 %  |          |
| 2000          | 64.5 ±1 %  |          | 37.5 ±1 %  |          | 3.6 ±1 %  |          |
| 2100          | 61.0 ±1 %  |          | 35.7 ±1 %  |          | 3.6 ±1 %  |          |
| 2300          | 55.5 ±1 %  |          | 32.6 ±1 %  |          | 3.6 ±1 %  |          |
| 2450          | 51.5 ±1 %  | 51.45    | 30.4 ±1 %  | 30.60    | 3.6 ±1 %  | 3.58     |
| 2600          | 48.5 ±1 %  |          | 28.8 ±1 %  |          | 3.6 ±1 %  |          |
| 3000          | 41.5 ±1 %  |          | 25.0 ±1 %  |          | 3.6 ±1 %  |          |
| 3300          | -          |          | -          |          | -         |          |
| 3500          | 37.0 ±1 %  |          | 26.4 ±1 %  |          | 3.6 ±1 %  |          |
| 3700          | 34.7 ±1 %  |          | 26.4 ±1 %  |          | 3.6 ±1 %  |          |
| 3900          | -          |          | -          |          | -         |          |
| 4200          | -          |          | -          |          | -         |          |
| 4600          | -          |          | -          |          | -         |          |
| 4900          | -          |          | -          |          | -         |          |

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.

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7.1 HEAD LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|----------------------------------------|----------|-------------------------------|----------|
|                  | required                               | measured | required                      | measured |
| 300              | 45.3 $\pm$ 10 %                        |          | 0.87 $\pm$ 10 %               |          |
| 450              | 43.5 $\pm$ 10 %                        |          | 0.87 $\pm$ 10 %               |          |
| 750              | 41.9 $\pm$ 10 %                        |          | 0.89 $\pm$ 10 %               |          |
| 835              | 41.5 $\pm$ 10 %                        |          | 0.90 $\pm$ 10 %               |          |
| 900              | 41.5 $\pm$ 10 %                        |          | 0.97 $\pm$ 10 %               |          |
| 1450             | 40.5 $\pm$ 10 %                        |          | 1.20 $\pm$ 10 %               |          |
| 1500             | 40.4 $\pm$ 10 %                        |          | 1.23 $\pm$ 10 %               |          |
| 1640             | 40.2 $\pm$ 10 %                        |          | 1.31 $\pm$ 10 %               |          |
| 1750             | 40.1 $\pm$ 10 %                        |          | 1.37 $\pm$ 10 %               |          |
| 1800             | 40.0 $\pm$ 10 %                        |          | 1.40 $\pm$ 10 %               |          |
| 1900             | 40.0 $\pm$ 10 %                        |          | 1.40 $\pm$ 10 %               |          |
| 1950             | 40.0 $\pm$ 10 %                        |          | 1.40 $\pm$ 10 %               |          |
| 2000             | 40.0 $\pm$ 10 %                        |          | 1.40 $\pm$ 10 %               |          |
| 2100             | 39.8 $\pm$ 10 %                        |          | 1.49 $\pm$ 10 %               |          |
| 2300             | 39.5 $\pm$ 10 %                        |          | 1.67 $\pm$ 10 %               |          |
| 2450             | 39.2 $\pm$ 10 %                        | 41.9     | 1.80 $\pm$ 10 %               | 1.88     |
| 2600             | 39.0 $\pm$ 10 %                        |          | 1.96 $\pm$ 10 %               |          |
| 3000             | 38.5 $\pm$ 10 %                        |          | 2.40 $\pm$ 10 %               |          |
| 3300             | 38.2 $\pm$ 10 %                        |          | 2.71 $\pm$ 10 %               |          |
| 3500             | 37.9 $\pm$ 10 %                        |          | 2.91 $\pm$ 10 %               |          |
| 3700             | 37.7 $\pm$ 10 %                        |          | 3.12 $\pm$ 10 %               |          |
| 3900             | 37.5 $\pm$ 10 %                        |          | 3.32 $\pm$ 10 %               |          |
| 4200             | 37.1 $\pm$ 10 %                        |          | 3.63 $\pm$ 10 %               |          |
| 4600             | 36.7 $\pm$ 10 %                        |          | 4.04 $\pm$ 10 %               |          |
| 4900             | 36.3 $\pm$ 10 %                        |          | 4.35 $\pm$ 10 %               |          |

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.

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|                                           |                                                         |
|-------------------------------------------|---------------------------------------------------------|
| Software                                  | OPENSAR V5                                              |
| Phantom                                   | SN 13/09 SAM68                                          |
| Probe                                     | SN 41/18 EPG0333                                        |
| Liquid                                    | Head Liquid Values: $\epsilon_p$ : 41.9 $\sigma$ : 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<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             |              | 3.06              |              |
| 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              |              |
| 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             | 52.92 (5.29) | 24                | 23.68 (2.37) |
| 2600             | 55.3             |              | 24.6              |              |
| 3000             | 63.8             |              | 25.7              |              |
| 3300             | -                |              | -                 |              |
| 3500             | 67.1             |              | 25                |              |
| 3700             | 67.4             |              | 24.2              |              |
| 3900             | -                |              | -                 |              |
| 4200             | -                |              | -                 |              |
| 4600             | -                |              | -                 |              |
| 4900             | -                |              | -                 |              |

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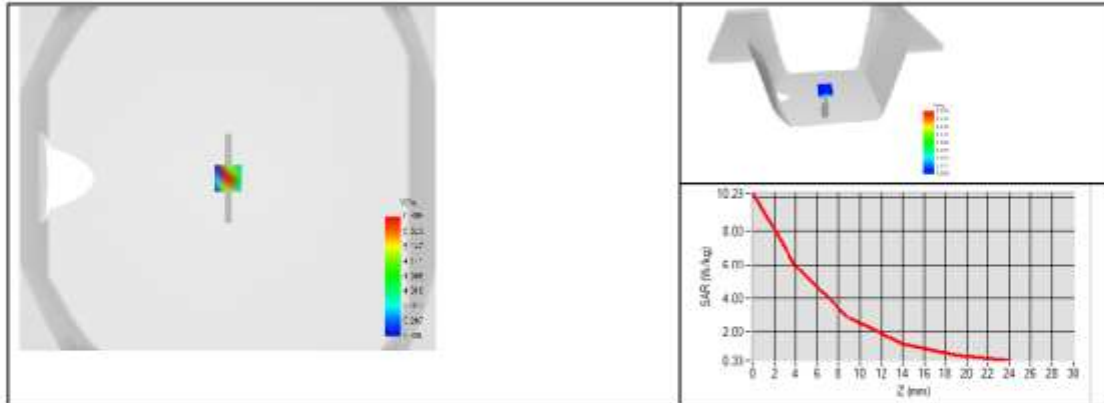
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7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 $\pm 10$ %                         |          | 0.80 $\pm 10$ %               |          |
| 300              | 58.2 $\pm 10$ %                         |          | 0.92 $\pm 10$ %               |          |
| 450              | 56.7 $\pm 10$ %                         |          | 0.94 $\pm 10$ %               |          |
| 750              | 55.5 $\pm 10$ %                         |          | 0.96 $\pm 10$ %               |          |
| 835              | 55.2 $\pm 10$ %                         |          | 0.97 $\pm 10$ %               |          |
| 900              | 55.0 $\pm 10$ %                         |          | 1.05 $\pm 10$ %               |          |
| 915              | 55.0 $\pm 10$ %                         |          | 1.06 $\pm 10$ %               |          |
| 1450             | 54.0 $\pm 10$ %                         |          | 1.30 $\pm 10$ %               |          |
| 1610             | 53.8 $\pm 10$ %                         |          | 1.40 $\pm 10$ %               |          |
| 1800             | 53.3 $\pm 10$ %                         |          | 1.52 $\pm 10$ %               |          |
| 1900             | 53.3 $\pm 10$ %                         |          | 1.52 $\pm 10$ %               |          |
| 2000             | 53.3 $\pm 10$ %                         |          | 1.52 $\pm 10$ %               |          |
| 2100             | 53.2 $\pm 10$ %                         |          | 1.62 $\pm 10$ %               |          |
| 2300             | 52.9 $\pm 10$ %                         |          | 1.81 $\pm 10$ %               |          |
| 2450             | 52.7 $\pm 10$ %                         | 53.4     | 1.95 $\pm 10$ %               | 2.14     |
| 2600             | 52.5 $\pm 10$ %                         |          | 2.16 $\pm 10$ %               |          |
| 3000             | 52.0 $\pm 10$ %                         |          | 2.73 $\pm 10$ %               |          |
| 3300             | 51.6 $\pm 10$ %                         |          | 3.08 $\pm 10$ %               |          |
| 3500             | 51.3 $\pm 10$ %                         |          | 3.31 $\pm 10$ %               |          |
| 3700             | 51.0 $\pm 10$ %                         |          | 3.55 $\pm 10$ %               |          |
| 3900             | 50.8 $\pm 10$ %                         |          | 3.78 $\pm 10$ %               |          |
| 4200             | 50.4 $\pm 10$ %                         |          | 4.13 $\pm 10$ %               |          |
| 4600             | 49.8 $\pm 10$ %                         |          | 4.60 $\pm 10$ %               |          |
| 4900             | 49.4 $\pm 10$ %                         |          | 4.95 $\pm 10$ %               |          |
| 5200             | 49.0 $\pm 10$ %                         |          | 5.30 $\pm 10$ %               |          |
| 5300             | 48.9 $\pm 10$ %                         |          | 5.42 $\pm 10$ %               |          |
| 5400             | 48.7 $\pm 10$ %                         |          | 5.53 $\pm 10$ %               |          |
| 5500             | 48.6 $\pm 10$ %                         |          | 5.65 $\pm 10$ %               |          |
| 5600             | 48.5 $\pm 10$ %                         |          | 5.77 $\pm 10$ %               |          |
| 5800             | 48.2 $\pm 10$ %                         |          | 6.00 $\pm 10$ %               |          |

