



## SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.138.4.33..SATU.A

## 1 INTRODUCTION

This document contains a summary of the suggested methods and requirements set forth by the IEEE 1528 and CEI/IEC 62209 standards for liquid permittivity measurements and the measurements that were performed to verify that the product complies with the fore mentioned standards.

## 2 DEVICE UNDER TEST

| Device Under Test              |                          |
|--------------------------------|--------------------------|
| Device Type                    | LIMESAR DIELECTRIC PROBE |
| Manufacturer                   | MVG                      |
| Model                          | SCLMP                    |
| Serial Number                  | SN 19/15 OCPG 71         |
| Product Condition (new / used) | Used                     |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

MVG's Dielectric Probes are built in accordance to the IEEE 1528 and CEI/IEC 62209 standards. The product is designed for use with the LIMESAR test bench only.



Figure 1 – MVG LIMESAR Dielectric Probe

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#### 4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209-1 & 2 standards outline techniques for dielectric property measurements. The LIMESAR test bench employs one of the methods outlined in the standards, using a contact probe or open-ended coaxial transmission-line probe and vector network analyzer. The standards recommend the measurement of two reference materials that have well established and stable dielectric properties to validate the system, one for the calibration and one for checking the calibration. The LIMESAR test bench uses De-ionized water as the reference for the calibration and either DMS or Methanol as the reference for checking the calibration. The following measurements were performed to verify that the product complies with the fore mentioned standards.

##### 4.1 LIQUID PERMITTIVITY MEASUREMENTS

The permittivity of a liquid with well established dielectric properties was measured and the measurement results compared to the values provided in the fore mentioned standards.

#### 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 DIELECTRIC PERMITTIVITY MEASUREMENT

The following uncertainties apply to the Dielectric Permittivity measurement:

| Uncertainty analysis of Permittivity Measurement      |                           |                          |            |    |                              |
|-------------------------------------------------------|---------------------------|--------------------------|------------|----|------------------------------|
| ERROR SOURCES                                         | Uncertainty value (+/- %) | Probability Distribution | Divisor    | ci | Standard Uncertainty (+/- %) |
| Repeatability (n repeats, mid-band)                   | 4.00%                     | N                        | 1          | 1  | 4.000%                       |
| Deviation from reference liquid                       | 5.00%                     | R                        | $\sqrt{3}$ | 1  | 2.887%                       |
| Network analyser-drift, linearity                     | 2.00%                     | R                        | $\sqrt{3}$ | 1  | 1.155%                       |
| Test-port cable variations                            | 0.00%                     | U                        | $\sqrt{2}$ | 1  | 0.000%                       |
| Combined standard uncertainty                         |                           |                          |            |    | 5.066%                       |
| Expanded uncertainty (confidence level of 95%, k = 2) |                           |                          |            |    | 10.0%                        |

| Uncertainty analysis of Conductivity Measurement      |                           |                          |            |    |                              |
|-------------------------------------------------------|---------------------------|--------------------------|------------|----|------------------------------|
| ERROR SOURCES                                         | Uncertainty value (+/- %) | Probability Distribution | Divisor    | ci | Standard Uncertainty (+/- %) |
| Repeatability (n repeats, mid-band)                   | 3.50%                     | N                        | 1          | 1  | 3.500%                       |
| Deviation from reference liquid                       | 3.00%                     | R                        | $\sqrt{3}$ | 1  | 1.732%                       |
| Network analyser-drift, linearity                     | 2.00%                     | R                        | $\sqrt{3}$ | 1  | 1.155%                       |
| Test-port cable variations                            | 0.00%                     | U                        | $\sqrt{2}$ | 1  | 0.000%                       |
| Combined standard uncertainty                         |                           |                          |            |    | 4.072%                       |
| Expanded uncertainty (confidence level of 95%, k = 2) |                           |                          |            |    | 8.1%                         |

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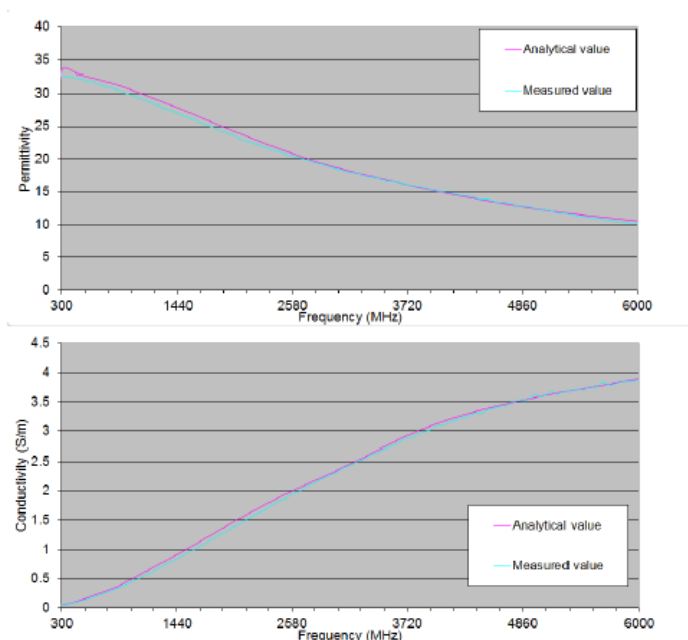
### 6 CALIBRATION MEASUREMENT RESULTS

#### Measurement Condition

|                    |         |
|--------------------|---------|
| Software           | LIMESAR |
| Liquid Temperature | 21°C    |
| Lab Temperature    | 21°C    |
| Lab Humidity       | 44%     |

#### 6.1 LIQUID PERMITTIVITY MEASUREMENT

A liquid of known characteristics (methanol at 20°C) is measured with the probe and the results (complex permittivity  $\epsilon' + j\epsilon''$ ) are compared with the well-known theoretical values for this liquid.



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### 7 LIST OF EQUIPMENT

| Equipment Summary Sheet         |                      |                    |                             |                             |
|---------------------------------|----------------------|--------------------|-----------------------------|-----------------------------|
| Equipment Description           | Manufacturer / Model | Identification No. | Current Calibration Date    | Next Calibration Date       |
| LIMESAR Test Bench              | Version 3            | NA                 | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer                | Rhode & Schwarz ZVA  | SN100132           | 02/2021                     | 02/2024                     |
| Methanol CAS 67-56-1            | Alpha Aesar          | Lot D13W011        | Validated. No cal required. | Validated. No cal required. |
| Temperature and Humidity Sensor | Control Company      | 11-661-9           | 09/2021                     | 09/2022                     |

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## Appendix D: Dipole Calibration Report

SID750





## SAR Reference Dipole Calibration Report

Ref : ACR.156.3.15.SATU.A

**SHENZHEN TCT TESTING TECHNOLOGY CO., LTD**

**2101&2201, ZHENCHANG FACTORY, RENSHAN  
INDUSTRIAL ZONE, FUHAI SUBDISTRICT, BAOAN  
DISTRICT, SHENZHEN, GUANGDONG, 518103,  
PEOPLES REPUBLIC OF CHINA**

**COMOSAR REFERENCE DIPOLE**

**FREQUENCY: 750 MHZ**

**SERIAL NO.: SN 16/15 DIP 0G750-368**

**Calibrated at MVG US**

**2105 Barrett Park Dr. - Kennesaw, GA 30144**



**Calibration Date: 06/05/2021**

### *Summary:*

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



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.1563.15.SATU.A

|               | Name          | Function        | Date       | Signature            |
|---------------|---------------|-----------------|------------|----------------------|
| Prepared by : | Jérôme LUC    | Product Manager | 06/05/2021 | <i>JS</i>            |
| Checked by :  | Jérôme LUC    | Product Manager | 06/05/2021 | <i>JS</i>            |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 06/05/2021 | <i>Kim Rutkowski</i> |

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

| Issue | Date       | Modifications   |
|-------|------------|-----------------|
| A     | 06/05/2021 | Initial release |
|       |            |                 |
|       |            |                 |
|       |            |                 |



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## 1 INTRODUCTION

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

## 2 DEVICE UNDER TEST

| Device Under Test              |                                  |
|--------------------------------|----------------------------------|
| Device Type                    | COMOSAR 750 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                              |
| Model                          | SID750                           |
| Serial Number                  | SN 16/15 DIP 0G750-368           |
| Product Condition (new / used) | Used                             |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

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



Figure 1 – MVG COMOSAR Validation Dipole



#### 4 MEASUREMENT METHOD

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

##### 4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of  $\geq 15$  dB or better. The return loss measurement shall be performed against a liquid filled flat phantom with the phantom constructed as outlined in the fore mentioned standards.

##### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

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

##### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

##### 5.3 VALIDATION MEASUREMENT

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

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



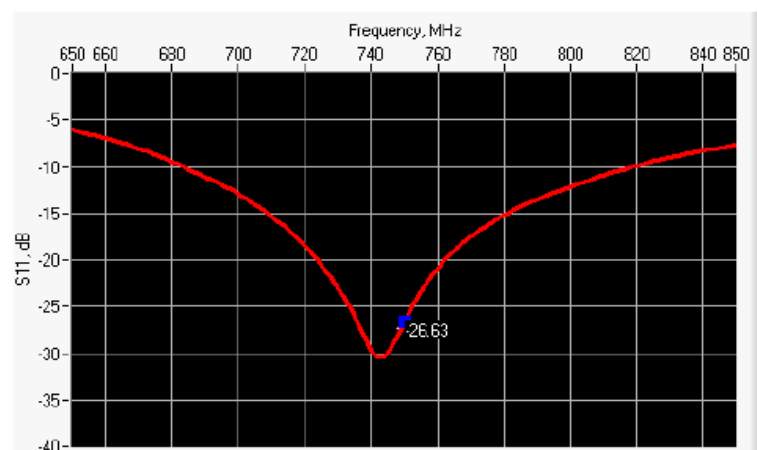
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|      |        |
|------|--------|
| 10 g | 20.1 % |
|------|--------|

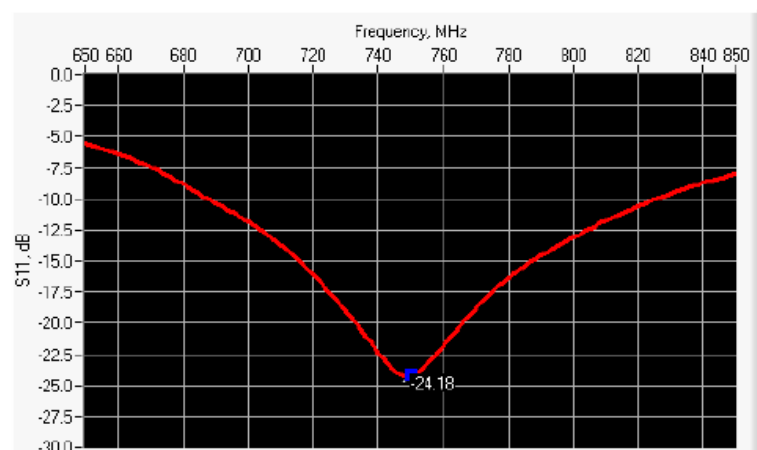
### 6 CALIBRATION MEASUREMENT RESULTS

#### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 750             | -26.63           | -20              | $54.1 \Omega + 1.4 j\Omega$ |

#### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 750             | -24.18           | -20              | $52.4 \Omega + 5.8 j\Omega$ |

#### 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 % |          |

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|      |             |      |             |      |            |      |
|------|-------------|------|-------------|------|------------|------|
| 450  | 290.0 ±1 %. |      | 166.7 ±1 %. |      | 6.35 ±1 %. |      |
| 750  | 176.0 ±1 %. | PASS | 100.0 ±1 %. | PASS | 6.35 ±1 %. | PASS |
| 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 %.  |      | 28.8 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3000 | 41.5 ±1 %.  |      | 25.0 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3500 | 37.0 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3700 | 34.7 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |

## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

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

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

### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

|                                           |                                                            |
|-------------------------------------------|------------------------------------------------------------|
| Software                                  | OPENSAR V4                                                 |
| Phantom                                   | SN 20/09 SAM71                                             |
| Probe                                     | SN 18/11 EPG122                                            |
| Liquid                                    | Head Liquid Values: $\epsilon_{ps}$ : 41.8 $\sigma$ : 0.90 |
| Distance between dipole center and liquid | 15.0 mm                                                    |
| Area scan resolution                      | $dx=8mm/dy=8mm$                                            |
| Zoon Scan Resolution                      | $dx=8mm/dy=8mm/dz=5mm$                                     |
| Frequency                                 | 750 MHz                                                    |
| Input power                               | 20 dBm                                                     |
| Liquid Temperature                        | 21 °C                                                      |
| Lab Temperature                           | 21 °C                                                      |
| Lab Humidity                              | 45 %                                                       |

| Frequency<br>MHz | 1 g SAR (W/kg/W) |             | 10 g SAR (W/kg/W) |             |
|------------------|------------------|-------------|-------------------|-------------|
|                  | required         | measured    | required          | measured    |
| 300              | 2.85             |             | 1.94              |             |
| 450              | 4.58             |             | 3.06              |             |
| 750              | 8.49             | 8.31 (0.73) | 5.55              | 5.71 (0.54) |
| 835              | 9.56             |             | 6.22              |             |
| 900              | 10.9             |             | 6.99              |             |
| 1450             | 29               |             | 16                |             |
| 1500             | 30.5             |             | 16.8              |             |
| 1640             | 34.2             |             | 18.4              |             |
| 1750             | 36.4             |             | 19.3              |             |
| 1800             | 38.4             |             | 20.1              |             |

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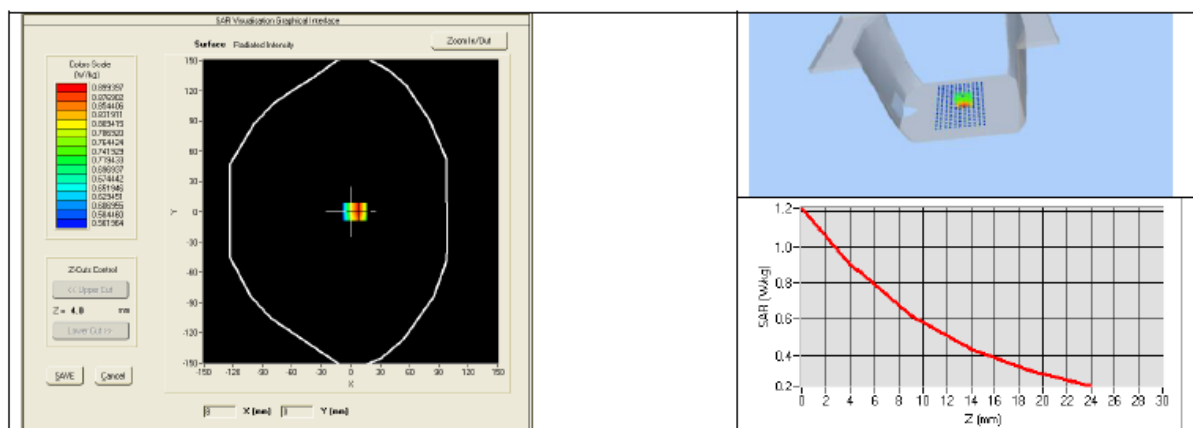
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|      |      |  |      |  |
|------|------|--|------|--|
| 1900 | 39.7 |  | 20.5 |  |
| 1950 | 40.5 |  | 20.9 |  |
| 2000 | 41.1 |  | 21.1 |  |
| 2100 | 43.6 |  | 21.9 |  |
| 2300 | 48.7 |  | 23.3 |  |
| 2450 | 52.4 |  | 24   |  |
| 2600 | 55.3 |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



### 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 $\pm$ 5 %                          |          | 0.80 $\pm$ 5 %                |          |
| 300              | 58.2 $\pm$ 5 %                          |          | 0.92 $\pm$ 5 %                |          |
| 450              | 56.7 $\pm$ 5 %                          |          | 0.94 $\pm$ 5 %                |          |
| 750              | 55.5 $\pm$ 5 %                          | PASS     | 0.96 $\pm$ 5 %                | PASS     |
| 835              | 55.2 $\pm$ 5 %                          |          | 0.97 $\pm$ 5 %                |          |
| 900              | 55.0 $\pm$ 5 %                          |          | 1.05 $\pm$ 5 %                |          |
| 915              | 55.0 $\pm$ 5 %                          |          | 1.06 $\pm$ 5 %                |          |
| 1450             | 54.0 $\pm$ 5 %                          |          | 1.30 $\pm$ 5 %                |          |
| 1610             | 53.8 $\pm$ 5 %                          |          | 1.40 $\pm$ 5 %                |          |
| 1800             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 1900             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 2000             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 2100             | 53.2 $\pm$ 5 %                          |          | 1.62 $\pm$ 5 %                |          |
| 2450             | 52.7 $\pm$ 5 %                          |          | 1.95 $\pm$ 5 %                |          |

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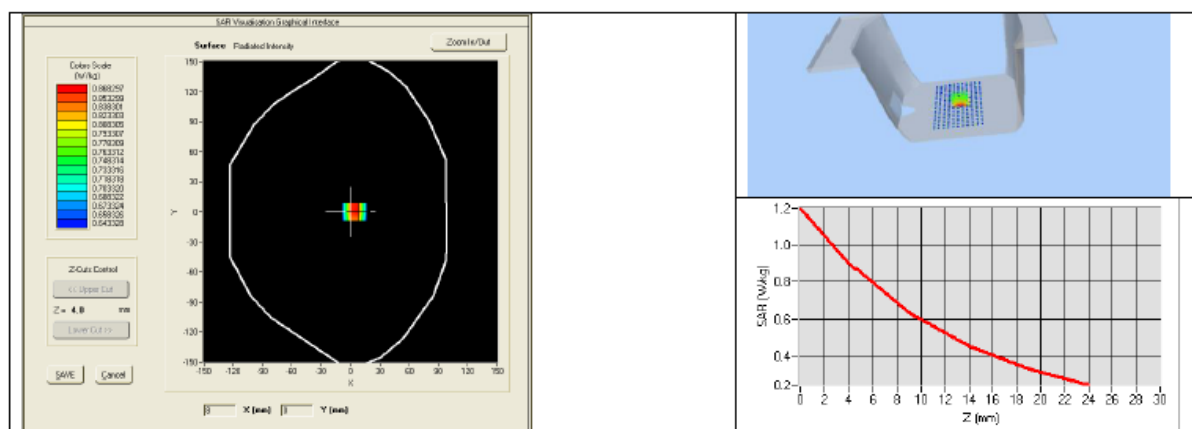
Ref: ACR.156.3.15.SATU.A

|      |            |  |            |  |
|------|------------|--|------------|--|
| 2600 | 52.5 ±5 %  |  | 2.16 ±5 %  |  |
| 3000 | 52.0 ±5 %  |  | 2.73 ±5 %  |  |
| 3500 | 51.3 ±5 %  |  | 3.31 ±5 %  |  |
| 5200 | 49.0 ±10 % |  | 5.30 ±10 % |  |
| 5300 | 48.9 ±10 % |  | 5.42 ±10 % |  |
| 5400 | 48.7 ±10 % |  | 5.53 ±10 % |  |
| 5500 | 48.6 ±10 % |  | 5.65 ±10 % |  |
| 5600 | 48.5 ±10 % |  | 5.77 ±10 % |  |
| 5800 | 48.2 ±10 % |  | 6.00 ±10 % |  |

