

# SAR TEST REPORT

**Report No.:** SET2021-17612

**Product Name:** Multipurpose Night Vision Monocular

**Model Name:** PFN640+,RH25,PFN384+,RL25

**FCC ID:** 2AY3N-PFNPLUS

**Applicant:** InfiRay Technologies Co., Ltd.

**Address:** Building C3,A1,Innovation Industrial Park Hefei Anhui,P.R.China

**Test Date:** 2021.12.05-2021.12.05

**Issued by:** CCIC Southern Testing Co., Ltd.

**Lab Location:** Electronic Testing Building, No. 43 Shahe Road, Xili Street, Nanshan District, Shenzhen, Guangdong, China

**Tel:** 86 755 26627338      **Fax:** 86 755 26627238

**Mail:** manager@ccic-set.com **Website:** <http://www.ccic-set.com>

This test report consists of 51 pages in total. It may be duplicated completely for legal use with the approval of the applicant. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product endorsement by CCIC-SET. The test results in the report only apply to the tested sample. The CCIC-SET does not assume responsibility for any conclusions and generalizations drawn from the test results with regard to other specimens or samples of the type of the equipment represented by the test item. The test report shall be invalid without all the signatures of testing engineers, reviewer and approver. Any objections must be raised to CCIC-SET within 15 days since the date when the report is received. It will not be taken into consideration beyond this limit.

# Test Report

**Applicant:** InfiRay Technologies Co., Ltd.

**Brand Name:** InfiRay

**Trade Name:** InfiRay

**Applicant Address:** Building C3,A1,Innovation Industrial Park Hefei Anhui,P.R.China

**Manufacturer:** InfiRay Technologies Co., Ltd.

**Manufacturer Address:** Building C3,A1,Innovation Industrial Park Hefei Anhui,P.R.China

**47CFR §2.1093-** Radiofrequency Radiation Exposure Evaluation: Portable Devices;

**ANSI C95.1-1992:** Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.( IEEE Std C95.1-1991)

**Test Standards:** **IEEE 1528-2013:** IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

**Test Result:** Pass

*Xinyuan Fang*

2021-12-30

**Tested by:** Xinyuan Fang, Test Engineer

*Chris You*

2021-12-30

**Reviewed by:** Chris You, Senior Engineer

*Shuangwen Zhang*

2021-12-30

**Approved by:** Shuangwen Zhang , Manager

## Contents

|  |    |
|--|----|
| <b>1. Administration Data</b> .....                              | 4  |
| 1.1 Testing Laboratory .....                                     | 4  |
| 1.2 List of test Equipment .....                                 | 4  |
| <b>2. Equipment Under Test (EUT)</b> .....                       | 5  |
| <b>3. Specific Absorption Rate (SAR)</b> .....                   | 6  |
| 3.1 SAR Introduction .....                                       | 6  |
| 3.2 Probe Specification .....                                    | 8  |
| <b>4. Tissue check and recommend Dielectric Parameters</b> ..... | 9  |
| 4.1 Recommended Tissue Dielectric Parameters .....               | 9  |
| 4.2.liquid check results.....                                    | 10 |
| <b>5. System check procedure</b> .....                           | 11 |
| <b>6. SAR measurement procedure</b> .....                        | 13 |
| <b>7. RF Conducted Power</b> .....                               | 15 |
| <b>8. Measurement Uncertainty</b> .....                          | 17 |
| <b>ANNEX A: SAR Test Setup</b> .....                             | 21 |
| <b>ANNEX B: System Check Plots</b> .....                         | 24 |
| <b>ANNEX C: SAR Test Plots</b> .....                             | 27 |
| <b>ANNEX D: Calibration Certificate</b> .....                    | 30 |

## 1. Administration Data

### 1.1 Testing Laboratory

|  |  |
|--|--|
| <b>Test Site:</b>                      | CCIC Southern Testing Co., Ltd.  |
| <b>Address:</b>                        | Electronic Testing Building, No. 43 Shahe Road, Xili Street, Nanshan District, Shenzhen, Guangdong, China  |
| <b>A2LA Accreditation:</b>             | CCIC-SET is a third party testing organization accredited by A2LA according to ISO/IEC 17025:2017. The accreditation certificate number is 5721.01   |
| <b>FCC Designation No.:<br/>CN1283</b> | CCIC Southern Testing Co., Ltd EMC Laboratory has been registered and fully described in a report filed with the FCC (Federal Communications Commission). The acceptance letter from the FCC is maintained in our files. Designation Number: CN1283, valid time is until April 19th, 2023      |
| <b>ISED Registration:<br/>11185A-1</b> | CAB identifier: CN0064<br><br>CCIC Southern Testing Co., Ltd. EMC Laboratory has been registered by Certification and Engineering Bureau of Industry Canada for the performance of radiated measurements with Registration No. 11185A-1 on Aug. 04, 2016, valid time is until Jun. 30th, 2023. |

### 1.2 List of test Equipment

This table is a complete overview of the SAR measurement equipment. Devices used during the test described are marked .

|                                     | EQUIPMENT                          | Model         | Serial number          | Calibration Date | Due Date   |
|-------------------------------------|------------------------------------|---------------|------------------------|------------------|------------|
| <input checked="" type="checkbox"/> | SAR Probe                          | SSE2          | SN27/15 EPGO348        | 2020/12/14       | 2021/12/13 |
| <input checked="" type="checkbox"/> | Dipole                             | SID2450       | SN_09/13_DIP2G450-220  | 2020/06/25       | 2023/06/24 |
| <input checked="" type="checkbox"/> | Multimeter                         | Keithley-2000 | 4014020                | 2021/04/02       | 2022/04/01 |
| <input checked="" type="checkbox"/> | System Simulator(R&S)              | CMW500        | 130805                 | 2021/03/19       | 2022/03/18 |
| <input checked="" type="checkbox"/> | KEYSIGHT                           | E7515A        | MY56040357             | 2021/04/02       | 2022/04/01 |
| <input checked="" type="checkbox"/> | Vector Network Analyzer(R&S)       | ZVB8          | A0802530               | 2021/04/26       | 2022/04/25 |
| <input checked="" type="checkbox"/> | PC 3.5 Fixed Match Calibration Kit | ZV-Z32        | 100571                 | 2021/04/26       | 2022/04/25 |
| <input checked="" type="checkbox"/> | Dielectric Probe Kit               | SCLMP         | SN 09/13 OCPG51        | 2021/04/26       | 2022/04/25 |
| <input checked="" type="checkbox"/> | Signal Generator                   | SMU200A       | A140801888             | 2021/03/12       | 2022/03/11 |
| <input checked="" type="checkbox"/> | Amplifier                          | Nucleitudes   | 143060                 | 2021/03/12       | 2022/03/11 |
| <input checked="" type="checkbox"/> | Directional Coupler                | DC6180A       | 305827                 | 2021/03/12       | 2022/03/11 |
| <input checked="" type="checkbox"/> | Power Meter                        | NRP2          | A140401673             | 2021/03/12       | 2022/03/11 |
| <input checked="" type="checkbox"/> | Power Sensor                       | NPR-Z11       | 1138.3004.02-114072-nq | 2021/03/12       | 2022/03/11 |
| <input checked="" type="checkbox"/> | Power Meter                        | NRVS          | A0802531               | 2021/03/12       | 2022/03/11 |
| <input checked="" type="checkbox"/> | Power Sensor                       | NRV-Z4        | 100069                 | 2021/03/12       | 2022/03/11 |

## 2. Equipment Under Test (EUT)

### Identification of the Equipment under Test

|                           |  |                          |
|---------------------------|--|--------------------------|
| Device type :             | portable device  |                          |
| DUT Name:                 | Multipurpose Night Vision Monocular  |                          |
| exposure category:        | uncontrolled environment / general population                                      |                          |
| operating mode(s)         | 2.4G WI-FI   |                          |
| modulation:               | WI-FI(DSSS,OFDM)   |                          |
| Tested frequency range(s) | transmitter frequency range  | receiver frequency range |
| Wi-Fi:                    | 2412-2462 MHz  |                          |
| Hardware version :        | V1.1   |                          |
| Software version :        | V0102  |                          |
| Antenna type :            | Integrated antenna   |                          |
| MAX. SAR Value:           | Head:0.405 W/Kg( Limit:1.6W/Kg)<br>Body-Support: 0.405 W/Kg(1g-0mm, Limit:1.6W/Kg) |                          |

### 3. Specific Absorption Rate (SAR)

#### 3.1 SAR Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

The SAR definition is the time derivative (rate) of the incremental energy ( $dW$ ) absorbed by (dissipated in) an incremental mass ( $dm$ ) contained in a volume element ( $dv$ ) of a given density ( $d\rho$ ). The equation description is as below:

$$\text{SAR} = \frac{d}{dt} \left( \frac{dW}{dm} \right) = \frac{d}{dt} \left( \frac{dW}{\rho dv} \right)$$

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be either related to the temperature elevation in tissue by

$$\text{SAR} = C \frac{\delta T}{\delta t}$$

where  $C$  is the specific heat capacity,  $\delta T$  is the temperature rise and  $\delta t$  the exposure duration, or related to the electrical field in the tissue by

$$\text{SAR} = \frac{\sigma |E|^2}{\rho}$$

where  $\sigma$  is the conductivity of the tissue,  $\rho$  is the mass density of the tissue and  $E$  is the rms electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

## Phantoms

The phantom used for all tests i.e. for both system checks and device testing, was the twin-headed "SAM Phantom", manufactured by SATIMO. The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region, where shell thickness increases to 6mm).

System checking was performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.

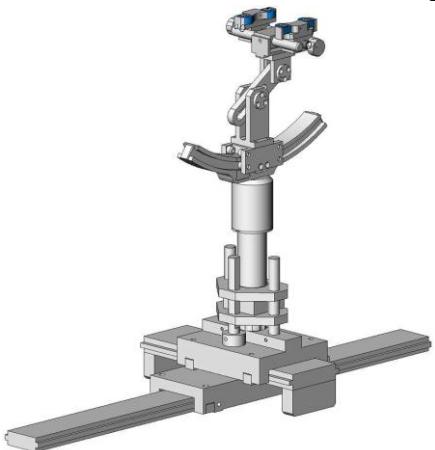


SAM Twin Phantom

## Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SATIMO as an integral part of the COMOSAR test system.

The device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.