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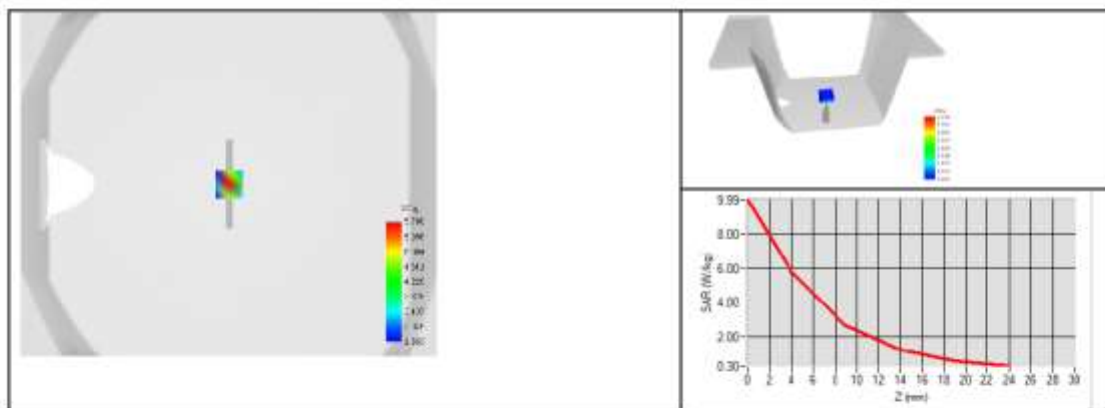
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7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                                             |
|-------------------------------------------|-------------------------------------------------------------|
| Software                                  | OPENSAR V5                                                  |
| Phantom                                   | SN 13/09 SAM68                                              |
| Probe                                     | SN 41/18 EPG0333                                            |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}' : 53.4$ $\sigma : 2.14$ |
| 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<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 2450             | 54.47 (5.45)     | 23.42 (2.34)      |





## 8 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             | 05/2019                                       | 05/2022                                       |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223             | 05/2019                                       | 05/2022                                       |
| Calipers                           | Mitutoyo                | SN 0009732         | 10/2019                                       | 10/2022                                       |
| Reference Probe                    | MVG                     | EPGO333 SN 41/18   | 05/2020                                       | 05/2021                                       |
| Multimeter                         | Keithley 2000           | 1160271            | 02/2020                                       | 02/2023                                       |
| Signal Generator                   | Rohde & Schwarz SMB     | 106589             | 04/2019                                       | 04/2022                                       |
| Amplifier                          | Aethercomm              | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                        | NI-USB 5680             | 170100013          | 05/2019                                       | 05/2022                                       |
| Directional Coupler                | Narda 4216-20           | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor      | Testo 184 H1            | 44220687           | 05/2020                                       | 05/2023                                       |

## Dipole Impedance and Return Loss calibration Report

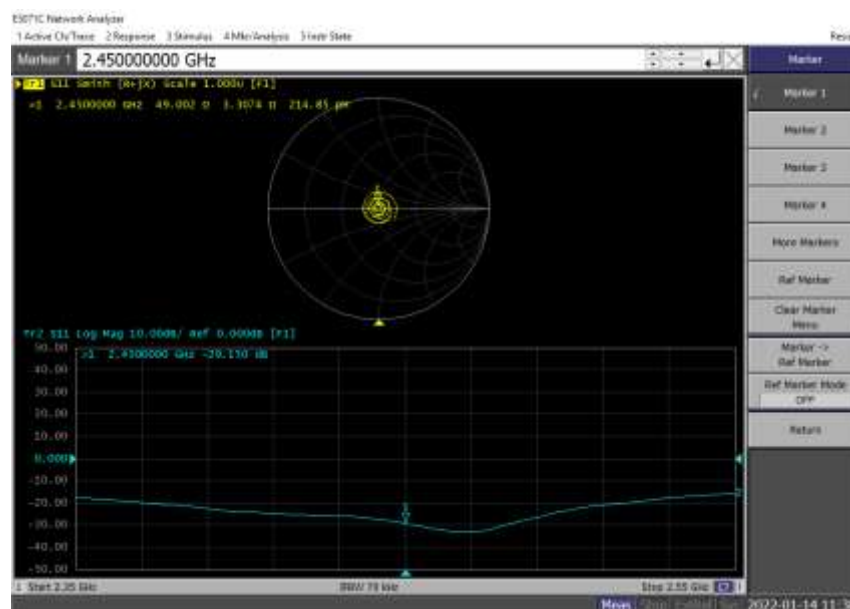
**Object:** SID2450 - SN 50/20 DIP 2G450-514  
**Calibration Date:** January 14, 2022  
**Calibration reference:** IEEE Std 1528:2013, IEC 62209-1:2016, FCC KDB 865664 D01  
**Calibrated By:** *Janet Wei* (Janet Wei, SAR project engineer)  
**Reviewed By:** *Winner Zhang* (Winner Zhang, Technical manager)

### Environment of Test Site

|                       |           |
|-----------------------|-----------|
| Temperature:          | 18 ~ 25°C |
| Humidity:             | 50~60% RH |
| Atmospheric Pressure: | 1011 mbar |

### Test Data

Measurement Plot for Head TSL In 2022



### Comparison with Original report

| Items                    | Calibrated By MVG | Calibrated By JYT In 2022 | Deviation     | Limit                    |
|--------------------------|-------------------|---------------------------|---------------|--------------------------|
| Impedence for Head TSL   | 51.2Ω+3.1jΩ       | 49.00Ω+3.31jΩ             | -2.20Ω+0.21jΩ | ±5Ω                      |
| Return Loss for Head TSL | -29.61dB          | -29.15dB                  | -1.55%        | ±20%(No less than 20 dB) |

### Result

Compliance



## SAR Reference Dipole Calibration Report

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Cancel and replace the report ACR.15.14.21.MVGB.A

**JIANYAN TESTING GROUP  
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XIXIANG ROAD, BAOAN DISTRICT,  
SHENZHEN, GUANGDONG, PR CHINA  
**MVG COMOSAR REFERENCE DIPOLE**  
FREQUENCY: 2600 MHZ  
SERIAL NO.: SN 50/20 DIP 2G600-515

**Calibrated at MVG**  
**Z.I. de la pointe du diable**  
**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**  
**29280 PLOUZANE - FRANCE**

**Calibration date: 01/14/2021**



Accreditations #2-6789 and #2-6814  
Scope available on [www.cofrac.fr](http://www.cofrac.fr)

### *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.15.14.21.MVGB.B

|               | Name         | Function            | Date      | Signature           |
|---------------|--------------|---------------------|-----------|---------------------|
| Prepared by : | Jérôme LUC   | Technical Manager   | 1/15/2021 | <i>JLS</i>          |
| Checked by :  | Jérôme LUC   | Technical Manager   | 1/15/2021 | <i>JLS</i>          |
| Approved by : | Yann Toutain | Laboratory Director | 2/8/2021  | <i>Yann Toutain</i> |

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|                | Customer Name                                 |
|----------------|-----------------------------------------------|
| Distribution : | JianYan Testing<br>Group Shenzhen<br>Co.,Ltd. |

| Issue | Name       | Date      | Modifications                |
|-------|------------|-----------|------------------------------|
| A     | Jérôme LUC | 1/15/2021 | Initial release              |
| B     | Jérôme LUC | 2/8/2021  | Change customer name/address |
|       |            |           |                              |
|       |            |           |                              |



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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 2600 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                               |
| Model                          | SID2600                           |
| Serial Number                  | SN 50/20 DIP 2G600-515            |
| Product Condition (new / used) | New                               |

## 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. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

##### 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 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.

#### 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    | 0.08 LIN                            |

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|-------------|--------------------------------|
| 0 - 300     | 0.20 mm                        |
| 300 - 450   | 0.44 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.