### 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                                          |
|-------------------------------------------|----------------------------------------------------------|
| Software                                  | OPENSAR V4                                               |
| Phantom                                   | SN 20/09 SAM71                                           |
| Probe                                     | SN 18/11 EPG122                                          |
| Liquid                                    | Body Liquid Values: $\epsilon_s' : 56.3$ $\sigma : 0.98$ |
| Distance between dipole center and liquid | 15.0 mm                                                  |
| Area scan resolution                      | $dx=8mm/dy=8mm$                                          |
| Zoon Scan Resolution                      | $dx=8mm/dy=8mm/dz=5mm$                                   |
| Frequency                                 | 750 MHz                                                  |
| Input power                               | 20 dBm                                                   |
| Liquid Temperature                        | 21 °C                                                    |
| Lab Temperature                           | 21 °C                                                    |
| Lab Humidity                              | 45 %                                                     |

| Frequency<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 750              | 8.46 (0.77)      | 5.81 (0.45)       |



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8 LIST OF EQUIPMENT

| Equipment Summary Sheet         |                      |                    |                                               |                                               |
|---------------------------------|----------------------|--------------------|-----------------------------------------------|-----------------------------------------------|
| Equipment Description           | Manufacturer / Model | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| SAM Phantom                     | MVG                  | SN-20/09-SAM71     | Validated. No cal required.                   | Validated. No cal required.                   |
| COMOSAR Test Bench              | Version 3            | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer                | Rhode & Schwarz ZVA  | SN100132           | 02/2021                                       | 02/2024                                       |
| Calipers                        | Carrera              | CALIPER-01         | 02/2021                                       | 02/2024                                       |
| Reference Probe                 | MVG                  | EPG122 SN 18/11    | 02/2021                                       | 02/2022                                       |
| Multimeter                      | Keithley 2000        | 1188656            | 02/2021                                       | 02/2024                                       |
| Signal Generator                | Agilent E4438C       | MY49070581         | 02/2021                                       | 02/2024                                       |
| Amplifier                       | Aethercomm           | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                     | HP E4418A            | US38261498         | 02/2021                                       | 02/2024                                       |
| Power Sensor                    | HP ECP-E26A          | US37181460         | 02/2021                                       | 02/2024                                       |
| Directional Coupler             | Narda 4216-20        | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature and Humidity Sensor | Control Company      | 11-661-9           | 02/2021                                       | 02/2024                                       |

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## SAR Reference Dipole Calibration Report

Ref : ACR.156.4.15.SATU.A

**SHENZHEN TCT TESTING TECHNOLOGY CO., LTD**

**2101&2201, ZHENCHANG FACTORY, RENSHAN INDUSTRIAL  
ZONE, FUHAI SUBDISTRICT, BAOAN DISTRICT, SHENZHEN  
GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA**

**MVG COMOSAR REFERENCE DIPOLE**

**FREQUENCY: 835 MHZ**

**SERIAL NO.: SN 16/15 DIP 0G835-369**

**Calibrated at MVG US**

**2105 Barrett Park Dr. - Kennesaw, GA 30144**



**Calibration Date: 06/05/2021**

### *Summary:*

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



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.4.15.SATU.A

|               | Name          | Function        | Date       | Signature |
|---------------|---------------|-----------------|------------|-----------|
| Prepared by : | Jérôme LUC    | Product Manager | 06/05/2021 |           |
| Checked by :  | Jérôme LUC    | Product Manager | 06/05/2021 |           |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 06/05/2021 |           |

|                | Customer Name                  |
|----------------|--------------------------------|
| Distribution : | SHENZHEN TONGCE<br>TESTING LAB |

| Issue | Date       | Modifications   |
|-------|------------|-----------------|
| A     | 06/05/2021 | Initial release |
|       |            |                 |
|       |            |                 |
|       |            |                 |



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.4.15.SATU.A

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.4.15.SATU.A

## 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 835 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                              |
| Model                          | SID835                           |
| Serial Number                  | SN 16/15 DIP 0G835-369           |
| Product Condition (new / used) | Used                             |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

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



Figure 1 – MVG COMOSAR Validation Dipole

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#### 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 phantom, with the phantom constructed as outlined in the fore mentioned standards.

##### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

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

##### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

##### 5.3 VALIDATION MEASUREMENT

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

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

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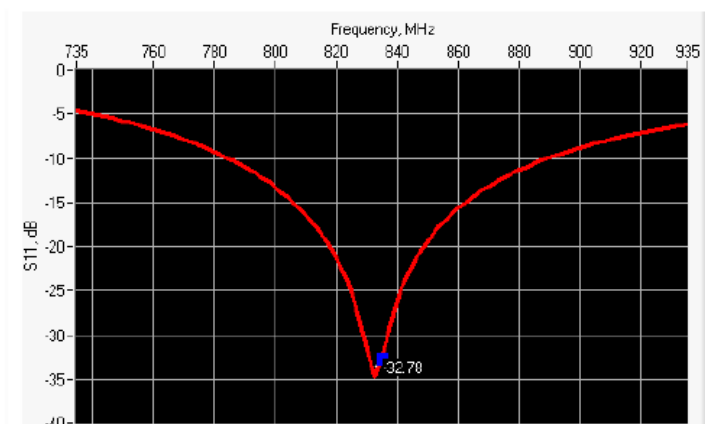
## SAR REFERENCE DIPOLE CALIBRATION REPORT

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

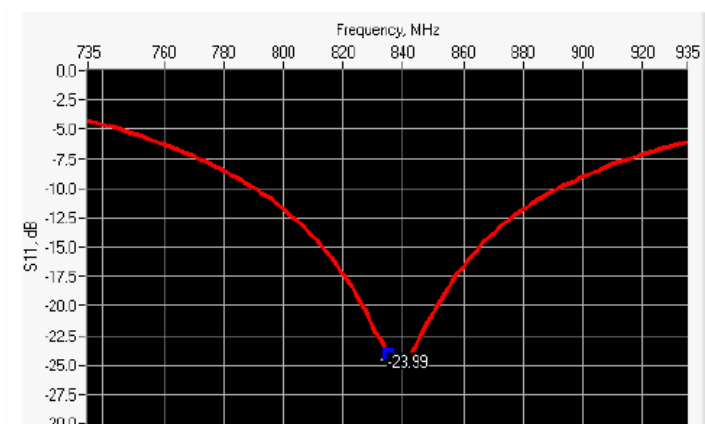
### 6 CALIBRATION MEASUREMENT RESULTS

#### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 835             | -32.78           | -20              | $51.5 \Omega + 1.7 j\Omega$ |

#### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 835             | -23.99           | -20              | $47.3 \Omega + 5.6 j\Omega$ |

#### 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 % |          |

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|      |             |      |             |      |            |      |
|------|-------------|------|-------------|------|------------|------|
| 450  | 290.0 ±1 %. |      | 166.7 ±1 %. |      | 6.35 ±1 %. |      |
| 750  | 176.0 ±1 %. |      | 100.0 ±1 %. |      | 6.35 ±1 %. |      |
| 835  | 161.0 ±1 %. | PASS | 89.8 ±1 %.  | PASS | 3.6 ±1 %.  | PASS |
| 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 %.  |      | 28.8 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3000 | 41.5 ±1 %.  |      | 25.0 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3500 | 37.0 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3700 | 34.7 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |

## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

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

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

### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

|                                           |                                                         |
|-------------------------------------------|---------------------------------------------------------|
| Software                                  | OPENSAR V4                                              |
| Phantom                                   | SN 20/09 SAM71                                          |
| Probe                                     | SN 18/11 EPG122                                         |
| Liquid                                    | Head Liquid Values: $\epsilon_p$ : 42.3 $\sigma$ : 0.92 |
| Distance between dipole center and liquid | 15.0 mm                                                 |
| Area scan resolution                      | $dx=8mm/dy=8mm$                                         |
| Zoon Scan Resolution                      | $dx=8mm/dy=8mm/dz=5mm$                                  |
| Frequency                                 | 835 MHz                                                 |
| Input power                               | 20 dBm                                                  |
| Liquid Temperature                        | 21 °C                                                   |
| Lab Temperature                           | 21 °C                                                   |
| Lab Humidity                              | 45 %                                                    |

| Frequency<br>MHz | 1 g SAR (W/kg/W) |             | 10 g SAR (W/kg/W) |             |
|------------------|------------------|-------------|-------------------|-------------|
|                  | required         | measured    | required          | measured    |
| 300              | 2.85             |             | 1.94              |             |
| 450              | 4.58             |             | 3.06              |             |
| 750              | 8.49             |             | 5.55              |             |
| 835              | 9.56             | 9.53 (0.82) | 6.22              | 6.12 (0.58) |
| 900              | 10.9             |             | 6.99              |             |
| 1450             | 29               |             | 16                |             |
| 1500             | 30.5             |             | 16.8              |             |
| 1640             | 34.2             |             | 18.4              |             |
| 1750             | 36.4             |             | 19.3              |             |
| 1800             | 38.4             |             | 20.1              |             |