Device holder

### 3.2 Probe Specification

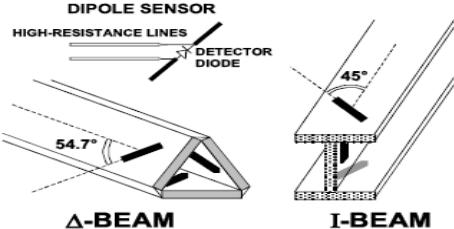


|               |  |
|---------------|--|
| Construction  | Symmetrical design with triangular core Interleaved sensors<br>Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE) |
| Calibration   | ISO/IEC 17025 calibration service available.   |
| Frequency     | 700 MHz to 3 GHz;<br>Linearity: $\pm 0.5$ dB (700 MHz to 3 GHz)  |
| Directivity   | $\pm 0.25$ dB in HSL (rotation around probe axis)<br>$\pm 0.5$ dB in tissue material (rotation normal to probe axis)   |
| Dynamic Range | 1.5 $\mu$ W/g to 100 mW/g;<br>Linearity: $\pm 0.5$ dB  |
| Dimensions    | Overall length: 330 mm (Tip: 20 mm)<br>Tip diameter: 5 mm<br>Distance from probe tip to dipole centers: <2.7 mm  |
| Application   | General dosimetry up to 3 GHz<br>Dosimetry in strong gradient fields<br>Compliance tests of mobile phones  |
| Frequency     | 700 MHz to 6 GHz;<br>Linearity: $\pm 0.5$ dB (700 MHz to 6 GHz)  |
| Dimensions    | Overall length: 330 mm<br>Tip diameter: 2.5 mm (Body: 8 mm)<br>Distance from probe tip to dipole centers: 1 mm   |
| Compatibility | COMOSAR  |

#### Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



## 4. Tissue check and recommend Dielectric Parameters

### 4.1 Recommended Tissue Dielectric Parameters

| Frequency<br>(MHz) | Tissue   |                              |
|--------------------|--|------------------------------|
|                    | Real part of the<br>complex relative<br>permittivity, $\epsilon_r$ | Conductivity, $\sigma$ (S/m) |
| 30                 | 55   | 0.75                         |
| 150                | 52.3   | 0.76                         |
| 300                | 45.3   | 0.87                         |
| 450                | 43.5   | 0.87                         |
| 750                | 41.9   | 0.89                         |
| 835                | 41.5   | 0.9                          |
| 900                | 41.5   | 0.97                         |
| 1450               | 40.5   | 1.2                          |
| 1800               | 40   | 1.4                          |
| 1900               | 40   | 1.4                          |
| 1950               | 40   | 1.4                          |
| 2000               | 40   | 1.4                          |
| 2100               | 39.8   | 1.49                         |
| 2450               | 39.2   | 1.8                          |
| 2600               | 39   | 1.96                         |
| 3000               | 38.5   | 2.4                          |
| 3500               | 37.9   | 2.91                         |
| 4000               | 37.4   | 3.43                         |
| 4500               | 36.8   | 3.94                         |
| 5000               | 36.2   | 4.45                         |
| 5200               | 36   | 4.66                         |
| 5400               | 35.8   | 4.86                         |
| 5600               | 35.5   | 5.07                         |
| 5800               | 35.3   | 5.27                         |
| 6000               | 35.1   | 5.48                         |

#### 4.2.liquid check results

Simulate liquid that are used for testing at each frequency, which are made mainly of sugar, salt and water solutions may be left in the phantoms. Dielectric Performance of Tissue Simulating Liquid

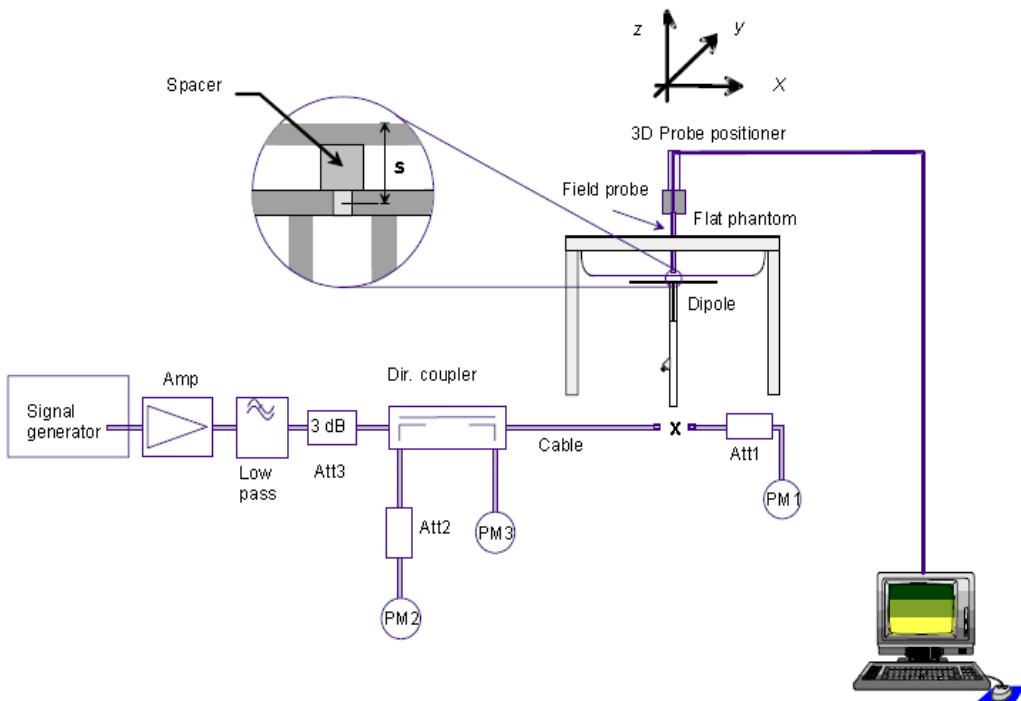
Dielectric Performance of Tissue Simulating Liquid

| /                | Frequency | Permittivity<br>$\epsilon$ | Conductivity<br>$\sigma$ (S/m) | Liquid Temp.<br>(°C) | Test Date  |
|------------------|-----------|----------------------------|--------------------------------|----------------------|------------|
| Target value     | 2450MHz   | 39.2±5%<br>(37.24~41.16)   | 1.80±5%<br>(1.71~1.89)         | 22.7                 | 2021/12/05 |
| Validation value |           | 38.92                      | 1.78                           |                      |            |

## 5. System check procedure

Prior to the assessment, the system validation kit was used to test whether the system was operating within its specifications of  $\pm 10\%$ . The validation results are tabulated below. And also the corresponding SAR plot is attached as well in the SAR plots files.

The following procedure, recommended for performing validation tests using box phantoms is based on the procedures described in the IEEE standard P1528. Setup according to the setup diagram below :



With the SG and Amp and with directional coupler in place, set up the source signal at the relevant frequency and use a power meter to measure the power at the end of the SMA cable that you intend to connect to the balanced dipole. Adjust the SG to make this, say, 0.01W (10 dBm). If this level is too high to read directly with the power meter sensor, insert a calibrated attenuator (e.g. 10 or 20 dB) and make a suitable correction to the power meter reading.

Note 1: In this method, the directional coupler is used for monitoring rather than setting the exact feed power level.

If, however, the directional coupler is used for power measurement, you should check the frequency range and power rating of the coupler and measure the coupling factor (referred to output) at the test frequency using a VNA.

Note 2: Remember that the use of a 3dB attenuator (as shown in Figure 8.1 of P1528) means that you need an RF amplifier of 2 times greater power for the same feed power. The other issue is the cable length. You might get up to 1dB of loss per meter of cable, so the cable length after the coupler needs to be quite short.

Note 3: For the validation testing done using CW signals, most power meters are suitable. However, if you are measuring the output of a modulated signal from either a signal generator or a handset, you must ensure that the power meter correctly reads the modulated signals.

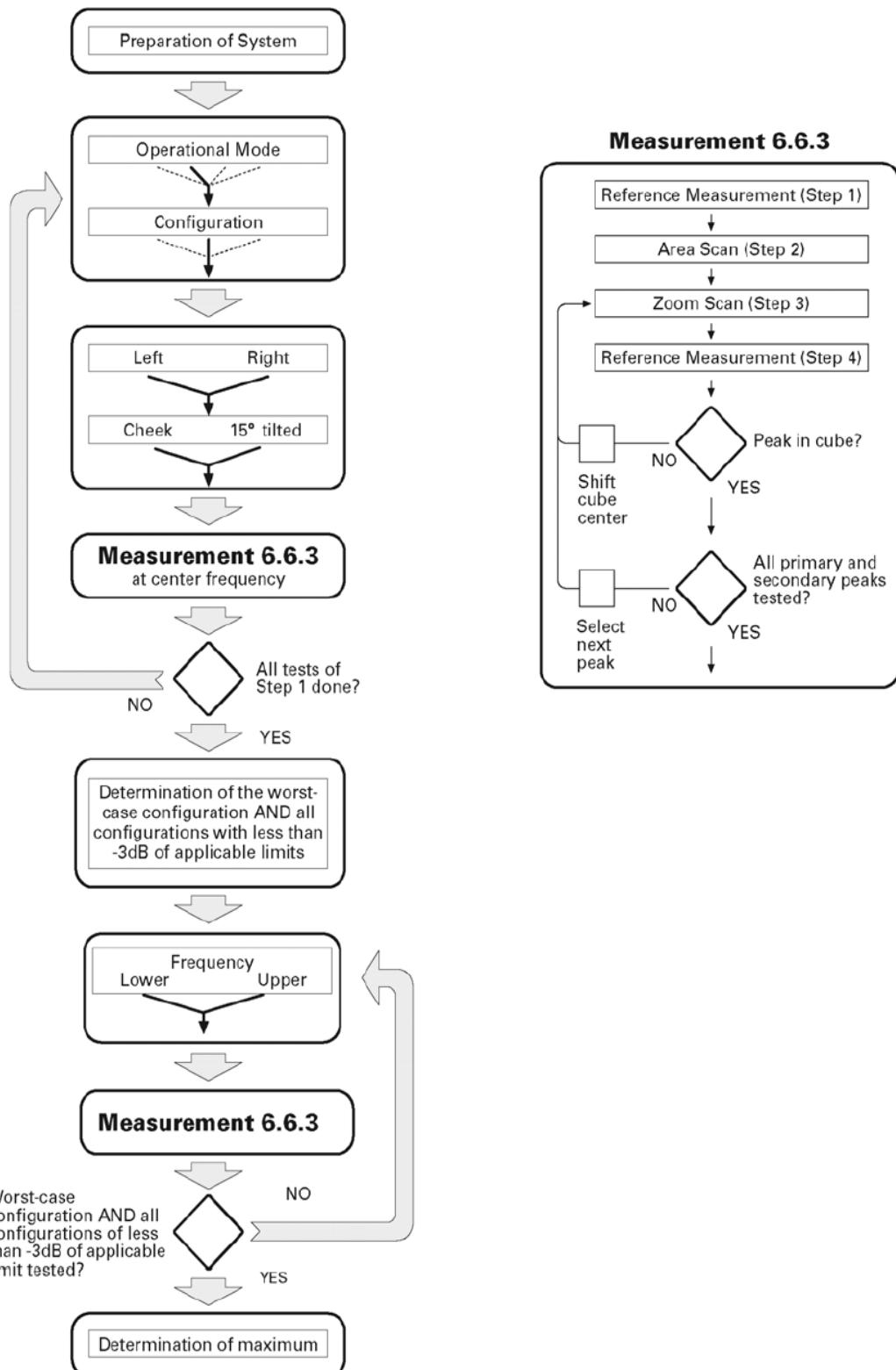
## System Check Results

| Frequency | Duty cycle | Target value (1-g)<br>(W/Kg)    | Test value<br>(1-g)<br>(W/Kg) | Test SAR<br>Normalized to<br>1W(w/Kg) | Test Date  |
|-----------|------------|---------------------------------|-------------------------------|---------------------------------------|------------|
| 2450MHz   | 1:1        | 53.71W/kg ±10%<br>(48.34~59.08) | 0.5412                        | 54.12                                 | 2021/12/05 |

\*Note: All SAR values are normalized to 1W forward power.

## 6. SAR measurement procedure

The SAR test against the head phantom was carried out as follow:



The same procedure should be also executed for the operation mode of the testing Frequency.

The SAR test against the body-worn was carried out as follow:

After an area scan has been done at a fixed distance of 2mm from the surface of the phantom on the source side, a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power drift during measurement to be assessed.

Above is the scanning procedure flow chart and table from the IEEEp1528 standard. This is the procedure for which all compliant testing should be carried out to ensure that all variations of the device position and transmission behavior are tested.