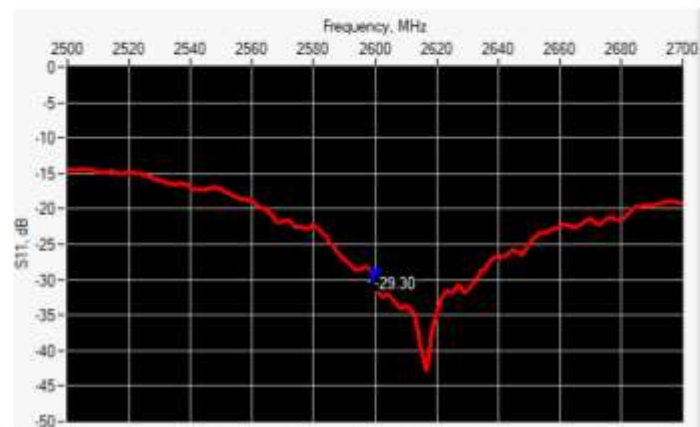
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| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
| 1 g         | 19 % (SAR)           |
| 10 g        | 19 % (SAR)           |

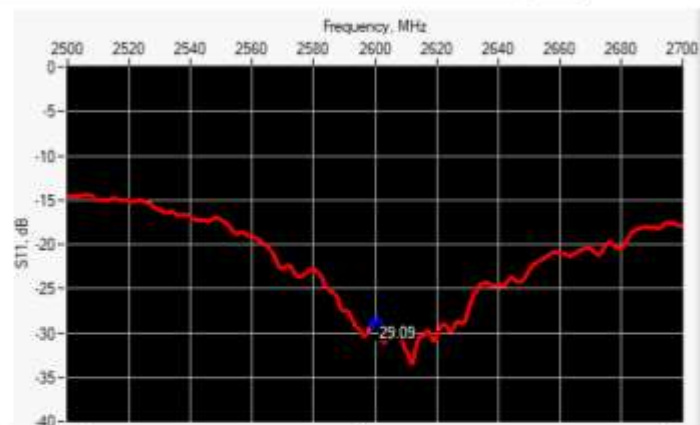
## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                      |
|-----------------|------------------|------------------|--------------------------------|
| 2600            | -29.30           | -20              | 48.6 $\Omega$ - 2.1 j $\Omega$ |

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                      |
|-----------------|------------------|------------------|--------------------------------|
| 2600            | -29.09           | -20              | 48.1 $\Omega$ - 2.9 j $\Omega$ |

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### 6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm        |          | h mm        |          | d mm       |          |
|---------------|-------------|----------|-------------|----------|------------|----------|
|               | required    | measured | required    | measured | required   | measured |
| 300           | 420.0 ±1 %. |          | 250.0 ±1 %. |          | 6.35 ±1 %. |          |
| 450           | 290.0 ±1 %. |          | 166.7 ±1 %. |          | 6.35 ±1 %. |          |
| 750           | 176.0 ±1 %. |          | 100.0 ±1 %. |          | 6.35 ±1 %. |          |
| 835           | 161.0 ±1 %. |          | 89.8 ±1 %.  |          | 3.6 ±1 %.  |          |
| 900           | 149.0 ±1 %. |          | 83.3 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1450          | 89.1 ±1 %.  |          | 51.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1500          | 80.5 ±1 %.  |          | 50.0 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1640          | 79.0 ±1 %.  |          | 45.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1750          | 75.2 ±1 %.  |          | 42.9 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1800          | 72.0 ±1 %.  |          | 41.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1900          | 68.0 ±1 %.  |          | 39.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 1950          | 66.3 ±1 %.  |          | 38.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2000          | 64.5 ±1 %.  |          | 37.5 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2100          | 61.0 ±1 %.  |          | 35.7 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2300          | 55.5 ±1 %.  |          | 32.6 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2450          | 51.5 ±1 %.  |          | 30.4 ±1 %.  |          | 3.6 ±1 %.  |          |
| 2600          | 48.5 ±1 %.  | 48.30    | 28.8 ±1 %.  | 28.67    | 3.6 ±1 %.  | 3.60     |
| 3000          | 41.5 ±1 %.  |          | 25.0 ±1 %.  |          | 3.6 ±1 %.  |          |
| 3300          | -           |          | -           |          | -          |          |
| 3500          | 37.0 ±1 %.  |          | 26.4 ±1 %.  |          | 3.6 ±1 %.  |          |
| 3700          | 34.7 ±1 %.  |          | 26.4 ±1 %.  |          | 3.6 ±1 %.  |          |
| 3900          | -           |          | -           |          | -          |          |
| 4200          | -           |          | -           |          | -          |          |
| 4600          | -           |          | -           |          | -          |          |
| 4900          | -           |          | -           |          | -          |          |

### 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.

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7.1 HEAD LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 300              | 45.3 $\pm$ 10 %                         |          | 0.87 $\pm$ 10 %               |          |
| 450              | 43.5 $\pm$ 10 %                         |          | 0.87 $\pm$ 10 %               |          |
| 750              | 41.9 $\pm$ 10 %                         |          | 0.89 $\pm$ 10 %               |          |
| 835              | 41.5 $\pm$ 10 %                         |          | 0.90 $\pm$ 10 %               |          |
| 900              | 41.5 $\pm$ 10 %                         |          | 0.97 $\pm$ 10 %               |          |
| 1450             | 40.5 $\pm$ 10 %                         |          | 1.20 $\pm$ 10 %               |          |
| 1500             | 40.4 $\pm$ 10 %                         |          | 1.23 $\pm$ 10 %               |          |
| 1640             | 40.2 $\pm$ 10 %                         |          | 1.31 $\pm$ 10 %               |          |
| 1750             | 40.1 $\pm$ 10 %                         |          | 1.37 $\pm$ 10 %               |          |
| 1800             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 1900             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 1950             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 2000             | 40.0 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 2100             | 39.8 $\pm$ 10 %                         |          | 1.49 $\pm$ 10 %               |          |
| 2300             | 39.5 $\pm$ 10 %                         |          | 1.67 $\pm$ 10 %               |          |
| 2450             | 39.2 $\pm$ 10 %                         |          | 1.80 $\pm$ 10 %               |          |
| 2600             | 39.0 $\pm$ 10 %                         | 41.5     | 1.96 $\pm$ 10 %               | 2.03     |
| 3000             | 38.5 $\pm$ 10 %                         |          | 2.40 $\pm$ 10 %               |          |
| 3300             | 38.2 $\pm$ 10 %                         |          | 2.71 $\pm$ 10 %               |          |
| 3500             | 37.9 $\pm$ 10 %                         |          | 2.91 $\pm$ 10 %               |          |
| 3700             | 37.7 $\pm$ 10 %                         |          | 3.12 $\pm$ 10 %               |          |
| 3900             | 37.5 $\pm$ 10 %                         |          | 3.32 $\pm$ 10 %               |          |
| 4200             | 37.1 $\pm$ 10 %                         |          | 3.63 $\pm$ 10 %               |          |
| 4600             | 36.7 $\pm$ 10 %                         |          | 4.04 $\pm$ 10 %               |          |
| 4900             | 36.3 $\pm$ 10 %                         |          | 4.35 $\pm$ 10 %               |          |

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.

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|                                           |                                                         |
|-------------------------------------------|---------------------------------------------------------|
| Software                                  | OPENSAR V5                                              |
| Phantom                                   | SN 13/09 SAM68                                          |
| Probe                                     | SN 41/18 EPG0333                                        |
| Liquid                                    | Head Liquid Values: $\epsilon_p$ : 41.5 $\sigma$ : 2.03 |
| 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                                 | 2600 MHz                                                |
| Input power                               | 20 dBm                                                  |
| Liquid Temperature                        | 20 +/- 1 °C                                             |
| Lab Temperature                           | 20 +/- 1 °C                                             |
| Lab Humidity                              | 30-70 %                                                 |

| 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             |              | 3.06              |              |
| 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              |              |
| 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             | 55.47 (5.55) | 24.6              | 24.11 (2.41) |
| 3000             | 63.8             |              | 25.7              |              |
| 3300             | -                |              | -                 |              |
| 3500             | 67.1             |              | 25                |              |
| 3700             | 67.4             |              | 24.2              |              |
| 3900             | -                |              | -                 |              |
| 4200             | -                |              | -                 |              |
| 4600             | -                |              | -                 |              |
| 4900             | -                |              | -                 |              |