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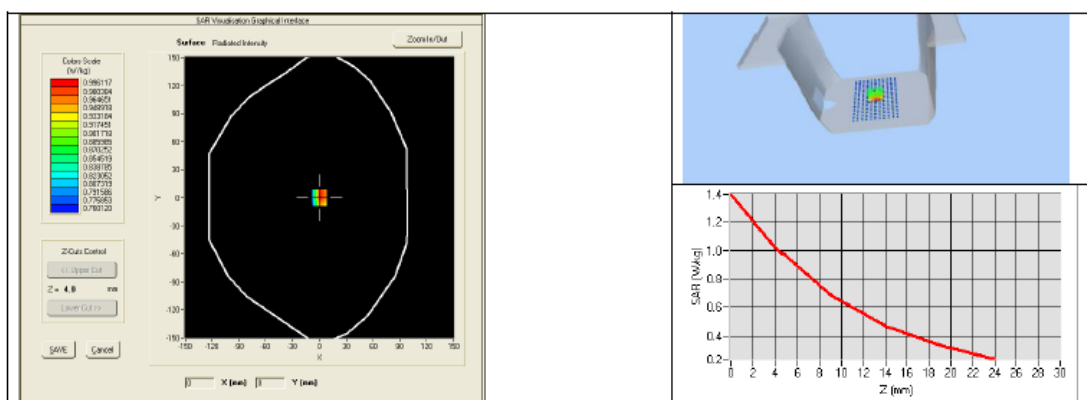
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|      |      |  |      |  |
|------|------|--|------|--|
| 1900 | 39.7 |  | 20.5 |  |
| 1950 | 40.5 |  | 20.9 |  |
| 2000 | 41.1 |  | 21.1 |  |
| 2100 | 43.6 |  | 21.9 |  |
| 2300 | 48.7 |  | 23.3 |  |
| 2450 | 52.4 |  | 24   |  |
| 2600 | 55.3 |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



### 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 $\pm$ 5 %                          |          | 0.80 $\pm$ 5 %                |          |
| 300              | 58.2 $\pm$ 5 %                          |          | 0.92 $\pm$ 5 %                |          |
| 450              | 56.7 $\pm$ 5 %                          |          | 0.94 $\pm$ 5 %                |          |
| 750              | 55.5 $\pm$ 5 %                          |          | 0.96 $\pm$ 5 %                |          |
| 835              | 55.2 $\pm$ 5 %                          | PASS     | 0.97 $\pm$ 5 %                | PASS     |
| 900              | 55.0 $\pm$ 5 %                          |          | 1.05 $\pm$ 5 %                |          |
| 915              | 55.0 $\pm$ 5 %                          |          | 1.06 $\pm$ 5 %                |          |
| 1450             | 54.0 $\pm$ 5 %                          |          | 1.30 $\pm$ 5 %                |          |
| 1610             | 53.8 $\pm$ 5 %                          |          | 1.40 $\pm$ 5 %                |          |
| 1800             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 1900             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 2000             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 2100             | 53.2 $\pm$ 5 %                          |          | 1.62 $\pm$ 5 %                |          |
| 2450             | 52.7 $\pm$ 5 %                          |          | 1.95 $\pm$ 5 %                |          |

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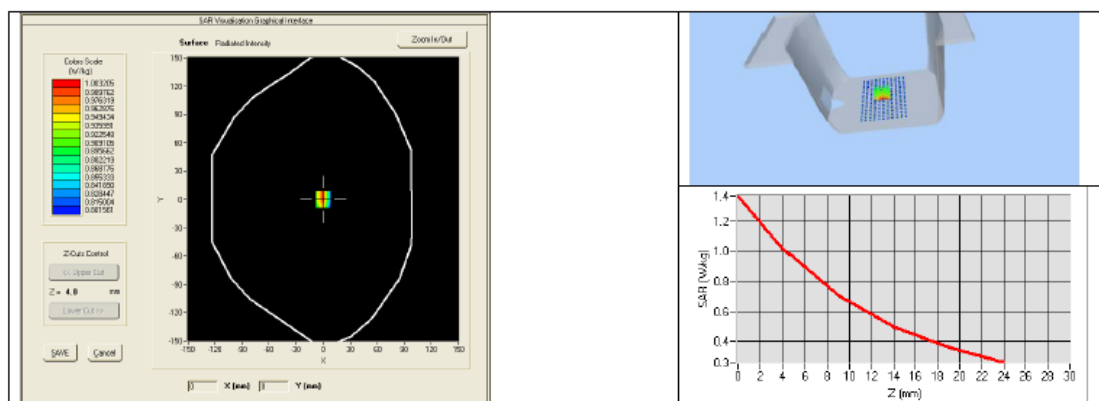
Ref: ACR.156.4.15.SATU.A

|      |            |  |            |  |
|------|------------|--|------------|--|
| 2600 | 52.5 ±5 %  |  | 2.16 ±5 %  |  |
| 3000 | 52.0 ±5 %  |  | 2.73 ±5 %  |  |
| 3500 | 51.3 ±5 %  |  | 3.31 ±5 %  |  |
| 5200 | 49.0 ±10 % |  | 5.30 ±10 % |  |
| 5300 | 48.9 ±10 % |  | 5.42 ±10 % |  |
| 5400 | 48.7 ±10 % |  | 5.53 ±10 % |  |
| 5500 | 48.6 ±10 % |  | 5.65 ±10 % |  |
| 5600 | 48.5 ±10 % |  | 5.77 ±10 % |  |
| 5800 | 48.2 ±10 % |  | 6.00 ±10 % |  |

### 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                                            |
|-------------------------------------------|------------------------------------------------------------|
| Software                                  | OPENSAR V4                                                 |
| Phantom                                   | SN 20/09 SAM71                                             |
| Probe                                     | SN 18/11 EPG122                                            |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}$ : 53.3 $\sigma$ : 0.97 |
| Distance between dipole center and liquid | 15.0 mm                                                    |
| Area scan resolution                      | $dx=8mm/dy=8mm$                                            |
| Zoon Scan Resolution                      | $dx=8mm/dy=8mm/dz=5mm$                                     |
| Frequency                                 | 835 MHz                                                    |
| Input power                               | 20 dBm                                                     |
| Liquid Temperature                        | 21 °C                                                      |
| Lab Temperature                           | 21 °C                                                      |
| Lab Humidity                              | 45 %                                                       |

| Frequency MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|---------------|------------------|-------------------|
|               | measured         | measured          |
| 835           | 9.62 (0.91)      | 6.44 (0.59)       |



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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.156.4.15.SATU.A

### 8 LIST OF EQUIPMENT

| Equipment Summary Sheet         |                      |                    |                                               |                                               |
|---------------------------------|----------------------|--------------------|-----------------------------------------------|-----------------------------------------------|
| Equipment Description           | Manufacturer / Model | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| SAM Phantom                     | MVG                  | SN-20/09-SAM71     | Validated. No cal required.                   | Validated. No cal required.                   |
| COMOSAR Test Bench              | Version 3            | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer                | Rhode & Schwarz ZVA  | SN100132           | 02/2021                                       | 02/2024                                       |
| Calipers                        | Carrera              | CALIPER-01         | 02/2021                                       | 02/2024                                       |
| Reference Probe                 | MVG                  | EPG122 SN 18/11    | 02/2021                                       | 02/2022                                       |
| Multimeter                      | Keithley 2000        | 1188656            | 02/2021                                       | 02/2024                                       |
| Signal Generator                | Agilent E4438C       | MY49070581         | 02/2021                                       | 02/2024                                       |
| Amplifier                       | Aethercomm           | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                     | HP E4418A            | US38261498         | 02/2021                                       | 02/2024                                       |
| Power Sensor                    | HP ECP-E26A          | US37181460         | 02/2021                                       | 02/2024                                       |
| Directional Coupler             | Narda 4216-20        | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature and Humidity Sensor | Control Company      | 11-661-9           | 02/2021                                       | 02/2024                                       |

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## SAR Reference Dipole Calibration Report

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**SHENZHEN TCT TESTING TECHNOLOGY CO., LTD**

**2101&2201, ZHENCHANG FACTORY, RENSHAN INDUSTRIAL  
ZONE, FUHAI SUBDISTRICT, BAOAN DISTRICT, SHENZHEN,  
GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA  
MVG COMOSAR REFERENCE DIPOLE**

**FREQUENCY: 1800 MHZ**

**SERIAL NO.: SN 16/15 DIP 1G800-371**

**Calibrated at MVG US**

**2105 Barrett Park Dr. - Kennesaw, GA 30144**



**Calibration Date: 06/05/2021**

### *Summary:*

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



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.6.15.SATU.A

|               | Name          | Function        | Date       | Signature            |
|---------------|---------------|-----------------|------------|----------------------|
| Prepared by : | Jérôme LUC    | Product Manager | 06/05/2021 | <i>JS</i>            |
| Checked by :  | Jérôme LUC    | Product Manager | 06/05/2021 | <i>JS</i>            |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 06/05/2021 | <i>Kim Rutkowski</i> |

|                | Customer Name               |
|----------------|-----------------------------|
| Distribution : | SHENZHEN TONGCE TESTING LAB |

| Issue | Date       | Modifications   |
|-------|------------|-----------------|
| A     | 06/05/2021 | Initial release |
|       |            |                 |
|       |            |                 |
|       |            |                 |

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.6.15.SATU.A

### 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 1800 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                               |
| Model                          | SID1800                           |
| Serial Number                  | SN 16/15 DIP 1G800-371            |
| Product Condition (new / used) | Used                              |

A yearly calibration interval is recommended.