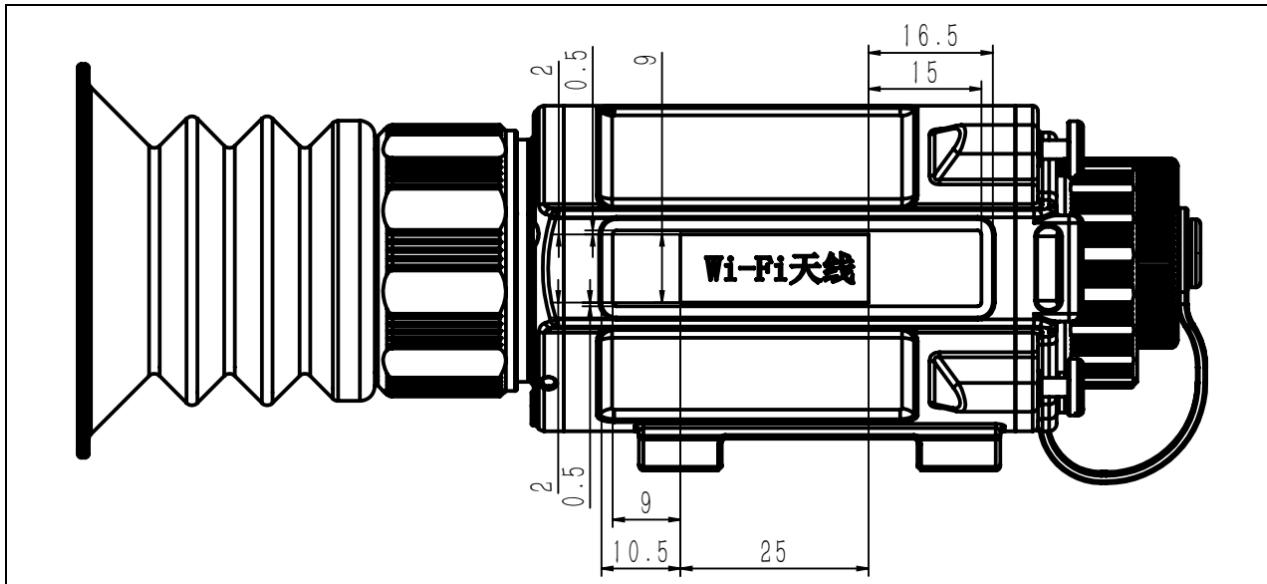
## 7. RF Conducted Power

### Wi-Fi 2.4G Output power

| 2.4G WI-FI<br>Channel/Freq.(MHz) | Average Power (dBm) |         |               |
|----------------------------------|---------------------|---------|---------------|
|                                  | 802.11b             | 802.11g | 802.11n(HT20) |
| 1(2412.0)                        | 14.83               | 13.53   | 13.00         |
| 6(2437.0)                        | 15.50               | 13.61   | 13.29         |
| 11(2462.0)                       | 15.40               | 13.67   | 12.31         |

| Operation Mode       | Channel<br>/Frequency | Output<br>Power(dBm) | Tune up Power in<br>tolerance (dBm) | Max. Tune<br>up(dBm) | Scaling<br>Factor |
|----------------------|-----------------------|----------------------|-------------------------------------|----------------------|-------------------|
| WIFI 2.4G<br>802.11b | 1/2412.0              | 14.83                | 14.0±1                              | 15.0                 | 1.040             |
|                      | 6/2437.0              | 15.50                | 15.0±1                              | 16.0                 | 1.122             |
|                      | 11/2462.0             | 15.40                | 14.5±1                              | 15.5                 | 1.023             |

### Antenna Location:



## Test Results

### Results overview of WI-FI 802.11b

| Head & Body-Support (0mm) | Channel /Frequency | Mode | SAR Value (W/kg)1-g | Power drift(%) | Scaled Factor | Scaled SAR (W/Kg)1-g | Limit (W/kg) | SAR Plot. |
|---------------------------|--------------------|------|---------------------|----------------|---------------|----------------------|--------------|-----------|
| Face Upward               | 6/2437             | DSSS | 0.059               | -2.10          | 1.122         | 0.066                | 1.6          | /         |
| Back Upward               | 6/2437             | DSSS | 0.021               | 1.08           | 1.122         | 0.024                | 1.6          | /         |
| Edge A                    | 6/2437             | DSSS | <b>0.361</b>        | -3.95          | 1.122         | <b>0.405</b>         | 1.6          | Yes       |
| Edge B                    | 6/2437             | DSSS | 0.043               | 0.75           | 1.122         | 0.048                | 1.6          | /         |
| Edge C                    | 6/2437             | DSSS | 0.009               | -3.82          | 1.122         | 0.010                | 1.6          | /         |

Note: 1) The EUT ANT side directly touch the Phantom.

2) Device can close to human head and the device surface can touch the Flat phantom, According to KDB4479498, for the head mode also use flat phantom to performed the head testing

3) The SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at mid-band channel for each test configuration is at least 3.0 dB lower than the SAR limit (< 1 W/kg), testing at the high and low channels is optional, apart from the worst case configuration.

## 8. Measurement Uncertainty

| No.                             | Uncertainty Component   | Type | Uncertainty Value (%) | Probability Distribution | k          | ci  | Standard Uncertainty (%) $ui(\%)$ | Degree of freedom $V_{eff}$ or $vi$ |
|---------------------------------|---|------|-----------------------|--------------------------|------------|-----|-----------------------------------|-------------------------------------|
| <b>Measurement System</b>       |   |      |                       |                          |            |     |                                   |                                     |
| 1                               | – Probe Calibration   | B    | 5.8                   | N                        | 1          | 1   | 5.8                               | $\infty$                            |
| 2                               | – Axial isotropy  | B    | 3.5                   | R                        | $\sqrt{3}$ | 0.5 | 1.43                              | $\infty$                            |
| 3                               | - Hemispherical Isotropy  | B    | 5.9                   | R                        | $\sqrt{3}$ | 0.5 | 2.41                              | $\infty$                            |
| 4                               | – Boundary Effect   | B    | 1                     | R                        | $\sqrt{3}$ | 1   | 0.58                              | $\infty$                            |
| 5                               | – Linearity   | B    | 4.7                   | R                        | $\sqrt{3}$ | 1   | 2.71                              | $\infty$                            |
| 6                               | – System Detection Limits   | B    | 1.0                   | R                        | $\sqrt{3}$ | 1   | 0.58                              | $\infty$                            |
| 7                               | Modulation response   | B    | 3                     | N                        | 1          | 1   | 3.00                              |                                     |
| 8                               | – Readout Electronics   | B    | 0.5                   | N                        | 1          | 1   | 0.50                              | $\infty$                            |
| 9                               | – Response Time   | B    | 1.4                   | R                        | $\sqrt{3}$ | 1   | 0.81                              | $\infty$                            |
| 10                              | – Integration Time  | B    | 3.0                   | R                        | $\sqrt{3}$ | 1   | 1.73                              | $\infty$                            |
| 11                              | – RF Ambient Conditions   | B    | 3.0                   | R                        | $\sqrt{3}$ | 1   | 1.73                              | $\infty$                            |
| 12                              | – Probe Position Mechanical tolerance   | B    | 1.4                   | R                        | $\sqrt{3}$ | 1   | 0.81                              | $\infty$                            |
| 13                              | – Probe Position with respect to Phantom Shell                                    | B    | 1.4                   | R                        | $\sqrt{3}$ | 1   | 0.81                              | $\infty$                            |
| 14                              | – Extrapolation, Interpolation and Integration Algorithms for Max. SAR evaluation | B    | 2.3                   | R                        | $\sqrt{3}$ | 1   | 1.33                              | $\infty$                            |
| <b>Uncertainties of the DUT</b> |   |      |                       |                          |            |     |                                   |                                     |
| 15                              | – Position of the DUT   | A    | 2.6                   | N                        | $\sqrt{3}$ | 1   | 2.6                               | 5                                   |
| 16                              | – Holder of the DUT   | A    | 3                     | N                        | $\sqrt{3}$ | 1   | 3.0                               | 5                                   |
| 17                              | – Output Power Variation<br>–SAR drift measurement                                | B    | 5.0                   | R                        | $\sqrt{3}$ | 1   | 2.89                              | $\infty$                            |

| Phantom and Tissue Parameters                                |   |   |     |     |            |     |       |          |
|--|---|---|-----|-----|------------|-----|-------|----------|
| 18   | – Phantom Uncertainty(shape and thickness tolerances)                         | B | 4   | R   | $\sqrt{3}$ | 1   | 2.31  | $\infty$ |
| 19   | Uncertainty in SAR correction for deviation(in permittivity and conductivity) | B | 2   | N   | 1          | 1   | 2.00  |          |
| 20   | – Liquid Conductivity Target –tolerance                                       | B | 2.5 | R   | $\sqrt{3}$ | 0.6 | 1.95  | $\infty$ |
| 21   | – Liquid Conductivity –measurement Uncertainty)                               | B | 4   | N   | $\sqrt{3}$ | 1   | 0.92  | 9        |
| 22   | – Liquid Permittivity Target tolerance  | B | 2.5 | R   | $\sqrt{3}$ | 0.6 | 1.95  | $\infty$ |
| 23   | – Liquid Permittivity –measurement uncertainty                                | B | 5   | N   | $\sqrt{3}$ | 1   | 1.15  | $\infty$ |
| <b>Combined Standard Uncertainty</b>                         |   |   |     | RSS |            |     | 10.63 |          |
| <b>Expanded uncertainty</b><br>(Confidence interval of 95 %) |   |   |     | K=2 |            |     | 21.26 |          |

## System Check Uncertainty

| No.                             | Uncertainty Component   | Type | Uncertainty Value (%) | Probability Distribution | k          | ci  | Standard Uncertainty (%) $u_i(\%)$ | Degree of freedom $V_{eff}$ or $v_i$ |
|---------------------------------|---|------|-----------------------|--------------------------|------------|-----|------------------------------------|--------------------------------------|
| <b>Measurement System</b>       |   |      |                       |                          |            |     |                                    |                                      |
| 1                               | – Probe Calibration   | B    | 5.8                   | N                        | 1          | 1   | 5.8                                | $\infty$                             |
| 2                               | – Axial isotropy  | B    | 3.5                   | R                        | $\sqrt{3}$ | 0.5 | 1.43                               | $\infty$                             |
| 3                               | - Hemispherical Isotropy  | B    | 5.9                   | R                        | $\sqrt{3}$ | 0.5 | 2.41                               | $\infty$                             |
| 4                               | – Boundary Effect   | B    | 1                     | R                        | $\sqrt{3}$ | 1   | 0.58                               | $\infty$                             |
| 5                               | – Linearity   | B    | 4.7                   | R                        | $\sqrt{3}$ | 1   | 2.71                               | $\infty$                             |
| 6                               | – System Detection Limits   | B    | 1                     | R                        | $\sqrt{3}$ | 1   | 0.58                               | $\infty$                             |
| 7                               | Modulation response   | B    | 0                     | N                        | 1          | 1   | 0.00                               |                                      |
| 8                               | – Readout Electronics   | B    | 0.5                   | N                        | 1          | 1   | 0.50                               | $\infty$                             |
| 9                               | – Response Time   | B    | 0.00                  | R                        | $\sqrt{3}$ | 1   | 0.00                               | $\infty$                             |
| 10                              | – Integration Time  | B    | 1.4                   | R                        | $\sqrt{3}$ | 1   | 0.81                               | $\infty$                             |
| 11                              | – RF Ambient Conditions   | B    | 3.0                   | R                        | $\sqrt{3}$ | 1   | 1.73                               | $\infty$                             |
| 12                              | – Probe Position Mechanical tolerance   | B    | 1.4                   | R                        | $\sqrt{3}$ | 1   | 0.81                               | $\infty$                             |
| 13                              | – Probe Position with respect to Phantom Shell                                    | B    | 1.4                   | R                        | $\sqrt{3}$ | 1   | 0.81                               | $\infty$                             |
| 14                              | – Extrapolation, Interpolation and Integration Algorithms for Max. SAR evaluation | B    | 2.3                   | R                        | $\sqrt{3}$ | 1   | 1.33                               | $\infty$                             |
| <b>Uncertainties of the DUT</b> |   |      |                       |                          |            |     |                                    |                                      |
| 15                              | Deviation of experimental source from numerical source                            | A    | 4                     | N                        | 1          | 1   | 4.00                               | 5                                    |
| 16                              | Input Power and SAR drift measurement   | A    | 5                     | R                        | $\sqrt{3}$ | 1   | 2.89                               | 5                                    |
| 17                              | Dipole Axis to Liquid Distance  | B    | 2                     | R                        | $\sqrt{3}$ | 1   | 1.2                                | $\infty$                             |

| Phantom and Tissue Parameters                                |   |   |     |     |            |     |       |          |
|--|---|---|-----|-----|------------|-----|-------|----------|
| 18   | – Phantom Uncertainty(shape and thickness tolerances)                         | B | 4   | R   | $\sqrt{3}$ | 1   | 2.31  | $\infty$ |
| 19   | Uncertainty in SAR correction for deviation(in permittivity and conductivity) | B | 2   | N   | 1          | 1   | 2.00  |          |
| 20   | – Liquid Conductivity Target –tolerance                                       | B | 2.5 | R   | $\sqrt{3}$ | 0.6 | 1.95  | $\infty$ |
| 21   | – Liquid Conductivity –measurement Uncertainty)                               | B | 4   | N   | $\sqrt{3}$ | 1   | 0.92  | 9        |
| 22   | – Liquid Permittivity Target tolerance  | B | 2.5 | R   | $\sqrt{3}$ | 0.6 | 1.95  | $\infty$ |
| 23   | – Liquid Permittivity –measurement uncertainty                                | B | 5   | N   | $\sqrt{3}$ | 1   | 1.15  | $\infty$ |
| <b>Combined Standard Uncertainty</b>                         |   |   |     | RSS |            |     | 10.15 |          |
| <b>Expanded uncertainty</b><br>(Confidence interval of 95 %) |   |   |     | K=2 |            |     | 20.29 |          |