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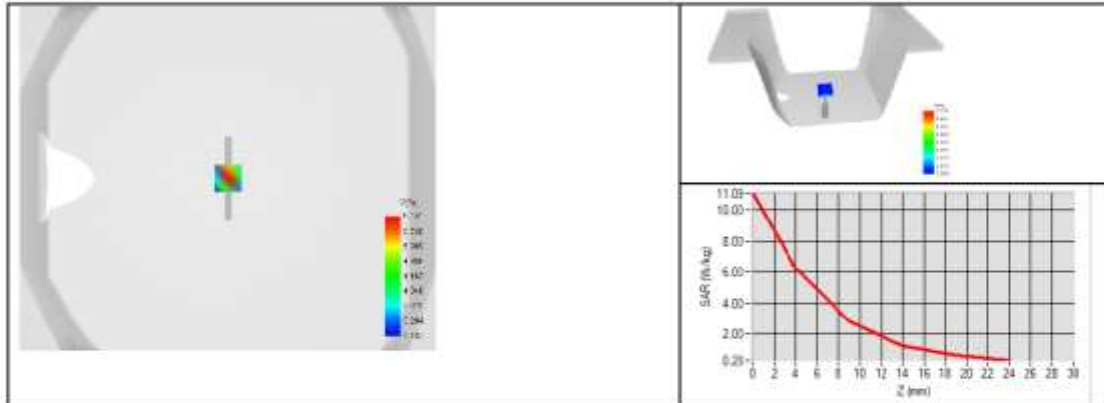
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## 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 $\pm$ 10 %                         |          | 0.80 $\pm$ 10 %               |          |
| 300              | 58.2 $\pm$ 10 %                         |          | 0.92 $\pm$ 10 %               |          |
| 450              | 56.7 $\pm$ 10 %                         |          | 0.94 $\pm$ 10 %               |          |
| 750              | 55.5 $\pm$ 10 %                         |          | 0.96 $\pm$ 10 %               |          |
| 835              | 55.2 $\pm$ 10 %                         |          | 0.97 $\pm$ 10 %               |          |
| 900              | 55.0 $\pm$ 10 %                         |          | 1.05 $\pm$ 10 %               |          |
| 915              | 55.0 $\pm$ 10 %                         |          | 1.06 $\pm$ 10 %               |          |
| 1450             | 54.0 $\pm$ 10 %                         |          | 1.30 $\pm$ 10 %               |          |
| 1610             | 53.8 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 1800             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 1900             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 2000             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 2100             | 53.2 $\pm$ 10 %                         |          | 1.62 $\pm$ 10 %               |          |
| 2300             | 52.9 $\pm$ 10 %                         |          | 1.81 $\pm$ 10 %               |          |
| 2450             | 52.7 $\pm$ 10 %                         |          | 1.95 $\pm$ 10 %               |          |
| 2600             | 52.5 $\pm$ 10 %                         | 52.7     | 2.16 $\pm$ 10 %               | 2.36     |
| 3000             | 52.0 $\pm$ 10 %                         |          | 2.73 $\pm$ 10 %               |          |
| 3300             | 51.6 $\pm$ 10 %                         |          | 3.08 $\pm$ 10 %               |          |
| 3500             | 51.3 $\pm$ 10 %                         |          | 3.31 $\pm$ 10 %               |          |
| 3700             | 51.0 $\pm$ 10 %                         |          | 3.55 $\pm$ 10 %               |          |
| 3900             | 50.8 $\pm$ 10 %                         |          | 3.78 $\pm$ 10 %               |          |
| 4200             | 50.4 $\pm$ 10 %                         |          | 4.13 $\pm$ 10 %               |          |
| 4600             | 49.8 $\pm$ 10 %                         |          | 4.60 $\pm$ 10 %               |          |
| 4900             | 49.4 $\pm$ 10 %                         |          | 4.95 $\pm$ 10 %               |          |
| 5200             | 49.0 $\pm$ 10 %                         |          | 5.30 $\pm$ 10 %               |          |
| 5300             | 48.9 $\pm$ 10 %                         |          | 5.42 $\pm$ 10 %               |          |
| 5400             | 48.7 $\pm$ 10 %                         |          | 5.53 $\pm$ 10 %               |          |
| 5500             | 48.6 $\pm$ 10 %                         |          | 5.65 $\pm$ 10 %               |          |
| 5600             | 48.5 $\pm$ 10 %                         |          | 5.77 $\pm$ 10 %               |          |
| 5800             | 48.2 $\pm$ 10 %                         |          | 6.00 $\pm$ 10 %               |          |

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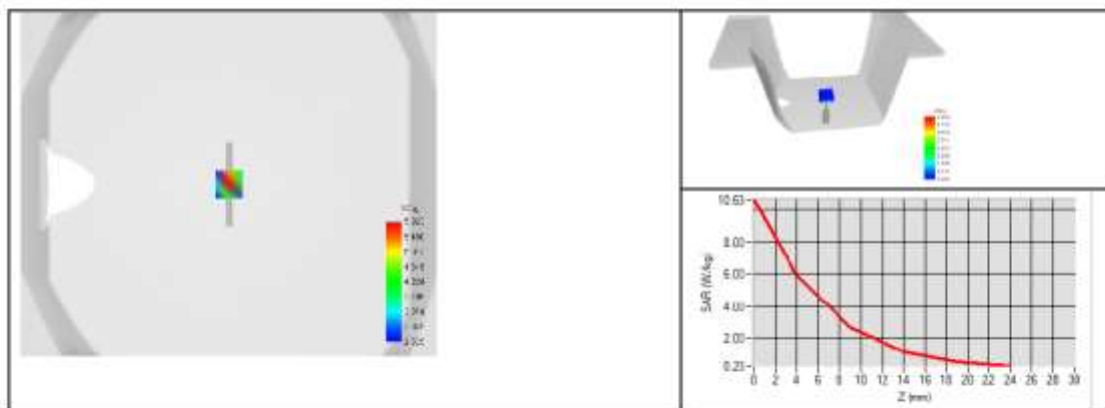
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7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                                             |
|-------------------------------------------|-------------------------------------------------------------|
| Software                                  | OPENSAR V5                                                  |
| Phantom                                   | SN 13/09 SAM68                                              |
| Probe                                     | SN 41/18 EPG0333                                            |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}' : 52.7$ $\sigma : 2.36$ |
| 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                                 | 2600 MHz                                                    |
| Input power                               | 20 dBm                                                      |
| Liquid Temperature                        | 20 +/- 1 °C                                                 |
| Lab Temperature                           | 20 +/- 1 °C                                                 |
| Lab Humidity                              | 30-70 %                                                     |

| Frequency<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 2600             | 55.37 (5.54)     | 23.26 (2.33)      |





## 8 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             | 05/2019                                       | 05/2022                                       |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223             | 05/2019                                       | 05/2022                                       |
| Calipers                           | Mitutoyo                | SN 0009732         | 10/2019                                       | 10/2022                                       |
| Reference Probe                    | MVG                     | EPGO333 SN 41/18   | 05/2020                                       | 05/2021                                       |
| Multimeter                         | Keithley 2000           | 1160271            | 02/2020                                       | 02/2023                                       |
| Signal Generator                   | Rohde & Schwarz SMB     | 106589             | 04/2019                                       | 04/2022                                       |
| Amplifier                          | Aethercomm              | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                        | NI-USB 5680             | 170100013          | 05/2019                                       | 05/2022                                       |
| Directional Coupler                | Narda 4216-20           | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor      | Testo 184 H1            | 44220687           | 05/2020                                       | 05/2023                                       |

## Dipole Impedance and Return Loss calibration Report

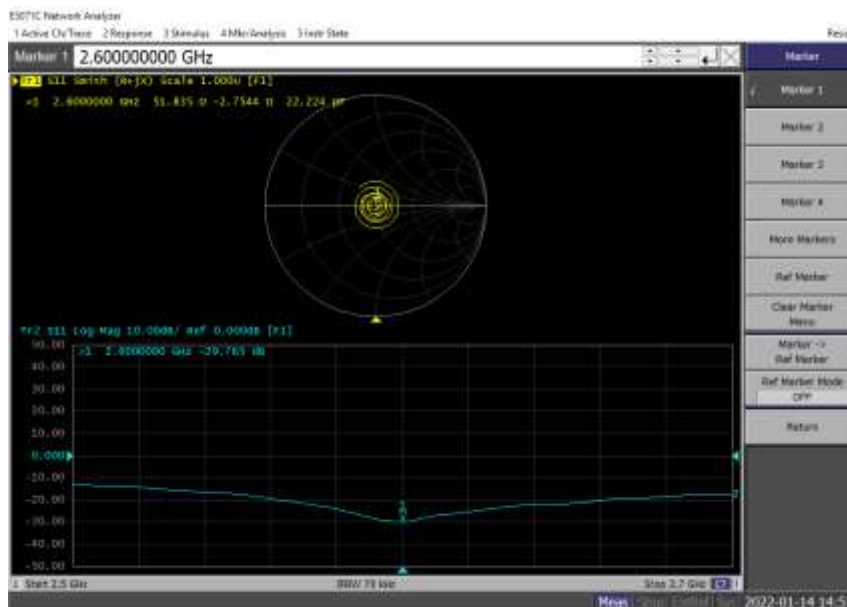
**Object:** SID2600 - SN 50/20 DIP 2G600-515  
**Calibration Date:** January 14, 2022  
**Calibration reference:** IEEE Std 1528:2013, IEC 62209-1:2016, FCC KDB 865664 D01  
**Calibrated By:** *Janet Wei* (Janet Wei, SAR project engineer)  
**Reviewed By:** *Winner Zhang* (Winner Zhang, Technical manager)

### Environment of Test Site

|                       |           |
|-----------------------|-----------|
| Temperature:          | 18 ~ 25°C |
| Humidity:             | 50~60% RH |
| Atmospheric Pressure: | 1011 mbar |

### Test Data

Measurement Plot for Head TSL In 2022



### Comparison with Original report

| Items                    | Calibrated By MVG | Calibrated By JYT In 2022 | Deviation    | Limit                    |
|--------------------------|-------------------|---------------------------|--------------|--------------------------|
| Impendence for Head TSL  | 48.6Ω-2.1jΩ       | 51.84Ω-2.75jΩ             | 3.24Ω-0.65jΩ | ±5Ω                      |
| Return Loss for Head TSL | -29.30dB          | -29.77dB                  | 1.60%        | ±20%(No less than 20 dB) |

### Result

Compliance



## SAR Reference Dipole Calibration Report

Ref : ACR.15.22.21.MVGB.B

Cancel and replace the report ACR.15.22.21.MVGB.A

**JIANYAN TESTING GROUP  
SHENZHEN CO.,LTD.**  
No.110~116, BUILDING B, JINYUAN BUSINESS BUILDING,  
XIXIANG ROAD, BAOAN DISTRICT,  
SHENZHEN, GUANGDONG, PR CHINA  
**MVG COMOSAR REFERENCE DIPOLE**  
FREQUENCY: 5200-5800 MHZ  
SERIAL NO.: SN 50/20 DIP 5G000-523

**Calibrated at MVG**  
**Z.I. de la pointe du diable**  
**Technopôle Brest Iroise – 295 avenue Alexis de Rochon**  
**29280 PLOUZANE - FRANCE**

**Calibration date: 01/14/2021**



Accreditations #2-6789 and #2-6814  
Scope available on [www.cofrac.fr](http://www.cofrac.fr)

### *Summary:*

This document presents the method and results from an accredited SAR reference dipole calibration performed at MVG, using the COMOSAR test bench. The test results covered by accreditation are traceable to the International System of Units (SI).