### 3 PRODUCT DESCRIPTION

#### 3.1 GENERAL INFORMATION

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



Figure 1 – MVG COMOSAR Validation Dipole

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#### 4 MEASUREMENT METHOD

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

##### 4.1 RETURN LOSS REQUIREMENTS

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

##### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

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

##### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

##### 5.3 VALIDATION MEASUREMENT

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

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

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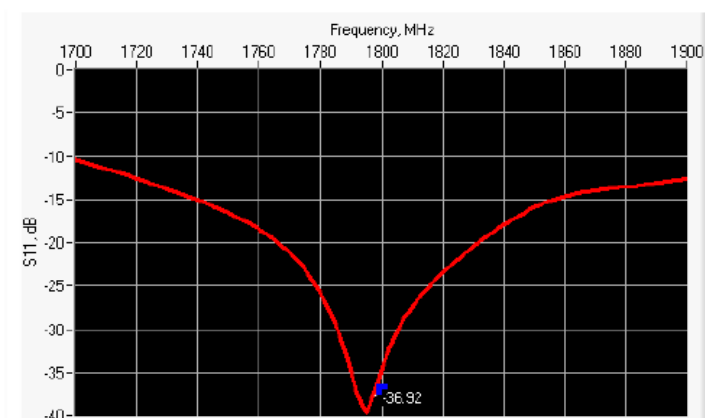
## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.6.15.SATU.A

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

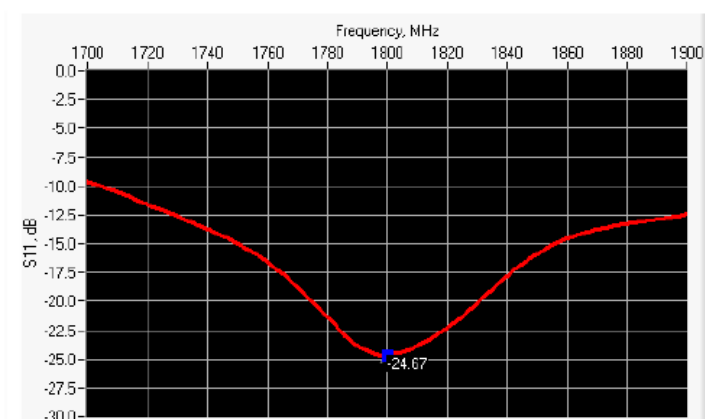
### 6 CALIBRATION MEASUREMENT RESULTS

#### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                      |
|-----------------|------------------|------------------|--------------------------------|
| 1800            | -36.92           | -20              | 48.3 $\Omega$ - 0.5 j $\Omega$ |

#### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                      |
|-----------------|------------------|------------------|--------------------------------|
| 1800            | -24.67           | -20              | 47.6 $\Omega$ - 5.1 j $\Omega$ |

#### 6.3 MECHANICAL DIMENSIONS

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

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|      |             |      |             |      |            |      |
|------|-------------|------|-------------|------|------------|------|
| 450  | 290.0 ±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 %.  | PASS | 41.7 ±1 %.  | PASS | 3.6 ±1 %.  | PASS |
| 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 %.  |      |
| 3500 | 37.0 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3700 | 34.7 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |

## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

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

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

### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

|                                           |                                              |
|-------------------------------------------|----------------------------------------------|
| Software                                  | OPENSAR V4                                   |
| Phantom                                   | SN 20/09 SAM71                               |
| Probe                                     | SN 18/11 EPG122                              |
| Liquid                                    | Head Liquid Values: eps' : 41.8 sigma : 1.38 |
| Distance between dipole center and liquid | 10.0 mm                                      |
| Area scan resolution                      | dx=8mm/dy=8mm                                |
| Zoon Scan Resolution                      | dx=8mm/dy=8mm/dz=5mm                         |
| Frequency                                 | 1800 MHz                                     |
| Input power                               | 20 dBm                                       |
| Liquid Temperature                        | 21 °C                                        |
| Lab Temperature                           | 21 °C                                        |
| Lab Humidity                              | 45 %                                         |

| Frequency<br>MHz | 1 g SAR (W/kg/W) |             | 10 g SAR (W/kg/W) |              |
|------------------|------------------|-------------|-------------------|--------------|
|                  | required         | measured    | required          | measured     |
| 300              | 2.85             |             | 1.94              |              |
| 450              | 4.58             |             | 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             | 37.67(3.60) | 20.1              | 20.23 (2.15) |

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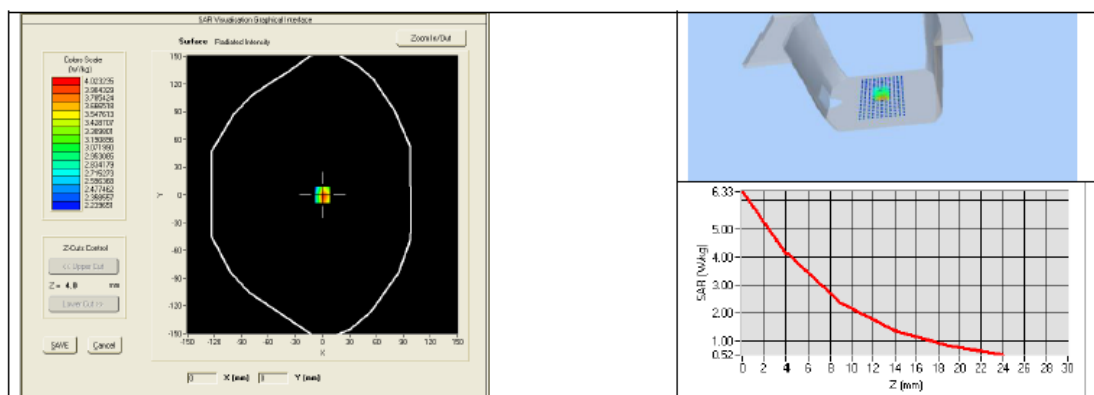
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|      |      |  |      |  |
|------|------|--|------|--|
| 1900 | 39.7 |  | 20.5 |  |
| 1950 | 40.5 |  | 20.9 |  |
| 2000 | 41.1 |  | 21.1 |  |
| 2100 | 43.6 |  | 21.9 |  |
| 2300 | 48.7 |  | 23.3 |  |
| 2450 | 52.4 |  | 24   |  |
| 2600 | 55.3 |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



### 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 $\pm$ 5 %                          |          | 0.80 $\pm$ 5 %                |          |
| 300              | 58.2 $\pm$ 5 %                          |          | 0.92 $\pm$ 5 %                |          |
| 450              | 56.7 $\pm$ 5 %                          |          | 0.94 $\pm$ 5 %                |          |
| 750              | 55.5 $\pm$ 5 %                          |          | 0.96 $\pm$ 5 %                |          |
| 835              | 55.2 $\pm$ 5 %                          |          | 0.97 $\pm$ 5 %                |          |
| 900              | 55.0 $\pm$ 5 %                          |          | 1.05 $\pm$ 5 %                |          |
| 915              | 55.0 $\pm$ 5 %                          |          | 1.06 $\pm$ 5 %                |          |
| 1450             | 54.0 $\pm$ 5 %                          |          | 1.30 $\pm$ 5 %                |          |
| 1610             | 53.8 $\pm$ 5 %                          |          | 1.40 $\pm$ 5 %                |          |
| 1800             | 53.3 $\pm$ 5 %                          | PASS     | 1.52 $\pm$ 5 %                | PASS     |
| 1900             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 2000             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 2100             | 53.2 $\pm$ 5 %                          |          | 1.62 $\pm$ 5 %                |          |
| 2450             | 52.7 $\pm$ 5 %                          |          | 1.95 $\pm$ 5 %                |          |

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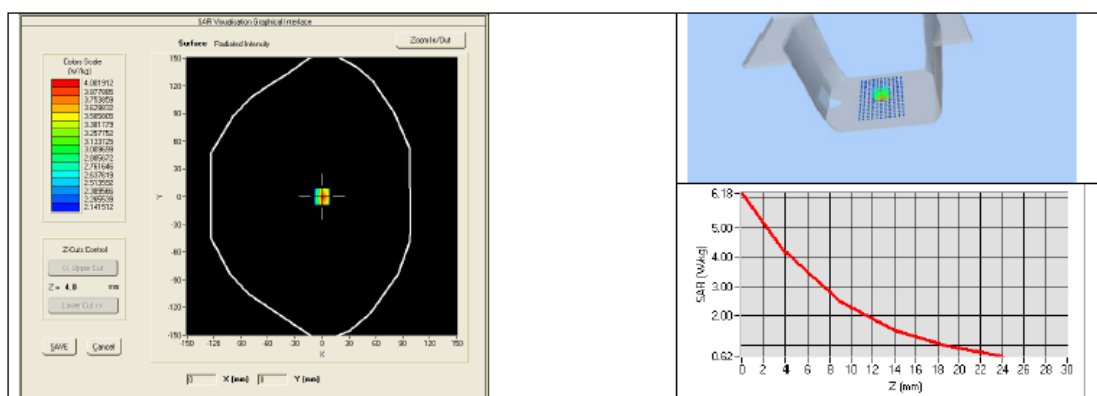
Ref: ACR.156.6.15.SATU.A

|      |            |  |            |  |
|------|------------|--|------------|--|
| 2600 | 52.5 ±5 %  |  | 2.16 ±5 %  |  |
| 3000 | 52.0 ±5 %  |  | 2.73 ±5 %  |  |
| 3500 | 51.3 ±5 %  |  | 3.31 ±5 %  |  |
| 5200 | 49.0 ±10 % |  | 5.30 ±10 % |  |
| 5300 | 48.9 ±10 % |  | 5.42 ±10 % |  |
| 5400 | 48.7 ±10 % |  | 5.53 ±10 % |  |
| 5500 | 48.6 ±10 % |  | 5.65 ±10 % |  |
| 5600 | 48.5 ±10 % |  | 5.77 ±10 % |  |
| 5800 | 48.2 ±10 % |  | 6.00 ±10 % |  |