## **ANNEX A: SAR Test Setup**

Photo 1: Measurement System SATIMO



Photo 2: Liquid deep(15cm)



Photo 3: Front Side 0mm



Photo 4: Back Side 0mm

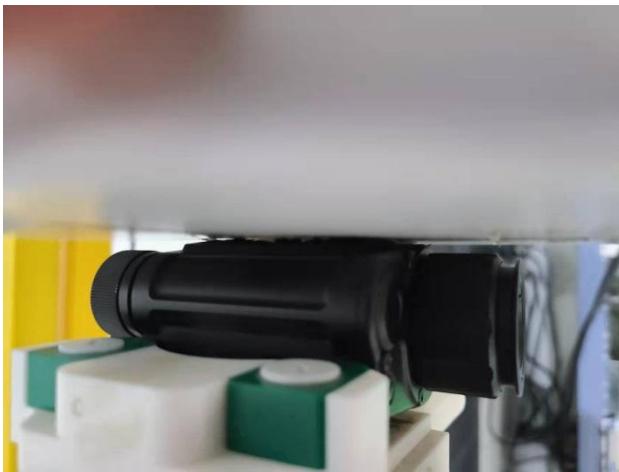


Photo 5: side A 0mm



Photo 6: side B 0mm



Photo 7: side C 0mm



EUT Front View



EUT Back View





## ANNEX B: System Check Plots

## System Performance Check (2450MHz)

Type: Phone measurement

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=5mm, dy=5mm, dz=5mm

Date of measurement: 12/05/2021

Measurement duration: 19 minutes 04 seconds

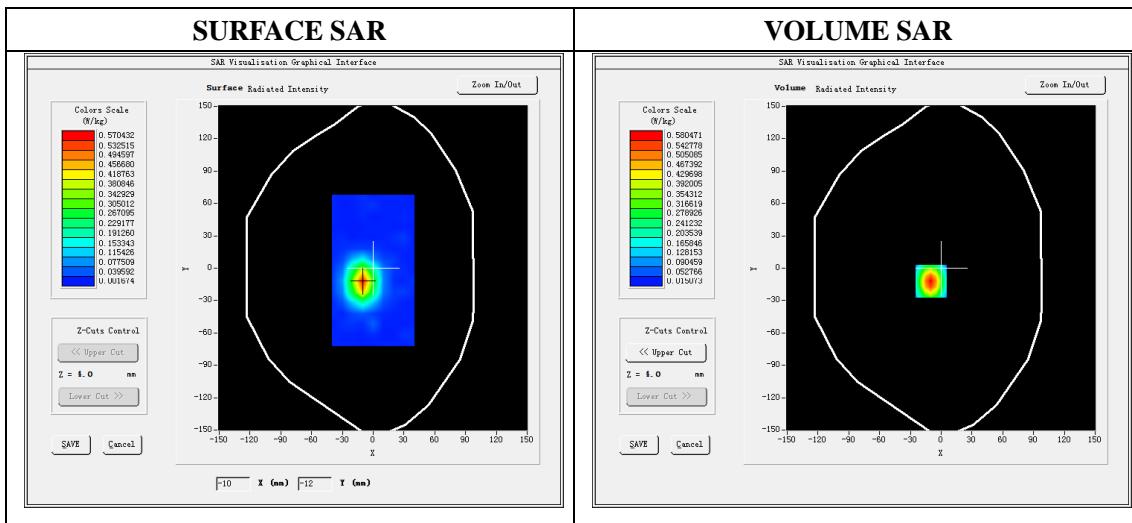
### A. Experimental conditions.

|                        |                            |
|------------------------|----------------------------|
| <b>Area Scan</b>       | dx=8mm dy=8mm              |
| <b>ZoomScan</b>        | 7x7x7,dx=5mm dy=5mm dz=5mm |
| <b>Phantom</b>         | Validation plane           |
| <b>Device Position</b> | Dipole                     |
| <b>Band</b>            | 2450MHz                    |
| <b>Channels</b>        | Middle                     |
| <b>Signal</b>          | CW (Crest factor: 1.0)     |

### B. SAR Measurement Results

#### Band SAR

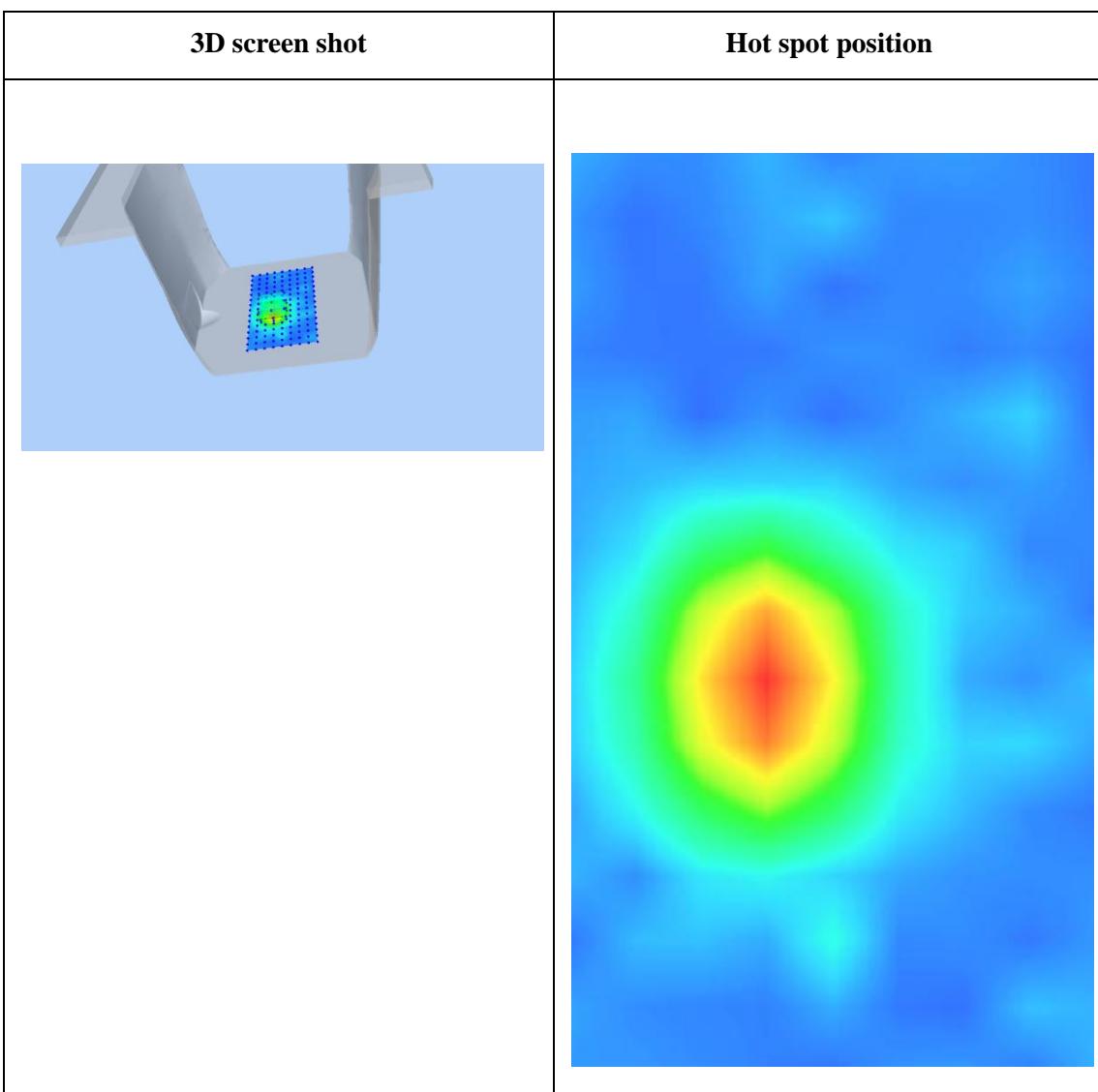
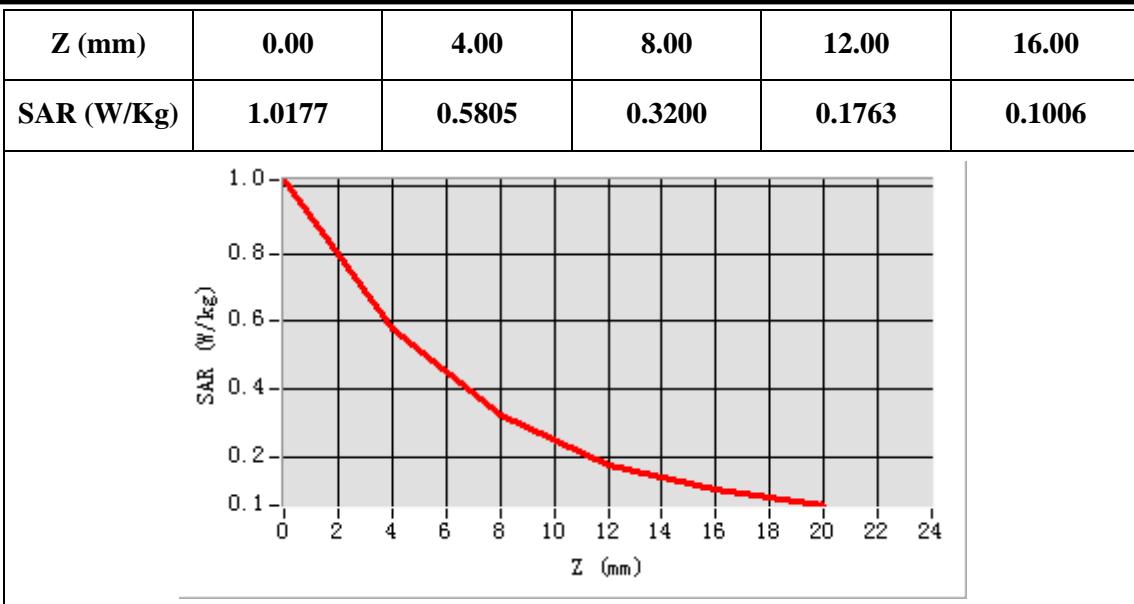
|  |                         |
|--|-------------------------|
| <b>E-Field Probe</b>                     | SATIMO SN_36/20_EPGO348 |
| <b>Frequency (MHz)</b>                   | 2450                    |
| <b>Relative permittivity (real part)</b> | 38.92                   |
| <b>Relative permittivity</b>             | 13.06                   |
| <b>Conductivity (S/m)</b>                | 1.78                    |
| <b>Power Drift (%)</b>                   | 2.15                    |
| <b>Liquid Temperature:</b>               | 22.7 °C                 |
| <b>ConvF:</b>                            | 2.40                    |