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.15.22.20.MVGB.B

|                      | <i>Name</i>  | <i>Function</i>     | <i>Date</i> | <i>Signature</i>    |
|----------------------|--------------|---------------------|-------------|---------------------|
| <i>Prepared by :</i> | Jérôme LUC   | Technical Manager   | 1/15/2021   | <i>JL</i>           |
| <i>Checked by :</i>  | Jérôme LUC   | Technical Manager   | 1/15/2021   | <i>JL</i>           |
| <i>Approved by :</i> | Yann Toutain | Laboratory Director | 2/8/2021    | <i>Yann Toutain</i> |

Signature

2021.02.08  
18:03:01+01'00'

IMB/170

|                       | <i>Customer Name</i>                          |
|-----------------------|-----------------------------------------------|
| <i>Distribution :</i> | JianYan Testing<br>Group Shenzhen<br>Co.,Ltd. |

| <i>Issue</i> | <i>Name</i> | <i>Date</i> | <i>Modifications</i>         |
|--------------|-------------|-------------|------------------------------|
| A            | Jérôme LUC  | 1/15/2021   | Initial release              |
| B            | Jérôme LUC  | 2/8/2021    | Change customer name/address |
|              |             |             |                              |
|              |             |             |                              |



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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 5200-5800 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                                    |
| Model                          | SID5000                                |
| Serial Number                  | SN 50/20 DIP 5G000-523                 |
| Product Condition (new / used) | New                                    |

## 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. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

##### 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 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.

#### 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    | 0.08 LIN                            |

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

| Length (mm) | Expanded Uncertainty on Length |
|-------------|--------------------------------|
| 0 - 300     | 0.20 mm                        |

##### 5.3 VALIDATION MEASUREMENT

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

| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
| 1 g         | 19 % (SAR)           |
| 10 g        | 19 % (SAR)           |

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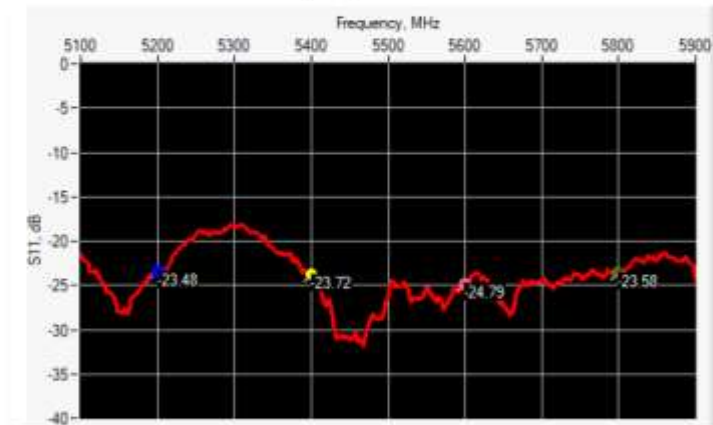
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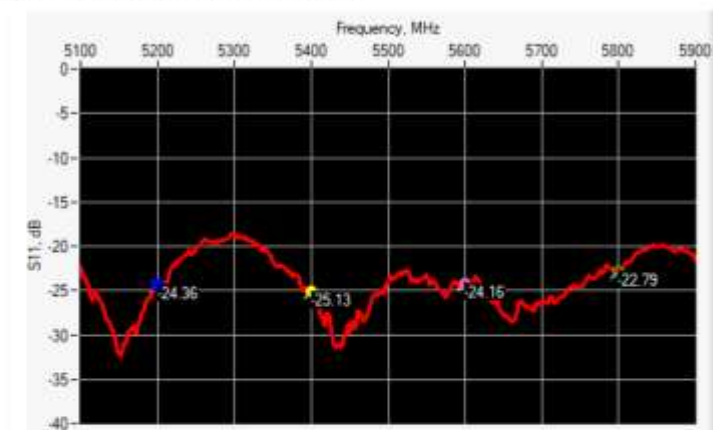
## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                     |
|-----------------|------------------|------------------|-------------------------------|
| 5200            | -23.48           | -20              | $46.37 \Omega - 5.61 j\Omega$ |
| 5400            | -23.72           | -20              | $48.57 \Omega + 6.35 j\Omega$ |
| 5600            | -24.79           | -20              | $45.54 \Omega + 3.63 j\Omega$ |
| 5800            | -23.58           | -20              | $45.27 \Omega + 4.61 j\Omega$ |

### 6.2 RETURN LOSS IN BODY LIQUID





**SAR REFERENCE DIPOLE CALIBRATION REPORT**

Ref: ACR.15.22.20.MVGB.B

| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                     |
|-----------------|------------------|------------------|-------------------------------|
| 5200            | -24.36           | -20              | $45.10 \Omega - 3.52 j\Omega$ |
| 5400            | -25.13           | -20              | $48.91 \Omega + 5.42 j\Omega$ |
| 5600            | -24.16           | -20              | $46.63 \Omega + 5.18 j\Omega$ |
| 5800            | -22.79           | -20              | $44.74 \Omega + 4.95 j\Omega$ |

### 6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm     |          | h mm      |          | d mm     |          |
|---------------|----------|----------|-----------|----------|----------|----------|
|               | required | measured | required  | measured | required | measured |
| 5000 to 6000  | 20.6±1 % | 20.64    | 40.3 ±1 % | 40.09    | 3.6 ±1 % | 3.60     |

## 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 MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|---------------|-----------------------------------------|----------|-------------------------------|----------|
|               | required                                | measured | required                      | measured |
| 5000          | 36.2 ±10 %                              |          | 4.45 ±10 %                    |          |
| 5100          | 36.1 ±10 %                              |          | 4.56 ±10 %                    |          |
| 5200          | 36.0 ±10 %                              | 34.06    | 4.66 ±10 %                    | 4.70     |
| 5300          | 35.9 ±10 %                              |          | 4.76 ±10 %                    |          |
| 5400          | 35.8 ±10 %                              | 33.39    | 4.86 ±10 %                    | 4.91     |
| 5500          | 35.6 ±10 %                              |          | 4.97 ±10 %                    |          |
| 5600          | 35.5 ±10 %                              | 32.77    | 5.07 ±10 %                    | 5.13     |
| 5700          | 35.4 ±10 %                              |          | 5.17 ±10 %                    |          |
| 5800          | 35.3 ±10 %                              | 32.40    | 5.27 ±10 %                    | 5.34     |
| 5900          | 35.2 ±10 %                              |          | 5.38 ±10 %                    |          |
| 6000          | 35.1 ±10 %                              |          | 5.48 ±10 %                    |          |

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## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

At those frequencies, the target SAR value can not be generic. Hereunder is the target SAR value defined by MVG, within the uncertainty for the system validation. All SAR values are normalized to 1 W net power. In bracket, the measured SAR is given with the used input power.

|                                    |                                                                                                                                                                                                                              |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Software                           | OPENSAR V5                                                                                                                                                                                                                   |
| Phantom                            | SN 13/09 SAM68                                                                                                                                                                                                               |
| Probe                              | SN 41/18 EPG0333                                                                                                                                                                                                             |
| Liquid                             | Head Liquid Values 5200 MHz: eps':34.06 sigma : 4.70<br>Head Liquid Values 5400 MHz: eps':33.39 sigma : 4.91<br>Head Liquid Values 5600 MHz: eps':32.77 sigma : 5.13<br>Head Liquid Values 5800 MHz: eps':32.40 sigma : 5.34 |
| Distance between dipole and liquid | 10 mm                                                                                                                                                                                                                        |
| Area scan resolution               | dx=8mm/dy=8mm                                                                                                                                                                                                                |
| Zoon Scan Resolution               | dx=4mm/dy=4m/dz=2mm                                                                                                                                                                                                          |
| Frequency                          | 5200 MHz<br>5400 MHz<br>5600 MHz<br>5800 MHz                                                                                                                                                                                 |
| Input power                        | 20 dBm                                                                                                                                                                                                                       |
| Liquid Temperature                 | 20 +/- 1 °C                                                                                                                                                                                                                  |
| Lab Temperature                    | 20 +/- 1 °C                                                                                                                                                                                                                  |
| Lab Humidity                       | 30-70 %                                                                                                                                                                                                                      |