### 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                              |
|-------------------------------------------|----------------------------------------------|
| Software                                  | OPENSAR V4                                   |
| Phantom                                   | SN 20/09 SAM71                               |
| Probe                                     | SN 18/11 EPG122                              |
| Liquid                                    | Body Liquid Values: eps' : 53.0 sigma : 1.52 |
| Distance between dipole center and liquid | 10.0 mm                                      |
| Area scan resolution                      | dx=8mm/dy=8mm                                |
| Zoon Scan Resolution                      | dx=8mm/dy=8mm/dz=5mm                         |
| Frequency                                 | 1800 MHz                                     |
| Input power                               | 20 dBm                                       |
| Liquid Temperature                        | 21 °C                                        |
| Lab Temperature                           | 21 °C                                        |
| Lab Humidity                              | 45 %                                         |

| Frequency<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 1800             | 37.69 (3.65)     | 20.57 (2.00)      |



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## 8 LIST OF EQUIPMENT

| Equipment Summary Sheet         |                      |                    |                                               |                                               |
|---------------------------------|----------------------|--------------------|-----------------------------------------------|-----------------------------------------------|
| Equipment Description           | Manufacturer / Model | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| SAM Phantom                     | MVG                  | SN-20/09-SAM71     | Validated. No cal required.                   | Validated. No cal required.                   |
| COMOSAR Test Bench              | Version 3            | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer                | Rhode & Schwarz ZVA  | SN100132           | 02/2021                                       | 02/2024                                       |
| Calipers                        | Carrera              | CALIPER-01         | 02/2021                                       | 02/2024                                       |
| Reference Probe                 | MVG                  | EPG122 SN 18/11    | 02/2021                                       | 02/2022                                       |
| Multimeter                      | Keithley 2000        | 1188656            | 02/2021                                       | 02/2024                                       |
| Signal Generator                | Agilent E4438C       | MY49070581         | 02/2021                                       | 02/2024                                       |
| Amplifier                       | Aethercomm           | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                     | HP E4418A            | US38261498         | 02/2021                                       | 02/2024                                       |
| Power Sensor                    | HP ECP-E26A          | US37181460         | 02/2021                                       | 02/2024                                       |
| Directional Coupler             | Narda 4216-20        | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature and Humidity Sensor | Control Company      | 11-661-9           | 02/2021                                       | 02/2024                                       |

SID1900



## SAR Reference Dipole Calibration Report

Ref : ACR.156.7.15.SATU.A

**SHENZHEN TCT TESTING TECHNOLOGY CO., LTD**

**2101&2201, ZHENCHANG FACTORY, RENSHAN INDUSTRIAL  
ZONE, FUHAI SUBDISTRICT, BAOAN DISTRICT, SHENZHEN,  
GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA  
MVG COMOSAR REFERENCE DIPOLE**

**FREQUENCY: 1900 MHZ**

**SERIAL NO.: SN 16/15 DIP 1G900-372**

**Calibrated at MVG US**

**2105 Barrett Park Dr. - Kennesaw, GA 30144**



**Calibration Date: 06/05/2021**

### *Summary:*

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



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.7.15.SATU.A

|               | Name          | Function        | Date       | Signature |
|---------------|---------------|-----------------|------------|-----------|
| Prepared by : | Jérôme LUC    | Product Manager | 06/05/2021 |           |
| Checked by :  | Jérôme LUC    | Product Manager | 06/05/2021 |           |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 06/05/2021 |           |

|                | Customer Name                  |
|----------------|--------------------------------|
| Distribution : | SHENZHEN TONGCE<br>TESTING LAB |

| Issue | Date       | Modifications   |
|-------|------------|-----------------|
| A     | 06/05/2021 | Initial release |
|       |            |                 |
|       |            |                 |
|       |            |                 |

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SAR REFERENCE DIPOLE CALIBRATION REPORT

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| 6.2 | Return Loss and Impedance In Body Liquid ..... | 6  |
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| 7.1 | Head Liquid Measurement .....                  | 7  |
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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 16/15 DIP 1G900-372            |
| Product Condition (new / used) | Used                              |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

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



Figure 1 – MVG COMOSAR Validation Dipole

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

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#### 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 phantom, with the phantom constructed as outlined in the fore mentioned standards.

##### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

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

##### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

##### 5.3 VALIDATION MEASUREMENT

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

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

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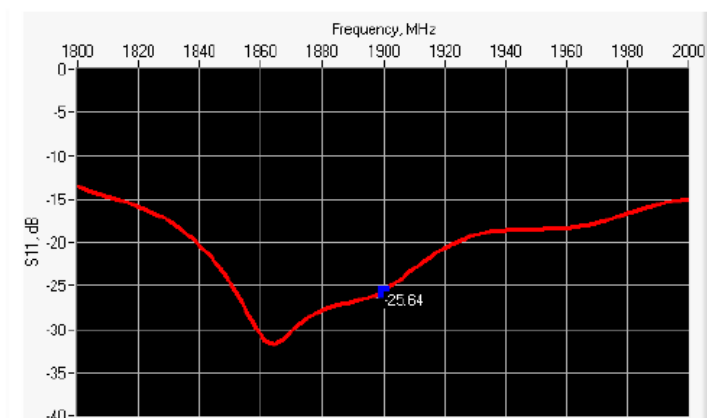
## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.7.15.SATU.A

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

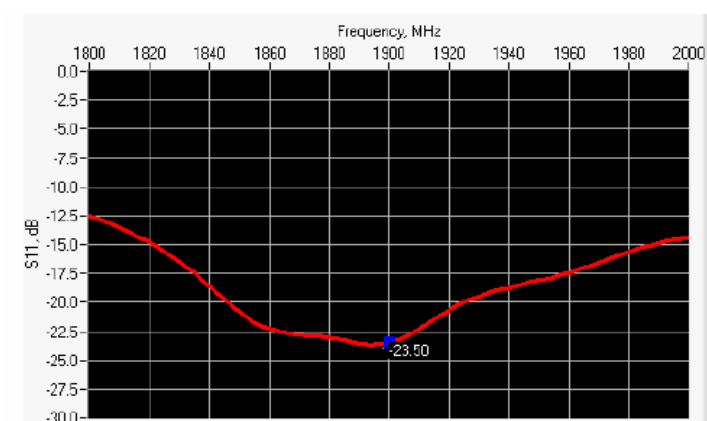
### 6 CALIBRATION MEASUREMENT RESULTS

#### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 1900            | -25.64           | -20              | $51.6 \Omega + 4.9 j\Omega$ |

#### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 1900            | -23.50           | -20              | $48.5 \Omega + 6.4 j\Omega$ |

#### 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 % |          |

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|      |             |      |             |      |            |      |
|------|-------------|------|-------------|------|------------|------|
| 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 %.  | PASS | 39.5 ±1 %.  | PASS | 3.6 ±1 %.  | PASS |
| 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 %.  |      |
| 3500 | 37.0 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3700 | 34.7 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |

## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

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

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

### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

|                                           |                                                            |
|-------------------------------------------|------------------------------------------------------------|
| Software                                  | OPENSAR V4                                                 |
| Phantom                                   | SN 20/09 SAM71                                             |
| Probe                                     | SN 18/11 EPG122                                            |
| Liquid                                    | Head Liquid Values: $\epsilon_{ps}$ : 40.4 $\sigma$ : 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                        | 21 °C                                                      |
| Lab Temperature                           | 21 °C                                                      |
| Lab Humidity                              | 45 %                                                       |

| Frequency<br>MHz | 1 g SAR (W/kg/W) |          | 10 g SAR (W/kg/W) |          |
|------------------|------------------|----------|-------------------|----------|
|                  | required         | measured | required          | measured |
| 300              | 2.85             |          | 1.94              |          |
| 450              | 4.58             |          | 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              |          |