Maximum location: X=-10.00, Y=-12.00

SAR Peak: 1.02 W/kg

|                       |          |
|-----------------------|----------|
| <b>SAR 10g (W/Kg)</b> | 0.251890 |
| <b>SAR 1g (W/Kg)</b>  | 0.541185 |





## **ANNEX C: SAR Test Plots**

## Testing result (WI-FI 802.11b, Edge A, Middle,0mm)

Type: Phone measurement

Date of measurement: 12/05/2021

Measurement duration: 18 minutes 49 seconds

Mobile Phone IMEI number: --

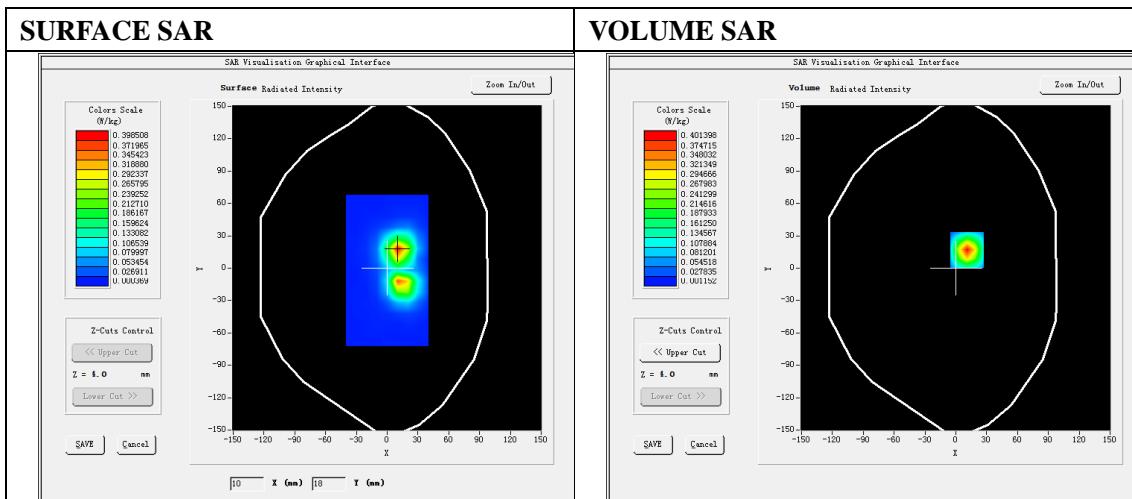
### A. Experimental conditions.

|                        |                               |
|------------------------|-------------------------------|
| <b>Area Scan</b>       | $dx=12mm dy=12mm$             |
| <b>ZoomScan</b>        | $7x7x7, dx=5mm dy=5mm dz=5mm$ |
| <b>Phantom</b>         | Validation plane              |
| <b>Device Position</b> | Body                          |
| <b>Band</b>            | WI-FI 802.11b                 |
| <b>Channels</b>        | Middle                        |
| <b>Signal</b>          | DSSS (Duty cycle: 1:1)        |

### B. SAR Measurement Results

#### Band SAR

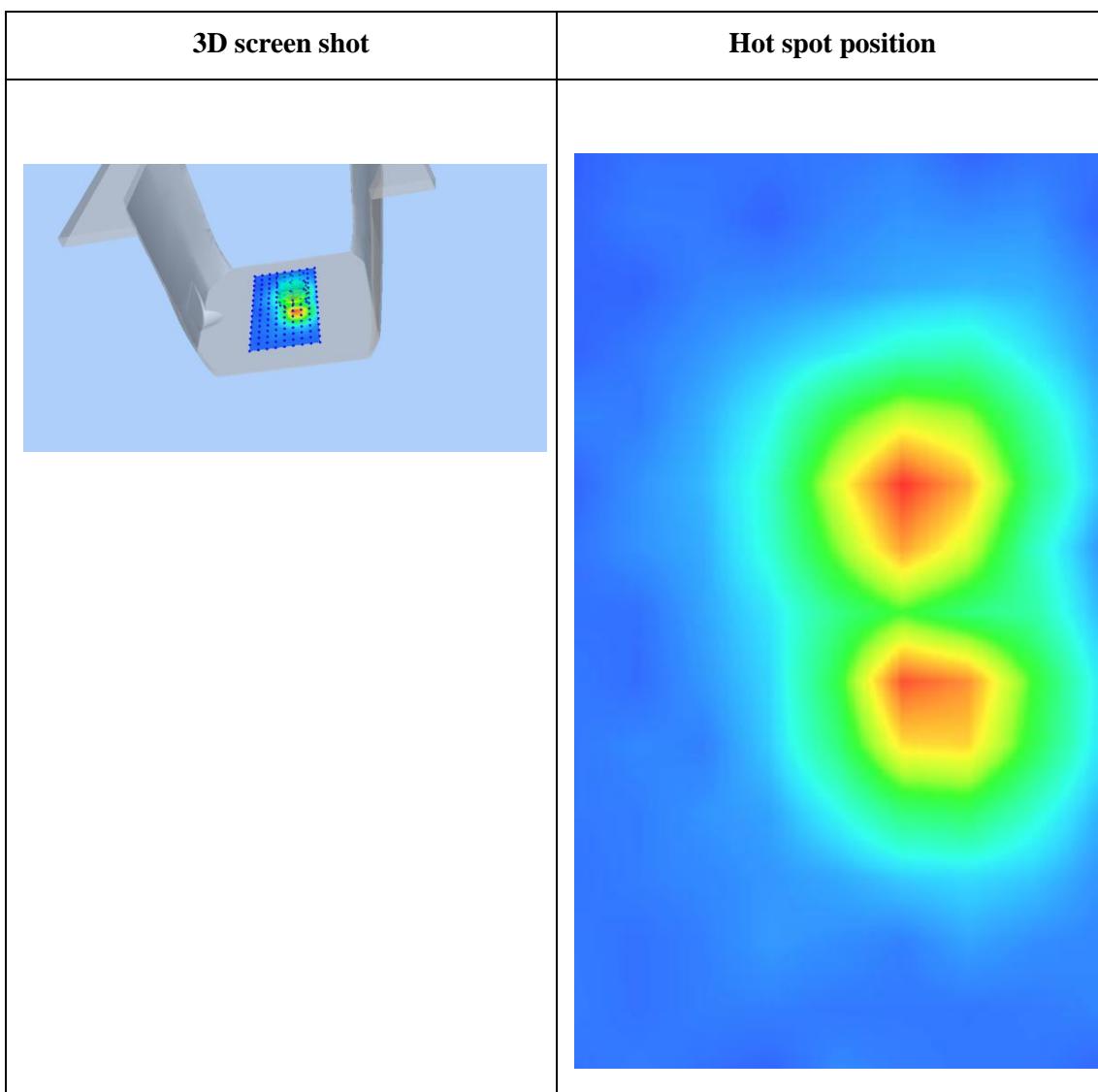
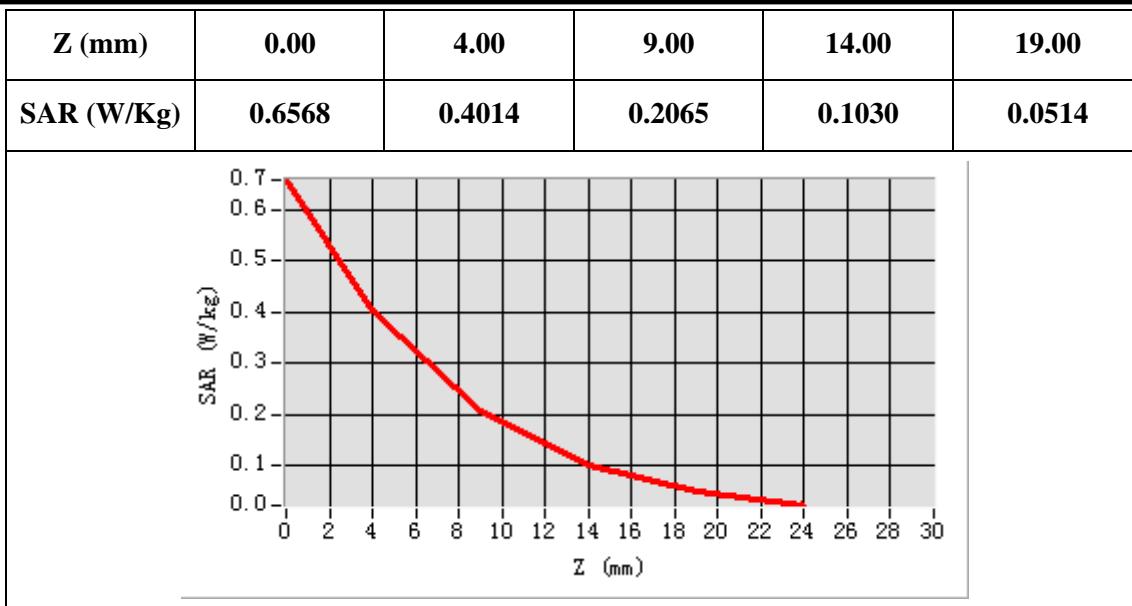
|   |       |
|---|-------|
| <b>Frequency (MHz)</b>                        | 2437  |
| <b>Relative permittivity (real part)</b>      | 39.02 |
| <b>Relative permittivity (imaginary part)</b> | 12.98 |
| <b>Conductivity (S/m)</b>                     | 1.76  |
| <b>Variation (%)</b>                          | -3.95 |
| <b>ConvF:</b>                                 | 2.40  |



Maximum location: X=11.00, Y=17.00

SAR Peak: 0.66 W/kg

|                       |          |
|-----------------------|----------|
| <b>SAR 10g (W/Kg)</b> | 0.160964 |
| <b>SAR 1g (W/Kg)</b>  | 0.360516 |





## **ANNEX D: Calibration Certificate**

## EPGO348 Probe Calibration Report

**COMOSAR E-Field Probe Calibration Report**

Ref : ACR.349.1.20.MVGB.A

**CCIC SOUTHERN TESTING CO., LTD**  
**ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD,**  
**XILI STREET, NANSHAN DISTRICT**  
**SHENZHEN, GUANGDONG, CHINA**  
**MVG COMOSAR DOSIMETRIC E-FIELD PROBE**  
**SERIAL NO.: SN 36/20 EPGO348**

**Calibrated at MVG****Z.I. de la pointe du diable**

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

**Calibration date: 12/14/2020**Accreditations #2-6789 and #2-6814  
Scope available on [www.cofrac.fr](http://www.cofrac.fr)**Summary:**

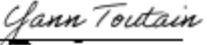
This document presents the method and results from an accredited COMOSAR E-Field Probe calibration performed at MVG, using the CALIPROBE test bench, for use with a MVG COMOSAR system only. The test results covered by accreditation are traceable to the International System of Units (SI).