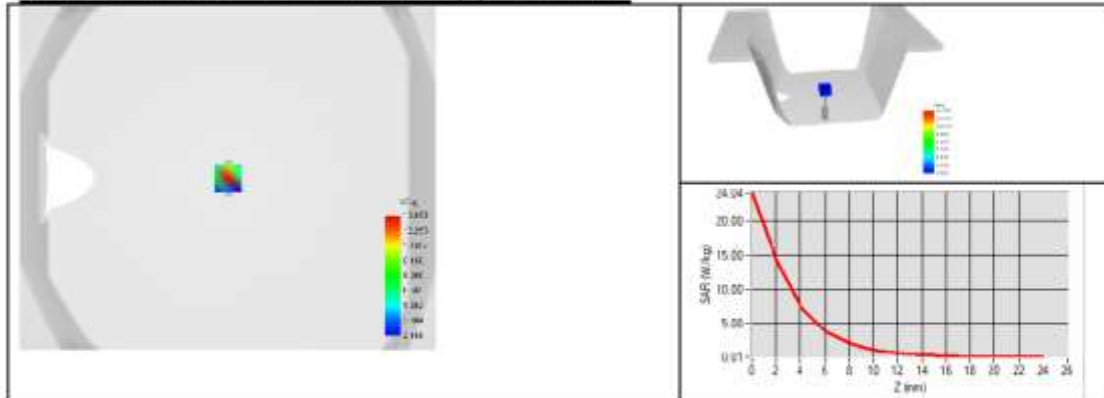
| Frequency (MHz) | 1 g SAR (W/kg) |              | 10 g SAR (W/kg) |              |
|-----------------|----------------|--------------|-----------------|--------------|
|                 | required       | measured     | required        | measured     |
| 5200            | 76.50          | 76.67 (7.67) | 21.60           | 22.60 (2.26) |
| 5400            | -              | 82.01 (8.20) | -               | 23.97 (2.40) |
| 5600            | -              | 77.76 (7.78) | -               | 23.08 (2.31) |
| 5800            | 78.00          | 78.36 (7.84) | 21.90           | 22.93 (2.29) |



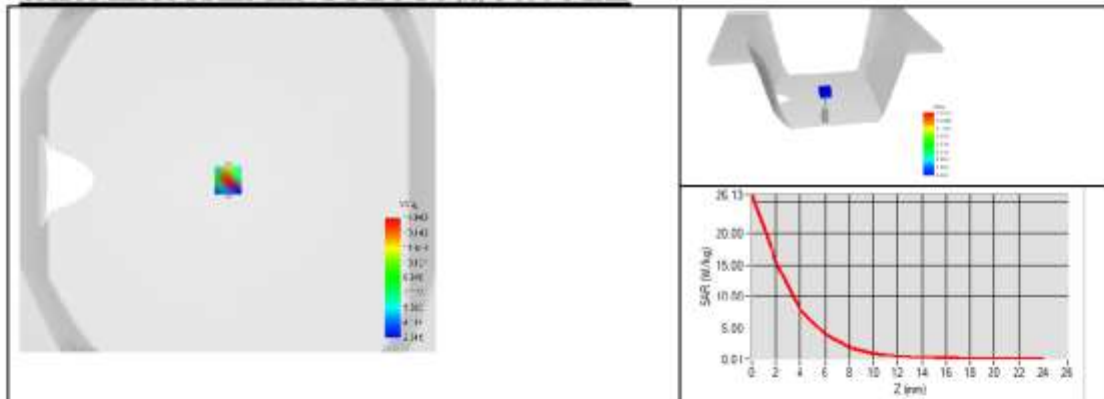
**SAR REFERENCE DIPOLE CALIBRATION REPORT**

Ref: ACR.15.22.20.MVGB.B

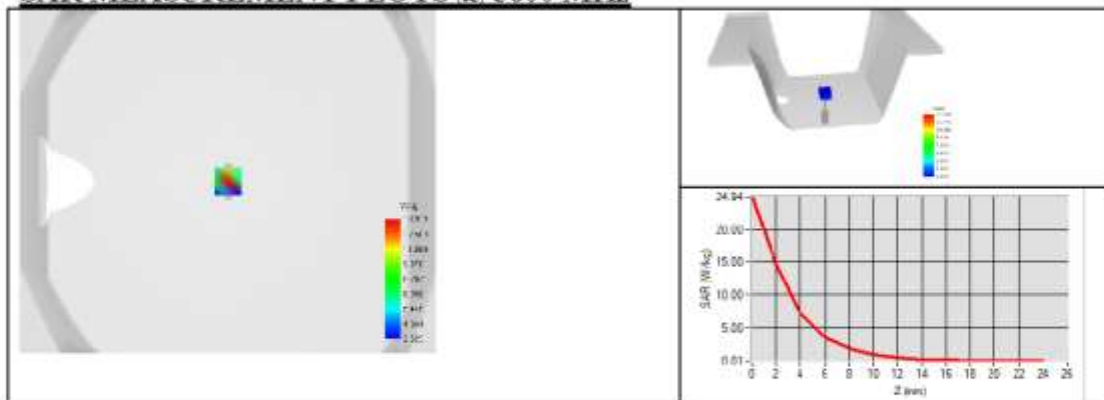
**SAR MEASUREMENT PLOTS @ 5200 MHz**



**SAR MEASUREMENT PLOTS @ 5400 MHz**



**SAR MEASUREMENT PLOTS @ 5600 MHz**



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*Template: ACR.DDD.N.YY.MVGB.ISSUE\_SAR Reference Dipole5GHz\_vA*

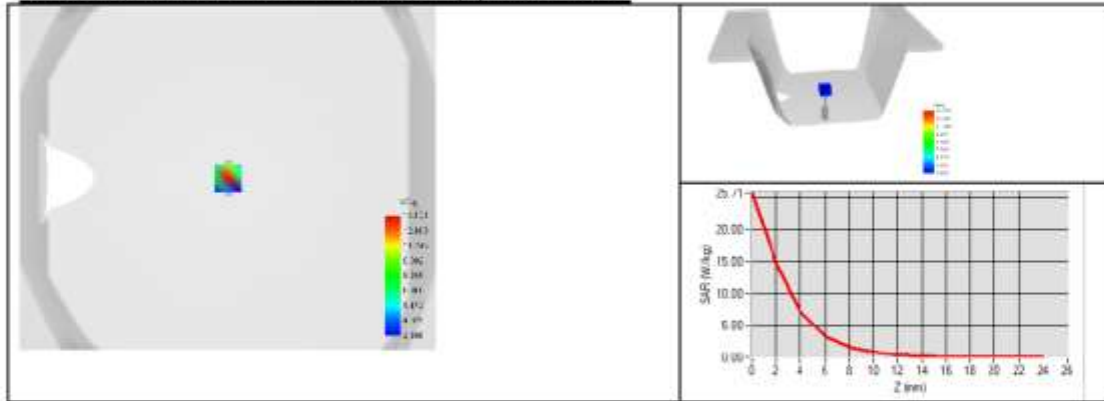
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SAR REFERENCE DIPOLE CALIBRATION REPORT

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**SAR MEASUREMENT PLOTS @ 5800 MHz**



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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.15.22.20.MVGB.B

### 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 5200             | 49.0 $\pm$ 10 %                         | 45.50    | 5.30 $\pm$ 10 %               | 5.63     |
| 5300             | 48.9 $\pm$ 10 %                         |          | 5.42 $\pm$ 10 %               |          |
| 5400             | 48.7 $\pm$ 10 %                         | 44.78    | 5.53 $\pm$ 10 %               | 5.95     |
| 5500             | 48.6 $\pm$ 10 %                         |          | 5.65 $\pm$ 10 %               |          |
| 5600             | 48.5 $\pm$ 10 %                         | 44.85    | 5.77 $\pm$ 10 %               | 6.26     |
| 5800             | 48.2 $\pm$ 10 %                         | 44.45    | 6.00 $\pm$ 10 %               | 6.58     |

### 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                    |                                                                                                                                                                                                                                                                      |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Software                           | OPENSAR V5                                                                                                                                                                                                                                                           |
| Phantom                            | SN 13/09 SAM68                                                                                                                                                                                                                                                       |
| Probe                              | SN 41/18 EPG0333                                                                                                                                                                                                                                                     |
| Liquid                             | Body Liquid Values 5200 MHz: $\epsilon_r'$ :45.50 sigma : 5.63<br>Body Liquid Values 5400 MHz: $\epsilon_r'$ :44.78 sigma : 5.95<br>Body Liquid Values 5600 MHz: $\epsilon_r'$ :44.85 sigma : 6.26<br>Body Liquid Values 5800 MHz: $\epsilon_r'$ :44.45 sigma : 6.58 |
| Distance between dipole and liquid | 10 mm                                                                                                                                                                                                                                                                |
| Area scan resolution               | dx=8mm/dy=8mm                                                                                                                                                                                                                                                        |
| Zoon Scan Resolution               | dx=4mm/dy=4m/dz=2mm                                                                                                                                                                                                                                                  |
| Frequency                          | 5200 MHz<br>5400 MHz<br>5600 MHz<br>5800 MHz                                                                                                                                                                                                                         |
| Input power                        | 20 dBm                                                                                                                                                                                                                                                               |
| Liquid Temperature                 | 20 $\pm$ 1 $^{\circ}$ C                                                                                                                                                                                                                                              |
| Lab Temperature                    | 20 $\pm$ 1 $^{\circ}$ C                                                                                                                                                                                                                                              |
| Lab Humidity                       | 30-70 %                                                                                                                                                                                                                                                              |

| Frequency (MHz) | 1 g SAR (W/kg) | 10 g SAR (W/kg) |
|-----------------|----------------|-----------------|
|                 | measured       | measured        |
| 5200            | 71.91 (7.19)   | 21.26 (2.13)    |
| 5400            | 76.01 (7.60)   | 22.21 (2.22)    |
| 5600            | 76.61 (7.66)   | 22.53 (2.25)    |
| 5800            | 72.55 (7.25)   | 21.08 (2.11)    |