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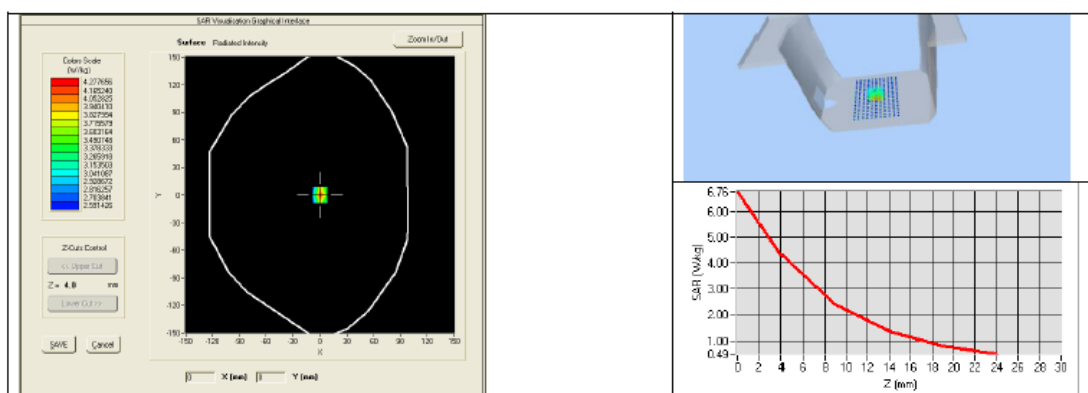
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|      |      |              |      |              |
|------|------|--------------|------|--------------|
| 1900 | 39.7 | 39.26 (3.85) | 20.5 | 20.49 (2.12) |
| 1950 | 40.5 |              | 20.9 |              |
| 2000 | 41.1 |              | 21.1 |              |
| 2100 | 43.6 |              | 21.9 |              |
| 2300 | 48.7 |              | 23.3 |              |
| 2450 | 52.4 |              | 24   |              |
| 2600 | 55.3 |              | 24.6 |              |
| 3000 | 63.8 |              | 25.7 |              |
| 3500 | 67.1 |              | 25   |              |



### 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 $\pm$ 5 %                          |          | 0.80 $\pm$ 5 %                |          |
| 300              | 58.2 $\pm$ 5 %                          |          | 0.92 $\pm$ 5 %                |          |
| 450              | 56.7 $\pm$ 5 %                          |          | 0.94 $\pm$ 5 %                |          |
| 750              | 55.5 $\pm$ 5 %                          |          | 0.96 $\pm$ 5 %                |          |
| 835              | 55.2 $\pm$ 5 %                          |          | 0.97 $\pm$ 5 %                |          |
| 900              | 55.0 $\pm$ 5 %                          |          | 1.05 $\pm$ 5 %                |          |
| 915              | 55.0 $\pm$ 5 %                          |          | 1.06 $\pm$ 5 %                |          |
| 1450             | 54.0 $\pm$ 5 %                          |          | 1.30 $\pm$ 5 %                |          |
| 1610             | 53.8 $\pm$ 5 %                          |          | 1.40 $\pm$ 5 %                |          |
| 1800             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 1900             | 53.3 $\pm$ 5 %                          | PASS     | 1.52 $\pm$ 5 %                | PASS     |
| 2000             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 2100             | 53.2 $\pm$ 5 %                          |          | 1.62 $\pm$ 5 %                |          |
| 2450             | 52.7 $\pm$ 5 %                          |          | 1.95 $\pm$ 5 %                |          |

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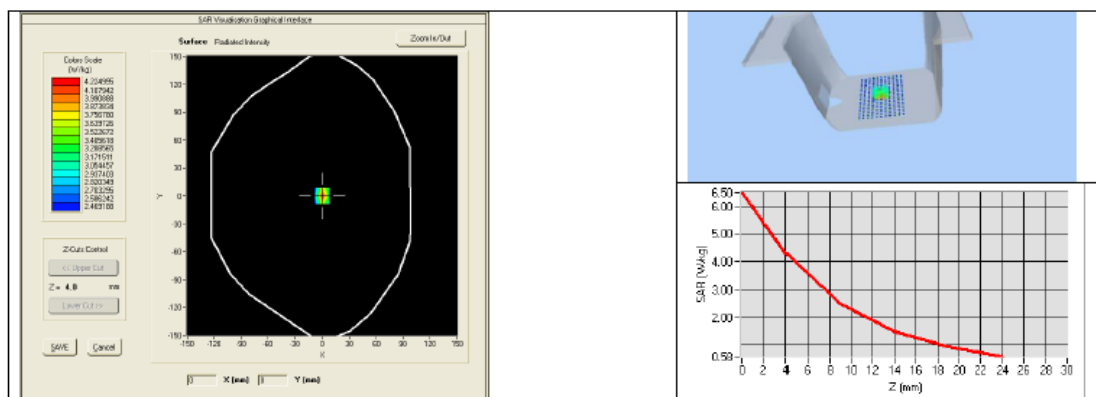
Ref: ACR.156.7.15.SATU.A

|      |            |  |            |  |
|------|------------|--|------------|--|
| 2600 | 52.5 ±5 %  |  | 2.16 ±5 %  |  |
| 3000 | 52.0 ±5 %  |  | 2.73 ±5 %  |  |
| 3500 | 51.3 ±5 %  |  | 3.31 ±5 %  |  |
| 5200 | 49.0 ±10 % |  | 5.30 ±10 % |  |
| 5300 | 48.9 ±10 % |  | 5.42 ±10 % |  |
| 5400 | 48.7 ±10 % |  | 5.53 ±10 % |  |
| 5500 | 48.6 ±10 % |  | 5.65 ±10 % |  |
| 5600 | 48.5 ±10 % |  | 5.77 ±10 % |  |
| 5800 | 48.2 ±10 % |  | 6.00 ±10 % |  |

### 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                              |
|-------------------------------------------|----------------------------------------------|
| Software                                  | OPENSAR V4                                   |
| Phantom                                   | SN 20/09 SAM71                               |
| Probe                                     | SN 18/11 EPG122                              |
| Liquid                                    | Body Liquid Values: eps' : 53.9 sigma : 1.55 |
| 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                        | 21 °C                                        |
| Lab Temperature                           | 21 °C                                        |
| Lab Humidity                              | 45 %                                         |

| Frequency<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 1900             | 38.71 (3.70)     | 20.53 (2.12)      |



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### 8 LIST OF EQUIPMENT

| Equipment Summary Sheet         |                      |                    |                                               |                                               |
|---------------------------------|----------------------|--------------------|-----------------------------------------------|-----------------------------------------------|
| Equipment Description           | Manufacturer / Model | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| SAM Phantom                     | MVG                  | SN-20/09-SAM71     | Validated. No cal required.                   | Validated. No cal required.                   |
| COMOSAR Test Bench              | Version 3            | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer                | Rhode & Schwarz ZVA  | SN100132           | 02/2021                                       | 02/2024                                       |
| Calipers                        | Carrera              | CALIPER-01         | 02/2021                                       | 02/2024                                       |
| Reference Probe                 | MVG                  | EPG122 SN 18/11    | 02/2021                                       | 02/2022                                       |
| Multimeter                      | Keithley 2000        | 1188656            | 02/2021                                       | 02/2024                                       |
| Signal Generator                | Agilent E4438C       | MY49070581         | 02/2021                                       | 02/2024                                       |
| Amplifier                       | Aethercomm           | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                     | HP E4418A            | US38261498         | 02/2021                                       | 02/2024                                       |
| Power Sensor                    | HP ECP-E26A          | US37181460         | 02/2021                                       | 02/2024                                       |
| Directional Coupler             | Narda 4216-20        | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature and Humidity Sensor | Control Company      | 11-661-9           | 02/2021                                       | 02/2024                                       |

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## SAR Reference Dipole Calibration Report

Ref : ACR.156.9.15.SATU.A

### SHENZHEN TCT TESTING TECHNOLOGY CO., LTD

2101&2201, ZHENCHANG FACTORY, RENSHAN INDUSTRIAL  
FUHAI SUBDISTRICT, BAOAN DISTRICT, SHENZHEN,  
GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA

### MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 2450 MHZ

SERIAL NO.: SN 16/15 DIP 2G450-374

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 06/05/2021

#### Summary:

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



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.SATU.A

|               | Name          | Function        | Date       | Signature            |
|---------------|---------------|-----------------|------------|----------------------|
| Prepared by : | Jérôme LUC    | Product Manager | 06/05/2021 | <i>JL</i>            |
| Checked by :  | Jérôme LUC    | Product Manager | 06/05/2021 | <i>JL</i>            |
| Approved by : | Kim RUTKOWSKI | Quality Manager | 06/05/2021 | <i>Kim Rutkowski</i> |

|                | Customer Name                  |
|----------------|--------------------------------|
| Distribution : | SHENZHEN TONGCE<br>TESTING LAB |

| Issue | Date       | Modifications   |
|-------|------------|-----------------|
| A     | 06/05/2021 | Initial release |
|       |            |                 |
|       |            |                 |
|       |            |                 |



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.SATU.A

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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 16/15 DIP 2G450-374            |
| Product Condition (new / used) | Used                              |

A yearly calibration interval is recommended.

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

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



**Figure 1 – MVG COMOSAR Validation Dipole**

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#### 4 MEASUREMENT METHOD

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

##### 4.1 RETURN LOSS REQUIREMENTS

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

##### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness.