Page: 1/10



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR\_349.1.20.MVGB.A

|               | Name         | Function            | Date       | Signature   |
|---------------|--------------|---------------------|------------|---|
| Prepared by : | Jérôme LUC   | Technical Manager   | 12/14/2020 |  |
| Checked by :  | Jérôme LUC   | Technical Manager   | 12/14/2020 |  |
| Approved by : | Yann Toutain | Laboratory Director | 12/15/2020 |  |

2020.12.1  
5 12:26:45  
+01'00'

|                | Customer Name                        |
|----------------|--------------------------------------|
| Distribution : | CCIC SOUTHERN<br>TESTING CO.,<br>LTD |

| Issue | Name       | Date       | Modifications   |
|-------|------------|------------|-----------------|
| A     | Jérôme LUC | 12/14/2020 | Initial release |
|       |            |            |                 |
|       |            |            |                 |
|       |            |            |                 |

Page: 2/10

Template\_ACR.DDD.N.YY.MVGB.ISSUE\_COMOSAR Probe vH

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

**TABLE OF CONTENTS**

|     |                                       |    |
|-----|---------------------------------------|----|
| 1   | Device Under Test .....               | 4  |
| 2   | Product Description .....             | 4  |
| 2.1 | General Information .....             | 4  |
| 3   | Measurement Method .....              | 4  |
| 3.1 | Linearity .....                       | 4  |
| 3.2 | Sensitivity .....                     | 5  |
| 3.3 | Lower Detection Limit .....           | 5  |
| 3.4 | Isotropy .....                        | 5  |
| 3.1 | Boundary Effect .....                 | 5  |
| 4   | Measurement Uncertainty .....         | 6  |
| 5   | Calibration Measurement Results ..... | 6  |
| 5.1 | Sensitivity in air .....              | 6  |
| 5.2 | Linearity .....                       | 7  |
| 5.3 | Sensitivity in liquid .....           | 8  |
| 5.4 | Isotropy .....                        | 9  |
| 6   | List of Equipment .....               | 10 |

Page: 3/10

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

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.349.1.20.MVGB.A

**1 DEVICE UNDER TEST**

| Device Under Test                        |   |
|--|---|
| Device Type                              | COMOSAR DOSIMETRIC E FIELD PROBE  |
| Manufacturer                             | MVG   |
| Model                                    | SSE2  |
| Serial Number                            | SN 36/20 EPGO348  |
| Product Condition (new / used)           | New   |
| Frequency Range of Probe                 | 0.15 GHz-6GHz   |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.214 MΩ<br>Dipole 2: R2=0.208 MΩ<br>Dipole 3: R3=0.238 MΩ |

**2 PRODUCT DESCRIPTION****2.1 GENERAL INFORMATION**

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



Figure 1 – MVG COMOSAR Dosimetric E field Dipole

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

**3 MEASUREMENT METHOD**

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

**3.1 LINEARITY**

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

Page: 4/10

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

*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*



### 3.2 SENSITIVITY

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

### 3.3 LOWER DETECTION LIMIT

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

### 3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 to 360 degrees in 15-degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

### 3.1 BOUNDARY EFFECT

The boundary effect is defined as the deviation between the SAR measured data and the expected exponential decay in the liquid when the probe is oriented normal to the interface. To evaluate this effect, the liquid filled flat phantom is exposed to fields from either a reference dipole or waveguide. With the probe normal to the phantom surface, the peak spatial average SAR is measured and compared to the analytical value at the surface.

The boundary effect uncertainty can be estimated according to the following uncertainty approximation formula based on linear and exponential extrapolations between the surface and  $d_{be}$  +  $d_{step}$  along lines that are approximately normal to the surface:

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

where

|                                   |  |
|-----------------------------------|--|
| $\text{SAR}_{\text{uncertainty}}$ | is the uncertainty in percent of the probe boundary effect   |
| $d_{be}$                          | is the distance between the surface and the closest <i>zoom-scan</i> measurement point, in millimetre  |
| $\Delta_{\text{step}}$            | is the separation distance between the first and second measurement points that are closest to the phantom surface, in millimetre, assuming the boundary effect at the second location is negligible |
| $\delta$                          | is the minimum penetration depth in millimetres of the head tissue-equivalent liquids defined in this standard, i.e., $\delta \approx 14$ mm at 3 GHz;   |
| $\Delta \text{SAR}_{\text{be}}$   | in percent of SAR is the deviation between the measured SAR value, at the distance $d_{be}$ from the boundary, and the analytical SAR value.   |

Page: 5/10

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

*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.349.1.20.MVGB.A

The measured worst case boundary effect SARuncertainty[%] for scanning distances larger than 4mm is 1.0% Limit ,2%).

#### 4 MEASUREMENT UNCERTAINTY

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

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

#### 5 CALIBRATION MEASUREMENT RESULTS

| Calibration Parameters |             |
|------------------------|-------------|
| Liquid Temperature     | 20 +/- 1 °C |
| Lab Temperature        | 20 +/- 1 °C |
| Lab Humidity           | 30-80 %     |

##### 5.1 SENSITIVITY IN AIR

| Normx dipole 1 ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) | Normy dipole 2 ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) | Normz dipole 3 ( $\mu\text{V}/(\text{V}/\text{m})^2$ ) |
|--|--|--|
| 0.45   | 0.66   | 0.91   |

| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|-------------------|-------------------|-------------------|
| 104               | 105               | 108               |

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

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

Page: 6/10

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

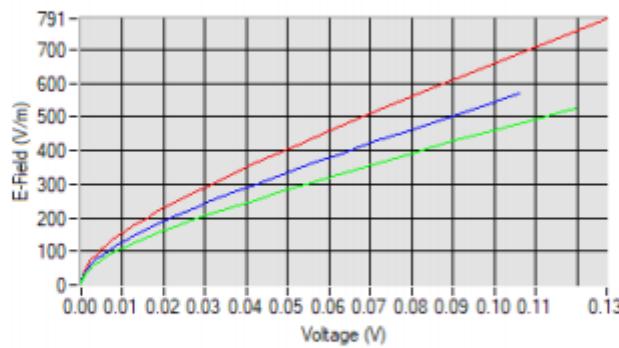
*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.349.1.20.MVGB.A

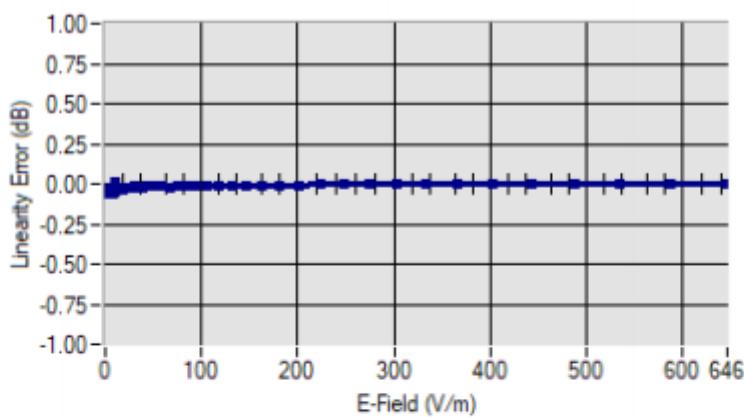
## Calibration curves



Dipole 1  
Dipole 2  
Dipole 3

5.2 LINEARITY

## Linearity



Linearity: +/-1.46% (+/-0.06dB)

Page: 7/10

Template: ACR.DDD.N.YY.MVGB.ISSUE: COMOSAR Probe vH

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.349.1.20.MVGB.A

5.3 SENSITIVITY IN LIQUID

| <u>Liquid</u> | <u>Frequency<br/>(MHz +/-<br/>100MHz)</u> | <u>ConvF</u> |
|---------------|---|--------------|
| HL600         | 600                                       | 1.81         |
| HL750         | 750                                       | 1.85         |
| HL835         | 835                                       | 1.93         |
| HL900         | 900                                       | 1.96         |
| HL1500        | 1500                                      | 2.21         |
| HL1750        | 1750                                      | 2.22         |
| HL1800        | 1800                                      | 2.17         |
| HL1900        | 1900                                      | 2.40         |
| HL2000        | 2000                                      | 2.43         |
| HL2300        | 2300                                      | 2.36         |
| HL2450        | 2450                                      | 2.40         |
| HL2600        | 2600                                      | 2.29         |
| HL3300        | 3300                                      | 2.28         |
| HL3500        | 3500                                      | 2.16         |
| HL3700        | 3700                                      | 2.19         |
| HL3900        | 3900                                      | 2.54         |
| HL4200        | 4200                                      | 2.86         |
| HL4600        | 4600                                      | 2.77         |
| HL4900        | 4900                                      | 2.63         |
| HL5200        | 5200                                      | 2.01         |
| HL5400        | 5400                                      | 2.04         |
| HL5600        | 5600                                      | 2.18         |
| HL5800        | 5800                                      | 2.07         |

LOWER DETECTION LIMIT: 9mW/kg

Page: 8/10

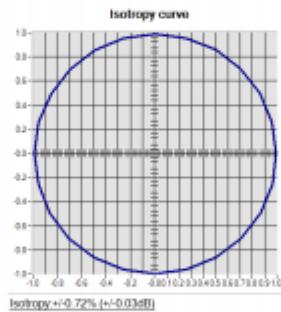
Template\_ACR.DDD.N.YY.MVGB.ISSUE\_COMOSAR Probe vH

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.349.1.20.MVGB.A

5.4 ISOTROPYHL1800 MHz

Page: 9/10

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

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.349.1.20.MVGB.A

## 6 LIST OF EQUIPMENT

| Equipment Summary Sheet            |                         |                    |   |   |
|------------------------------------|-------------------------|--------------------|---|---|
| Equipment Description              | Manufacturer / Model    | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| Flat Phantom                       | MVG                     | SN-20/09-SAM71     | Validated. No cal required.                   | Validated. No cal required.                   |
| COMOSAR Test Bench                 | Version 3               | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer                   | Rohde & Schwarz ZVM     | 100203             | 05/2019                                       | 05/2022                                       |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223             | 05/2019                                       | 05/2022                                       |
| Multimeter                         | Keithley 2000           | 1160271            | 02/2020                                       | 02/2023                                       |
| Signal Generator                   | Rohde & Schwarz SMB     | 106589             | 04/2019                                       | 04/2022                                       |
| Amplifier                          | Aethercomm              | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                        | NI-USB 5680             | 170100013          | 05/2019                                       | 05/2022                                       |
| Directional Coupler                | Narda 4216-20           | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Waveguide                          | Mega Industries         | 069Y7-158-13-712   | Validated. No cal required.                   | Validated. No cal required.                   |
| Waveguide Transition               | Mega Industries         | 069Y7-158-13-701   | Validated. No cal required.                   | Validated. No cal required.                   |
| Waveguide Termination              | Mega Industries         | 069Y7-158-13-701   | Validated. No cal required.                   | Validated. No cal required.                   |
| Temperature / Humidity Sensor      | Testo 184 H1            | 44220687           | 05/2020                                       | 05/2023                                       |

Page: 10/10

Template: ACR.DDD.N.YY.MVGB.ISSUE: COMOSAR Probe vH

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.

## SID2450 Dipole Calibration Report

**SAR Reference Dipole Calibration Report**

Ref : ACR.178.8.20.MVGB.A

**CCIC SOUTHERN TESTING CO., LTD**  
**ELECTRONIC TESTING BUILDING, NO. 43 SHAHE ROAD,**  
**XILI STREET, NANSHAN DISTRICT**  
**SHENZHEN, GUANGDONG, CHINA**  
**MVG COMOSAR REFERENCE DIPOLE**  
**FREQUENCY: 2450 MHZ**  
**SERIAL NO.: SN 09/13 DIP2G450-220**

**Calibrated at MVG MVG****Z.I. de la pointe du diable****Technopôle Brest Iroise – 295 avenue Alexis de Rochon  
29280 PLOUZANE - FRANCE****Calibration date: 06/25/2020**Accreditations #2-6789 and #2-6814  
Scope available on [www.cofrac.fr](http://www.cofrac.fr)**Summary:**

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

Page: 1/11



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.178.8.20.MVGB.A

|               | Name         | Function            | Date      | Signature   |
|---------------|--------------|---------------------|-----------|---|
| Prepared by : | Jérôme LUC   | Technical Manager   | 6/26/2020 |  |
| Checked by :  | Jérôme LUC   | Technical Manager   | 6/26/2020 |  |
| Approved by : | Yann Toutain | Laboratory Director | 6/26/2020 |  |

|                |                                      |
|----------------|--------------------------------------|
|                | Customer Name                        |
| Distribution : | CCIC SOUTHERN<br>TESTING CO.,<br>LTD |

| Issue | Name       | Date      | Modifications   |
|-------|------------|-----------|-----------------|
| A     | Jérôme LUC | 6/26/2020 | Initial release |
|       |            |           |                 |
|       |            |           |                 |
|       |            |           |                 |

Page: 2/11

Template\_ACR.DDD.N.VV.MVGB.ISSUE\_SAR Reference Dipole v6

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.