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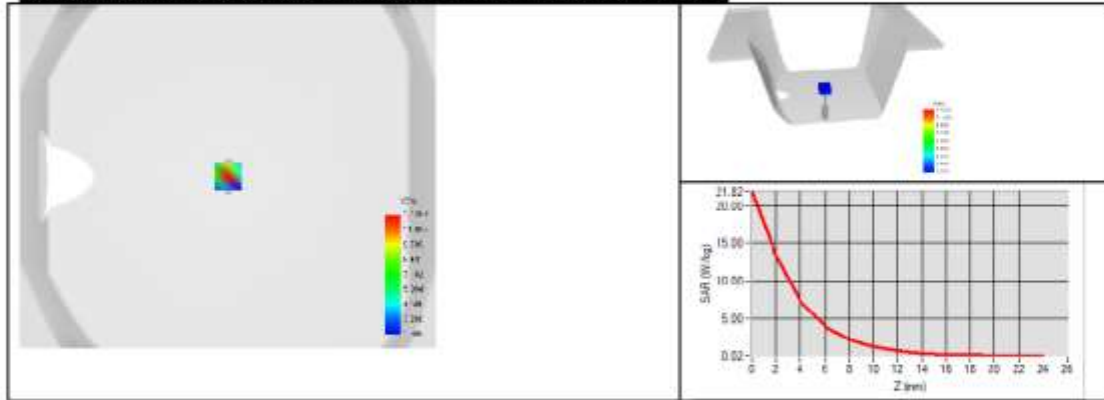
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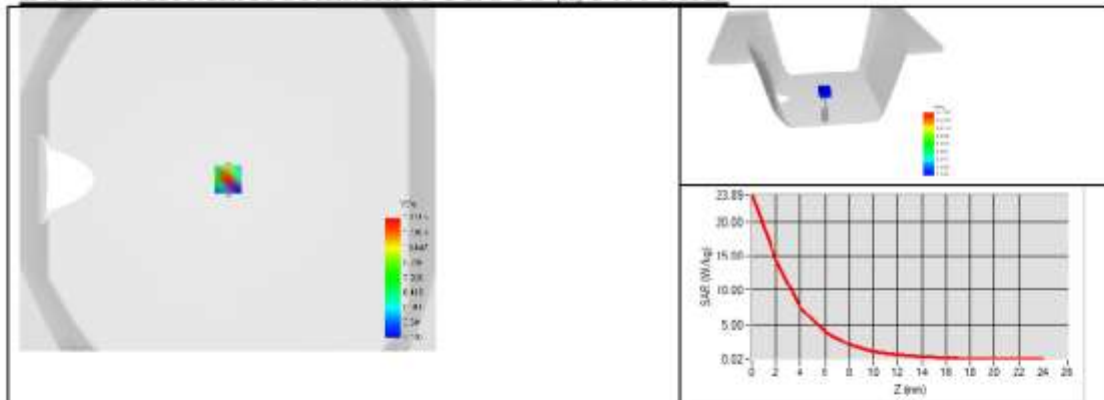
**SAR REFERENCE DIPOLE CALIBRATION REPORT**

Ref: ACR.15.22.20.MVGB.B

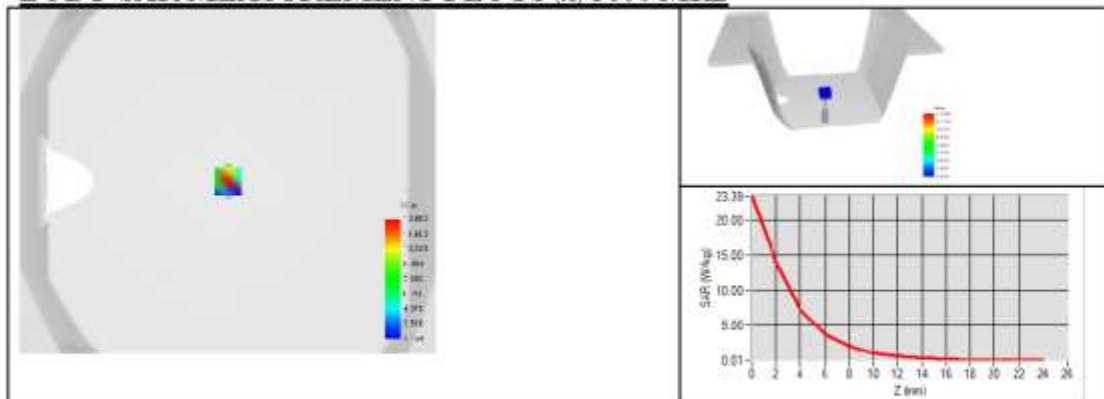
**BODY SAR MEASUREMENT PLOTS @ 5200 MHz**



**BODY SAR MEASUREMENT PLOTS @ 5400 MHz**



**BODY SAR MEASUREMENT PLOTS @ 5600 MHz**

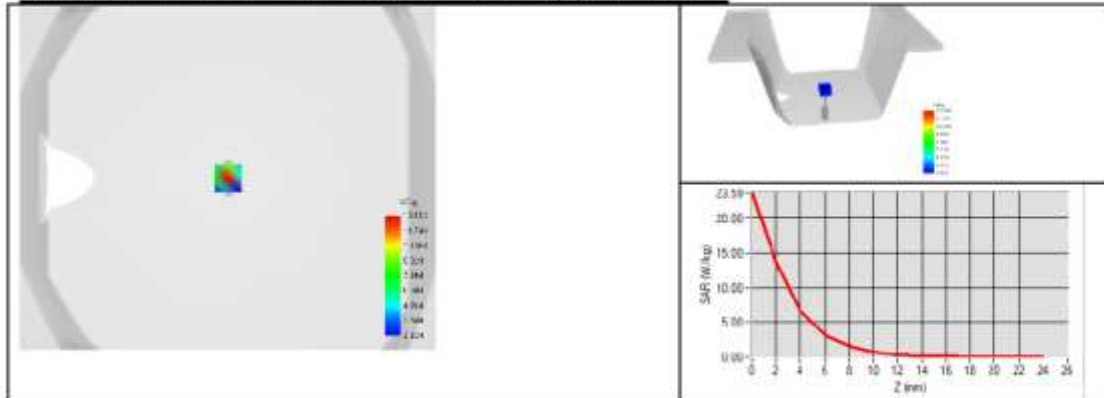




SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.15.22.20.MVGB.B

**BODY SAR MEASUREMENT PLOTS @ 5800 MHz**





## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR 15.22.20 MVGB B

## 8 LIST OF EQUIPMENT

| Equipment Summary Sheet            |                         |                    |                                               |                                               |
|------------------------------------|-------------------------|--------------------|-----------------------------------------------|-----------------------------------------------|
| Equipment Description              | Manufacturer / Model    | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| Flat 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             | 05/2019                                       | 05/2022                                       |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223             | 05/2019                                       | 05/2022                                       |
| Calipers                           | Mitutoyo                | SN 0009732         | 10/2019                                       | 10/2022                                       |
| Reference Probe                    | MVG                     | EPGO333 SN 41/18   | 05/2020                                       | 05/2021                                       |
| Multimeter                         | Keithley 2000           | 1160271            | 02/2020                                       | 02/2023                                       |
| Signal Generator                   | Rohde & Schwarz SMB     | 106589             | 04/2019                                       | 04/2022                                       |
| Amplifier                          | Aethercomm              | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                        | NI-USB 5680             | 170100013          | 05/2019                                       | 05/2022                                       |
| Directional Coupler                | Narda 4216-20           | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature and Humidity Sensor    | Testo 184 H1            | 44220687           | 05/2020                                       | 05/2023                                       |

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## Dipole Impedance and Return Loss calibration Report