#### 5 MEASUREMENT UNCERTAINTY

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

##### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

##### 5.3 VALIDATION MEASUREMENT

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

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

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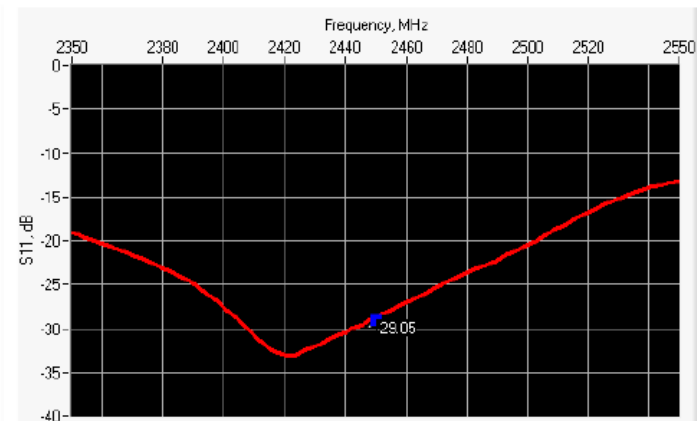
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|      |        |
|------|--------|
| 10 g | 20.1 % |
|------|--------|

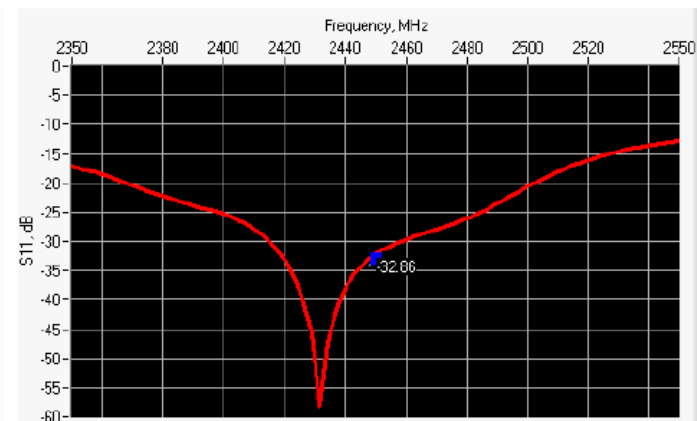
### 6 CALIBRATION MEASUREMENT RESULTS

#### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                      |
|-----------------|------------------|------------------|--------------------------------|
| 2450            | -29.05           | -20              | 46.7 $\Omega$ - 0.2 j $\Omega$ |

#### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                      |
|-----------------|------------------|------------------|--------------------------------|
| 2450            | -32.86           | -20              | 48.6 $\Omega$ - 1.9 j $\Omega$ |

#### 6.3 MECHANICAL DIMENSIONS

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

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|      |             |      |             |      |            |      |
|------|-------------|------|-------------|------|------------|------|
| 450  | 290.0 ±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 %.  | PASS | 30.4 ±1 %.  | PASS | 3.6 ±1 %.  | PASS |
| 2600 | 48.5 ±1 %.  |      | 28.8 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3000 | 41.5 ±1 %.  |      | 25.0 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3500 | 37.0 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |
| 3700 | 34.7 ±1 %.  |      | 26.4 ±1 %.  |      | 3.6 ±1 %.  |      |

## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

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

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.9.15.SATU.A

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

### 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

|                                           |                                                         |
|-------------------------------------------|---------------------------------------------------------|
| Software                                  | OPENSAR V4                                              |
| Phantom                                   | SN 20/09 SAM71                                          |
| Probe                                     | SN 18/11 EPG122                                         |
| Liquid                                    | Head Liquid Values: $\epsilon_{ps}$ : 38.3 sigma : 1.80 |
| 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                        | 21 °C                                                   |
| Lab Temperature                           | 21 °C                                                   |
| Lab Humidity                              | 45 %                                                    |

| Frequency<br>MHz | 1 g SAR (W/kg/W) |          | 10 g SAR (W/kg/W) |          |
|------------------|------------------|----------|-------------------|----------|
|                  | required         | measured | required          | measured |
| 300              | 2.85             |          | 1.94              |          |
| 450              | 4.58             |          | 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              |          |

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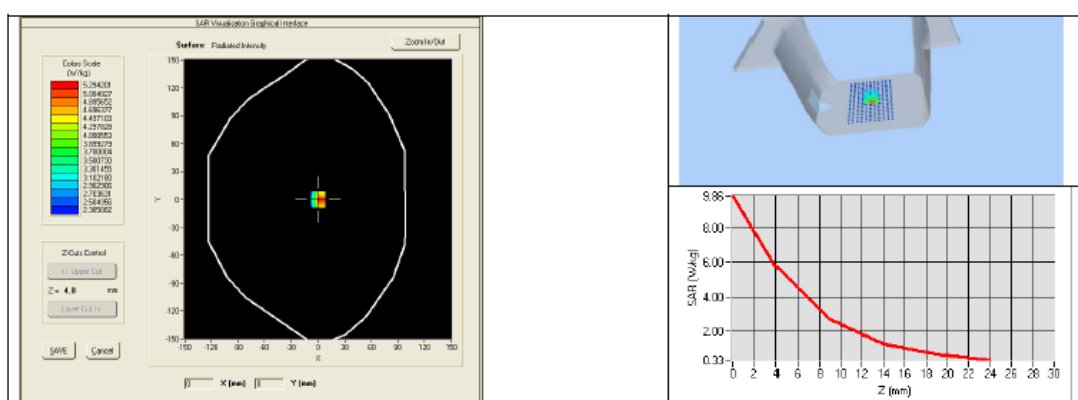
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|      |      |              |      |              |
|------|------|--------------|------|--------------|
| 1900 | 39.7 |              | 20.5 |              |
| 1950 | 40.5 |              | 20.9 |              |
| 2000 | 41.1 |              | 21.1 |              |
| 2100 | 43.6 |              | 21.9 |              |
| 2300 | 48.7 |              | 23.3 |              |
| 2450 | 52.4 | 53.26 (5.38) | 24   | 24.15 (2.49) |
| 2600 | 55.3 |              | 24.6 |              |
| 3000 | 63.8 |              | 25.7 |              |
| 3500 | 67.1 |              | 25   |              |



### 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|-----------------------------------------|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 $\pm$ 5 %                          |          | 0.80 $\pm$ 5 %                |          |
| 300              | 58.2 $\pm$ 5 %                          |          | 0.92 $\pm$ 5 %                |          |
| 450              | 56.7 $\pm$ 5 %                          |          | 0.94 $\pm$ 5 %                |          |
| 750              | 55.5 $\pm$ 5 %                          |          | 0.96 $\pm$ 5 %                |          |
| 835              | 55.2 $\pm$ 5 %                          |          | 0.97 $\pm$ 5 %                |          |
| 900              | 55.0 $\pm$ 5 %                          |          | 1.05 $\pm$ 5 %                |          |
| 915              | 55.0 $\pm$ 5 %                          |          | 1.06 $\pm$ 5 %                |          |
| 1450             | 54.0 $\pm$ 5 %                          |          | 1.30 $\pm$ 5 %                |          |
| 1610             | 53.8 $\pm$ 5 %                          |          | 1.40 $\pm$ 5 %                |          |
| 1800             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 1900             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 2000             | 53.3 $\pm$ 5 %                          |          | 1.52 $\pm$ 5 %                |          |
| 2100             | 53.2 $\pm$ 5 %                          |          | 1.62 $\pm$ 5 %                |          |
| 2450             | 52.7 $\pm$ 5 %                          | PASS     | 1.95 $\pm$ 5 %                | PASS     |

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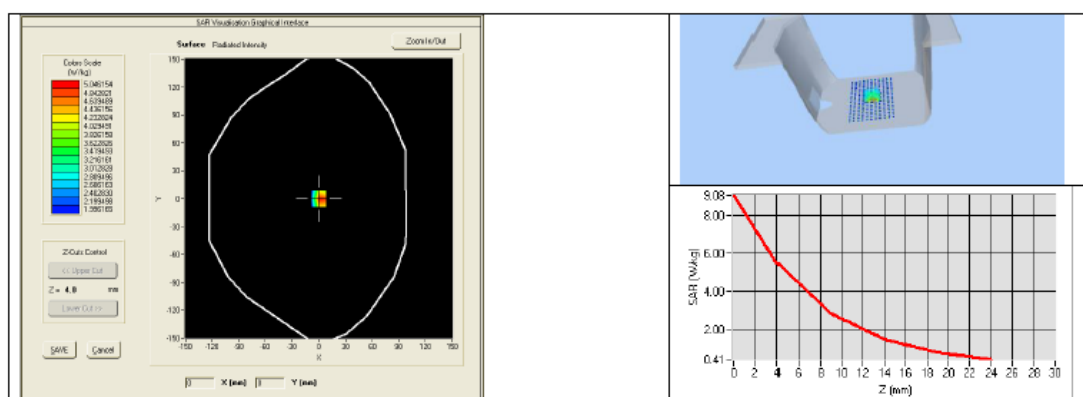
Ref: ACR.156.9.15.SATU.A

|      |            |  |            |  |
|------|------------|--|------------|--|
| 2600 | 52.5 ±5 %  |  | 2.16 ±5 %  |  |
| 3000 | 52.0 ±5 %  |  | 2.73 ±5 %  |  |
| 3500 | 51.3 ±5 %  |  | 3.31 ±5 %  |  |
| 5200 | 49.0 ±10 % |  | 5.30 ±10 % |  |
| 5300 | 48.9 ±10 % |  | 5.42 ±10 % |  |
| 5400 | 48.7 ±10 % |  | 5.53 ±10 % |  |
| 5500 | 48.6 ±10 % |  | 5.65 ±10 % |  |
| 5600 | 48.5 ±10 % |  | 5.77 ±10 % |  |
| 5800 | 48.2 ±10 % |  | 6.00 ±10 % |  |

### 7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

|                                           |                                                           |
|-------------------------------------------|-----------------------------------------------------------|
| Software                                  | OPENSAR V4                                                |
| Phantom                                   | SN 20/09 SAM71                                            |
| Probe                                     | SN 18/11 EPG122                                           |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}^*$ : 52.7 sigma : 1.94 |
| 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                        | 21 °C                                                     |
| Lab Temperature                           | 21 °C                                                     |
| Lab Humidity                              | 45 %                                                      |

| Frequency<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 2450             | 50.63 (5.01)     | 23.40 (2.37)      |



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