## TABLE OF CONTENTS

|     |  |    |
|-----|--|----|
| 1   | Introduction.....                              | 4  |
| 2   | Device Under Test .....                        | 4  |
| 3   | Product Description .....                      | 4  |
| 3.1 | General Information .....                      | 4  |
| 4   | Measurement Method .....                       | 5  |
| 4.1 | Return Loss Requirements .....                 | 5  |
| 4.2 | Mechanical Requirements .....                  | 5  |
| 5   | Measurement Uncertainty.....                   | 5  |
| 5.1 | Return Loss .....                              | 5  |
| 5.2 | Dimension Measurement .....                    | 5  |
| 5.3 | Validation Measurement .....                   | 5  |
| 6   | Calibration Measurement Results.....           | 6  |
| 6.1 | Return Loss and Impedance In Head Liquid ..... | 6  |
| 6.2 | Return Loss and Impedance In Body Liquid ..... | 6  |
| 6.3 | Mechanical Dimensions .....                    | 6  |
| 7   | Validation measurement .....                   | 7  |
| 7.1 | Head Liquid Measurement .....                  | 7  |
| 7.2 | SAR Measurement Result With Head Liquid .....  | 8  |
| 7.3 | Body Liquid Measurement .....                  | 9  |
| 7.4 | SAR Measurement Result With Body Liquid .....  | 10 |
| 8   | List of Equipment .....                        | 11 |



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.178.3.20.MVGB.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 2450 MHz REFERENCE DIPOLE |
| Manufacturer                   | MVG                               |
| Model                          | SID2450                           |
| Serial Number                  | SN 09/13 DIP2G450-220             |
| Product Condition (new / used) | Used                              |

## 3 PRODUCT DESCRIPTION

### 3.1 GENERAL INFORMATION

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



Figure 1 – MVG COMOSAR Validation Dipole



#### 4 MEASUREMENT METHOD

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

##### 4.1 RETURN LOSS REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a return loss of -20 dB or better. The return loss measurement shall be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. A direct method is used with a network analyser and its calibration kit, both with a valid ISO17025 calibration.

##### 4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimension's frequency and phantom shell thickness dependent. The COMOSAR test bench employs a 2 mm phantom shell thickness therefore the dipoles sold for use with the COMOSAR test bench comply with the requirements set forth for a 2 mm phantom shell thickness. A direct method is used with a ISO17025 calibrated caliper.

#### 5 MEASUREMENT UNCERTAINTY

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

##### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

| Frequency band | Expanded Uncertainty on Return Loss |
|----------------|-------------------------------------|
| 400-6000MHz    | 0.08 LIN                            |

##### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

##### 5.3 VALIDATION MEASUREMENT

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

| Scan Volume | Expanded Uncertainty |
|-------------|----------------------|
|             |                      |

Page: 5/11

*Template\_ACR.DDD.N.VY.MVGB.ISSUE\_SAR Reference Dipole vG*

*This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*



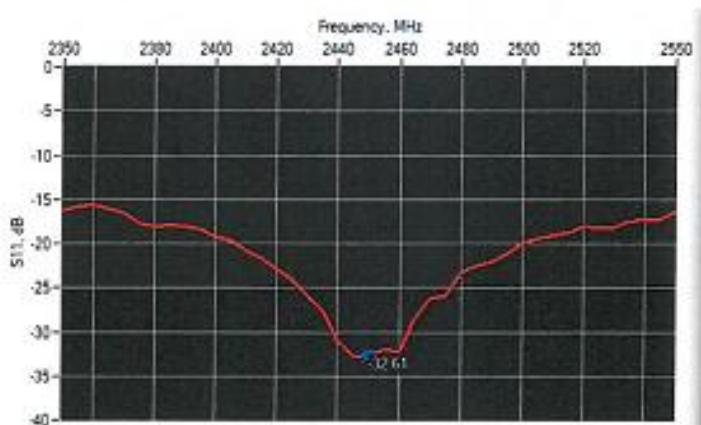
## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.178.8.20.MVGB.A

|      |            |
|------|------------|
| 1 g  | 19 % (SAR) |
| 10 g | 19 % (SAR) |

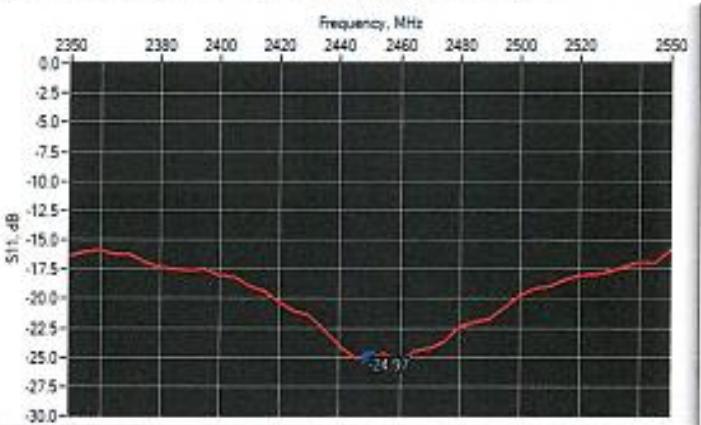
## 6 CALIBRATION MEASUREMENT RESULTS

## 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 2450            | -32.61           | -20              | $52.3 \Omega + 0.3 j\Omega$ |

## 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance                   |
|-----------------|------------------|------------------|-----------------------------|
| 2450            | -24.97           | -20              | $55.6 \Omega - 0.4 j\Omega$ |

## 6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm     |          | h mm     |          | d mm     |          |
|---------------|----------|----------|----------|----------|----------|----------|
|               | required | measured | required | measured | required | measured |
|               |          |          |          |          |          |          |

Page: 6/11

Template\_ACR.DDD.N.YE.MVGB.ISSUE\_SAR Reference Dipole vG

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref. ACR.178.8.20.MVGB.A

|      |                  |   |                  |   |                 |   |
|------|------------------|---|------------------|---|-----------------|---|
| 300  | 420.0 $\pm$ 1 %. |   | 250.0 $\pm$ 1 %. |   | 6.35 $\pm$ 1 %. |   |
| 450  | 290.0 $\pm$ 1 %. |   | 166.7 $\pm$ 1 %. |   | 6.35 $\pm$ 1 %. |   |
| 750  | 176.0 $\pm$ 1 %. |   | 100.0 $\pm$ 1 %. |   | 6.35 $\pm$ 1 %. |   |
| 835  | 161.0 $\pm$ 1 %. |   | 89.8 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 900  | 149.0 $\pm$ 1 %. |   | 83.3 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 1450 | 89.1 $\pm$ 1 %.  |   | 51.7 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 1500 | 80.5 $\pm$ 1 %.  |   | 50.0 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 1640 | 79.0 $\pm$ 1 %.  |   | 45.7 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 1750 | 75.2 $\pm$ 1 %.  |   | 42.9 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 1800 | 72.0 $\pm$ 1 %.  |   | 41.7 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 1900 | 68.0 $\pm$ 1 %.  |   | 39.5 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 1950 | 66.3 $\pm$ 1 %.  |   | 38.5 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 2000 | 64.5 $\pm$ 1 %.  |   | 37.5 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 2100 | 61.0 $\pm$ 1 %.  |   | 35.7 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 2300 | 55.5 $\pm$ 1 %.  |   | 32.6 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 2450 | 51.5 $\pm$ 1 %.  | - | 30.4 $\pm$ 1 %.  | - | 3.6 $\pm$ 1 %.  | - |
| 2600 | 48.5 $\pm$ 1 %.  |   | 28.8 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 3000 | 41.5 $\pm$ 1 %.  |   | 25.0 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 3500 | 37.0 $\pm$ 1 %.  |   | 26.4 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |
| 3700 | 34.7 $\pm$ 1 %.  |   | 26.4 $\pm$ 1 %.  |   | 3.6 $\pm$ 1 %.  |   |

## 7 VALIDATION MEASUREMENT

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

### 7.1 HEAD LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|---------------------------------------|----------|-------------------------------|----------|
|                  | required                              | measured | required                      | measured |
| 300              | 45.3 $\pm$ 10 %                       |          | 0.87 $\pm$ 10 %               |          |
| 450              | 43.5 $\pm$ 10 %                       |          | 0.87 $\pm$ 10 %               |          |
| 750              | 41.9 $\pm$ 10 %                       |          | 0.89 $\pm$ 10 %               |          |
| 835              | 41.5 $\pm$ 10 %                       |          | 0.90 $\pm$ 10 %               |          |
| 900              | 41.5 $\pm$ 10 %                       |          | 0.97 $\pm$ 10 %               |          |
| 1450             | 40.5 $\pm$ 10 %                       |          | 1.20 $\pm$ 10 %               |          |
| 1500             | 40.4 $\pm$ 10 %                       |          | 1.23 $\pm$ 10 %               |          |
| 1640             | 40.2 $\pm$ 10 %                       |          | 1.31 $\pm$ 10 %               |          |

Page: 7/11

*Template\_ACR.DDD.N.VV.MVGB.ISSUE\_SAR Reference Dipole v6**This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.*



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.178.8.20.MVGB.A

|      |            |      |            |      |
|------|------------|------|------------|------|
| 1750 | 40.1 ±10 % |      | 1.37 ±10 % |      |
| 1800 | 40.0 ±10 % |      | 1.40 ±10 % |      |
| 1900 | 40.0 ±10 % |      | 1.40 ±10 % |      |
| 1950 | 40.0 ±10 % |      | 1.40 ±10 % |      |
| 2000 | 40.0 ±10 % |      | 1.40 ±10 % |      |
| 2100 | 39.8 ±10 % |      | 1.49 ±10 % |      |
| 2300 | 39.5 ±10 % |      | 1.67 ±10 % |      |
| 2450 | 39.2 ±10 % | 41.9 | 1.80 ±10 % | 1.88 |
| 2600 | 39.0 ±10 % |      | 1.96 ±10 % |      |
| 3000 | 38.5 ±10 % |      | 2.40 ±10 % |      |
| 3500 | 37.9 ±10 % |      | 2.91 ±10 % |      |

## 7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

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

|   |  |
|---|--|
| Software                                  | OPENSAR V5   |
| Phantom                                   | SN 13/09 SAM68   |
| Probe                                     | SN 41/18 EPGO333   |
| Liquid                                    | Head Liquid Values: eps <sup>*</sup> : 41.9 sigma : 1.88 |
| Distance between dipole center and liquid | 10.0 mm  |
| Area scan resolution                      | dx=8mm/dy=8mm  |
| Zoom Scan Resolution                      | dx=5mm/dy=5mm/dz=5mm                                     |
| Frequency                                 | 2450 MHz   |
| Input power                               | 20 dBm   |
| Liquid Temperature                        | 20 +/- 1 °C  |
| Lab Temperature                           | 20 +/- 1 °C  |
| Lab Humidity                              | 30-70 %  |

| Frequency<br>MHz | 1 g SAR (W/kg/W) |          | 10 g SAR (W/kg/W) |          |
|------------------|------------------|----------|-------------------|----------|
|                  | required         | measured | required          | measured |
| 300              | 2.85             |          | 1.94              |          |
| 450              | 4.58             |          | 3.05              |          |
| 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              |          |

Page: 8/11

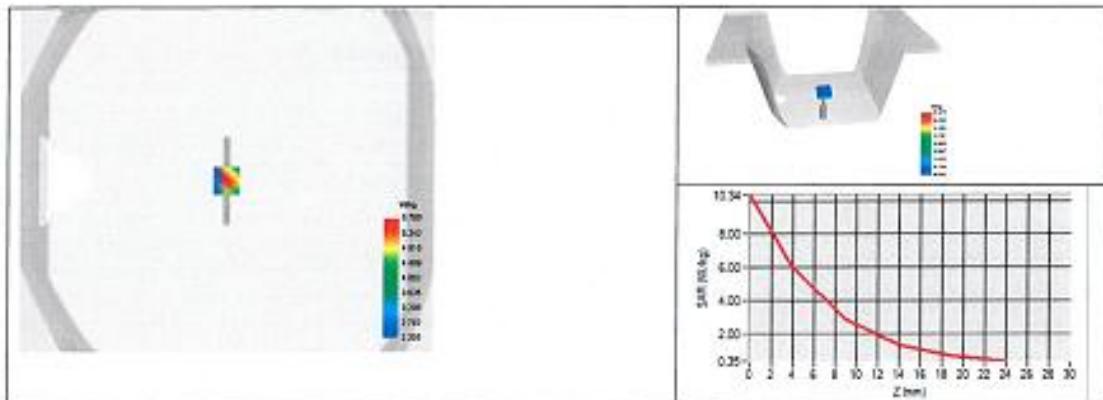
*Template\_ACR.DDD.N.YY.MVGB.ISSUE\_SAR Reference Dipole vG*  
This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.



## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.178.8.20.MVGB.A

|      |      |              |      |              |
|------|------|--------------|------|--------------|
| 1800 | 38.4 |              | 20.1 |              |
| 1900 | 39.7 |              | 20.5 |              |
| 1950 | 40.5 |              | 20.9 |              |
| 2000 | 41.1 |              | 21.1 |              |
| 2100 | 43.6 |              | 21.9 |              |
| 2300 | 48.7 |              | 23.3 |              |
| 2450 | 52.4 | 53.71 {5.37} | 24   | 24.17 {2.42} |
| 2600 | 55.3 |              | 24.6 |              |
| 3000 | 63.8 |              | 25.7 |              |
| 3500 | 67.1 |              | 25   |              |
| 3700 | 67.4 |              | 24.2 |              |



## 7.3 BODY LIQUID MEASUREMENT

| Frequency<br>MHz | Relative permittivity ( $\epsilon_r'$ ) |          | Conductivity ( $\sigma$ ) S/m |          |
|------------------|---|----------|-------------------------------|----------|
|                  | required                                | measured | required                      | measured |
| 150              | 61.9 ±10 %                              |          | 0.80 ±10 %                    |          |
| 300              | 58.2 ±10 %                              |          | 0.92 ±10 %                    |          |
| 450              | 56.7 ±10 %                              |          | 0.94 ±10 %                    |          |
| 750              | 55.5 ±10 %                              |          | 0.96 ±10 %                    |          |
| 835              | 55.2 ±10 %                              |          | 0.97 ±10 %                    |          |
| 900              | 55.0 ±10 %                              |          | 1.05 ±10 %                    |          |
| 915              | 55.0 ±10 %                              |          | 1.06 ±10 %                    |          |
| 1450             | 54.0 ±10 %                              |          | 1.30 ±10 %                    |          |
| 1610             | 53.8 ±10 %                              |          | 1.40 ±10 %                    |          |
| 1800             | 53.3 ±10 %                              |          | 1.52 ±10 %                    |          |
| 1900             | 53.3 ±10 %                              |          | 1.52 ±10 %                    |          |
| 2000             | 53.3 ±10 %                              |          | 1.52 ±10 %                    |          |
| 2100             | 53.2 ±10 %                              |          | 1.62 ±10 %                    |          |

Page: 9/11

Template\_ACR.DDD.N.YY.MVGB.ISSUE\_SAR Reference Dipole v6

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.



## SAR REFERENCE DIPOLE CALIBRATION REPORT

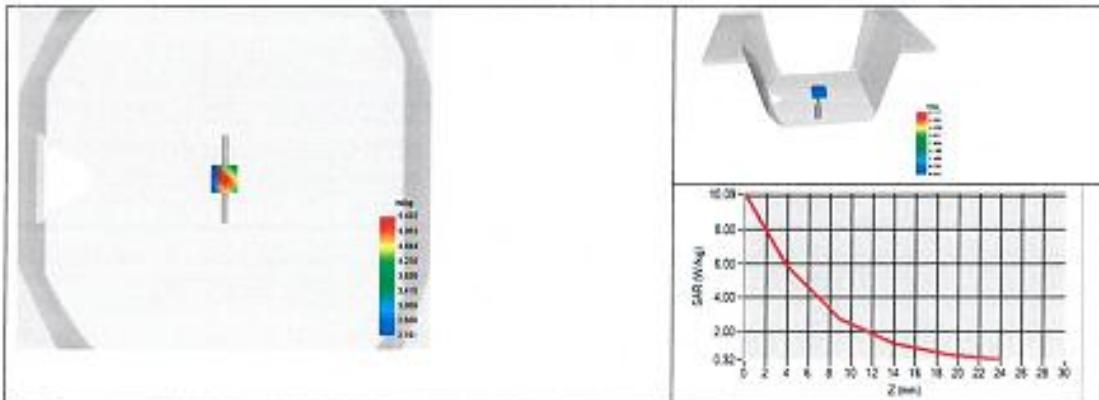
Ref: ACR.178.8.20.MVGB.A

|      |            |      |            |      |
|------|------------|------|------------|------|
| 2300 | 52.9 ±10 % |      | 1.81 ±10 % |      |
| 2450 | 52.7 ±10 % | 53.4 | 1.95 ±10 % | 2.14 |
| 2600 | 52.5 ±10 % |      | 2.16 ±10 % |      |
| 3000 | 52.0 ±10 % |      | 2.73 ±10 % |      |
| 3500 | 51.3 ±10 % |      | 3.31 ±10 % |      |
| 3700 | 51.0 ±10 % |      | 3.55 ±10 % |      |
| 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 v5   |
| Phantom                                   | SN 13/09 SAM68                                       |
| Probe                                     | SN 41/18 EPGO333                                     |
| Liquid                                    | Body Liquid Values: $\epsilon_r$ : 53.4 sigma : 2.14 |
| Distance between dipole center and liquid | 10.0 mm  |
| Area scan resolution                      | dx=8mm/dy=8mm  |
| Zoon Scan Resolution                      | dx=5mm/dy=5mm/dz=5mm                                 |
| Frequency                                 | 2450 MHz   |
| Input power                               | 20 dBm   |
| Liquid Temperature                        | 20 ± 1 °C  |
| Lab Temperature                           | 20 ± 1 °C  |
| Lab Humidity                              | 30-70 %  |

| Frequency<br>MHz | 1 g SAR (W/kg/W) | 10 g SAR (W/kg/W) |
|------------------|------------------|-------------------|
|                  | measured         | measured          |
| 2450             | 54.83 (5.48)     | 23.59 (2.36)      |



Page: 10/11

Template: ACR.DDD.N.YE.MVGB.ISSUE\_SAR Reference Dipole v5

This document shall not be reproduced, except in full or in part, without the written approval of MVG. The information contained herein is to be used only for the purpose for which it is submitted and is not to be released in whole or part without written approval of MVG.



## 8 LIST OF EQUIPMENT

| Equipment Summary Sheet            |                         |                    |   |   |
|------------------------------------|-------------------------|--------------------|---|---|
| Equipment Description              | Manufacturer / Model    | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| SAM Phantom                        | MVG                     | SN-13/09-SAM68     | Validated. No cal required.                   | Validated. No cal required.                   |
| COMOSAR Test Bench                 | Version 3               | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer                   | Rohde & Schwarz ZVM     | 100203             | 05/2019                                       | 05/2022                                       |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223             | 05/2019                                       | 05/2022                                       |
| Calipers                           | Mitutoyo                | SN 0009732         | 10/2019                                       | 10/2022                                       |
| Reference Probe                    | MVG                     | EPGO333 SN 41/18   | 05/2020                                       | 05/2021                                       |
| Multimeter                         | Keithley 2000           | 1160271            | 02/2020                                       | 02/2023                                       |
| Signal Generator                   | Rohde & Schwarz SMB     | 106589             | 04/2019                                       | 04/2022                                       |
| Amplifier                          | Aethercomm              | SN 048             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                        | NI-USB 5680             | 170100013          | 05/2019                                       | 05/2022                                       |
| Directional Coupler                | Narda 4216-20           | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor      | Control Company         | 150798832          | 11/2017                                       | 11/2020                                       |

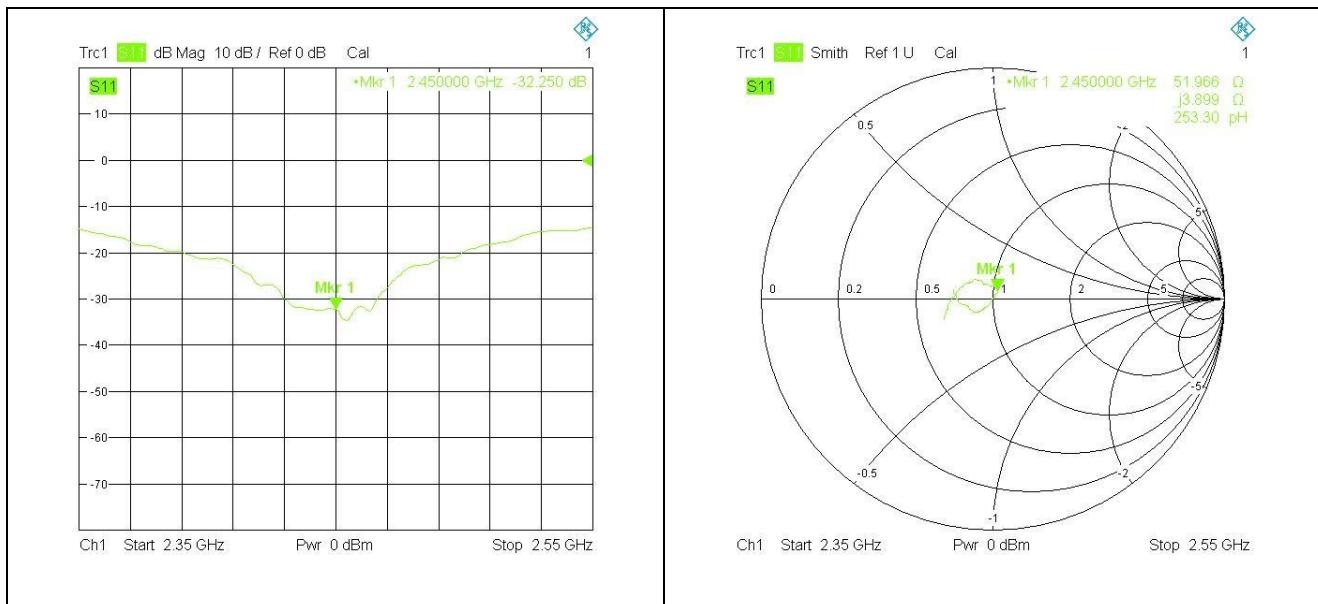
### Head 2450MHz

| Date of Measurement | Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) |
|---------------------|------------------|-----------|-----------|------------|
| 2020.06.25          | -32.61           | -         | 52.3      | -          |
| 2021.06.23          | -32.25           | 8.64      | 51.966    | -0.334     |

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

### <Dipole Verification Data>

### Head 2450MHz



—End of the Report—