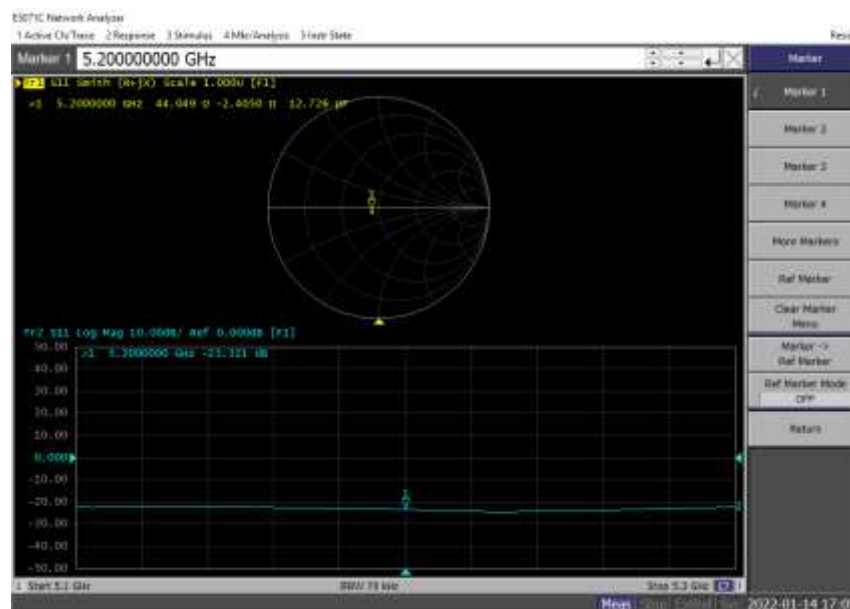
**Object:** SID5000 - SN 50/20 DIP 5G000-523  
**Calibration Date:** January 14, 2022  
**Calibration reference:** IEEE Std 1528:2013, IEC 62209-1:2016, FCC KDB 865664 D01  
**Calibrated By:** *Janet Wei* (Janet Wei, SAR project engineer)  
**Reviewed By:** *Winner Zhang* (Winner Zhang, Technical manager)

### Environment of Test Site

|                       |           |
|-----------------------|-----------|
| Temperature:          | 18 ~ 25°C |
| Humidity:             | 50~60% RH |
| Atmospheric Pressure: | 1011 mbar |

### Test Data

Measurement Plot for Head TSL In 2022

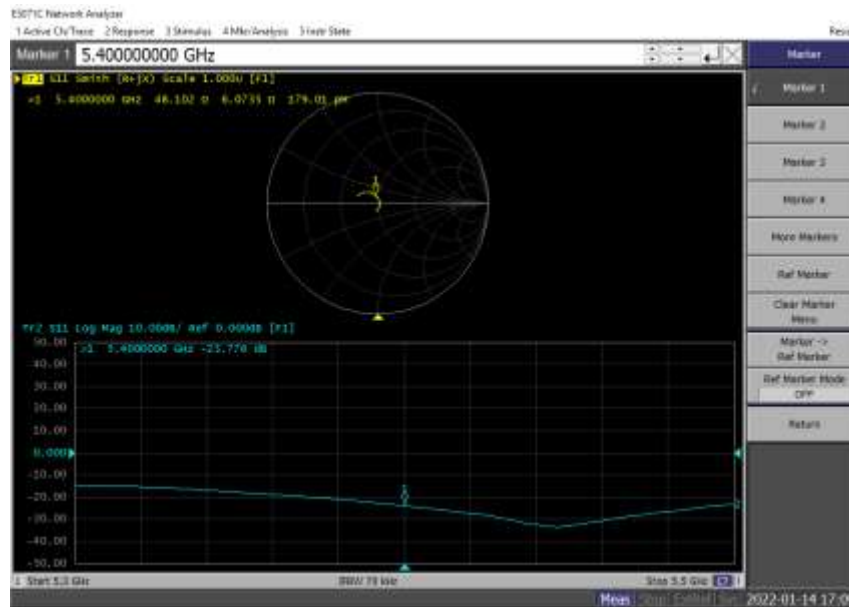


### Comparison with Original report

| Items                    | Calibrated By MVG | Calibrated By JYT In 2022 | Deviation    | Limit                    |
|--------------------------|-------------------|---------------------------|--------------|--------------------------|
| Impedence for Head TSL   | 46.37-5.61jΩ      | 44.05Ω-2.41jΩ             | -2.32Ω+3.2jΩ | ±5Ω                      |
| Return Loss for Head TSL | -23.48dB          | -23.32dB                  | -0.68%       | ±20%(No less than 20 dB) |

### Result

Compliance

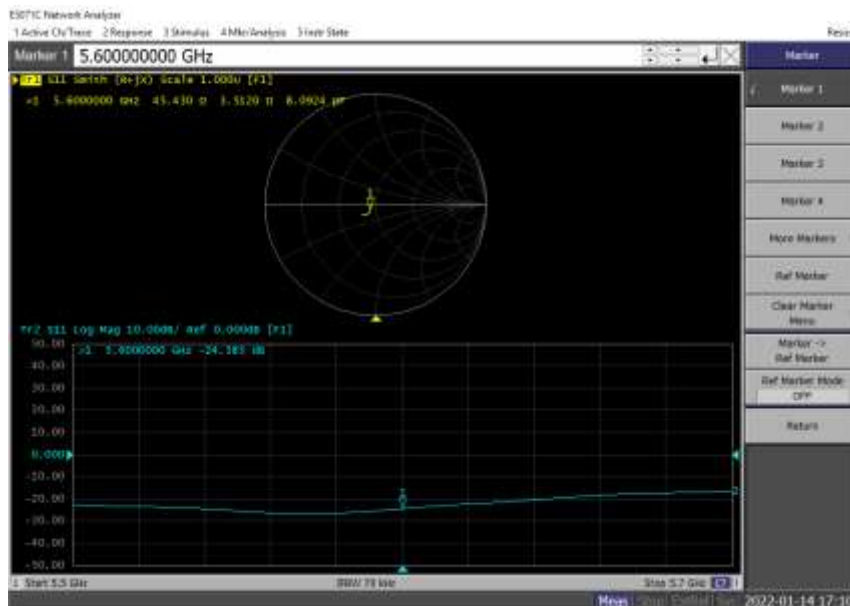


### Comparison with Original report

| Items                    | Calibrated By MVG | Calibrated By JYT<br>In 2022 | Deviation     | Limit                    |
|--------------------------|-------------------|------------------------------|---------------|--------------------------|
| Impedence for Head TSL   | 48.57+6.35jΩ      | 48.10Ω+6.07jΩ                | -0.47Ω-0.28jΩ | ±5Ω                      |
| Return Loss for Head TSL | -23.72dB          | -23.78dB                     | 0.25%         | ±20%(No less than 20 dB) |

### Result

Compliance



### Comparison with Original report

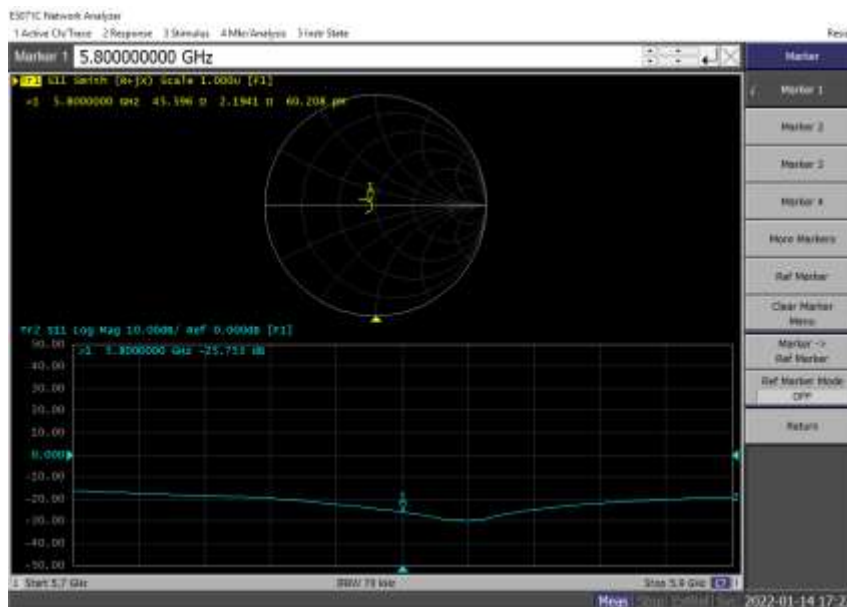
| Items                    | Calibrated By MVG | Calibrated By JYT<br>In 2022 | Deviation     | Limit                    |
|--------------------------|-------------------|------------------------------|---------------|--------------------------|
| Impedence for Head TSL   | 45.54+3.63jΩ      | 45.43Ω+3.51jΩ                | -0.11Ω-0.12jΩ | ±5Ω                      |
| Return Loss for Head TSL | -23.72dB          | -24.39dB                     | 2.82%         | ±20%(No less than 20 dB) |

### Result

Compliance

## Test Data

### Measurement Plot for Head TSL In 2022



### Comparison with Original report

| Items                    | Calibrated By MVG | Calibrated By JYT<br>In 2022 | Deviation    | Limit                    |
|--------------------------|-------------------|------------------------------|--------------|--------------------------|
| Impedence for Head TSL   | 45.27+4.61jΩ      | 45.60Ω+2.19jΩ                | 0.33Ω-2.42jΩ | ±5Ω                      |
| Return Loss for Head TSL | -23.58dB          | -25.75dB                     | 9.20%        | ±20%(No less than 20 dB) |

## Result

Compliance

-----End of Report-----