



# SAR TEST REPORT

**Report No.:** SET2021-07072

**Product:** Cabin Thermal Imaging monocular

**Trade Name:** InfiRay

**Model No.:** CBL19,CBL25

**FCC ID:** 2AYGT-CABIN

**Applicant:** IRayTechonlogyCo.,Ltd

**Address:** 11GUIYANG STREET, YANTAI ECONOMY AND  
TECHNOLOGY DEVELOPMENT DISTRICT, YANTAI  
SHANDONG P.R.CHINA.

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

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## Test Report

**Product.** .....: Cabin Thermal Imaging monocular  
**Model No.** .....: CBL19,CBL25  
**Brand Name**.....: InfiRay  
**FCC ID**.....: 2AYGT-CABIN  
**Applicant**.....: IRayTechonlogyCo.,Ltd  
**Applicant Address**.....: 11GUIYANG STREET, YANTAI ECONOMY AND  
TECHNOLOGY DEVELOPMENT DISTRICT, YANTAI  
SHANDONG P.R.CHINA.  
**Manufacturer**.....: IRayTechonlogyCo.,Ltd  
**Manufacturer Address:** 11GUIYANG STREET, YANTAI ECONOMY AND  
TECHNOLOGY DEVELOPMENT DISTRICT, YANTAI  
SHANDONG P.R.CHINA.  
**Test Standards**.....: **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)  
**RSS-102:** Radio Frequency Exposure Compliance of  
Radiocommunication Apparatus (All Frequency Bands)(Issue 5 of  
March 2015)  
**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  
**Test Date**.....: 2021.05.12-2021.05.12  
**Tested by** .....: Xinyuan Fang 2021-06-07  
Xinyuan Fang, Test Engineer  
**Reviewed by**.....: Chris You 2021-06-07  
Chris You, Senior Engineer  
**Approved by**.....: Shuangwen Zhang 2021-06-07  
Shuangwen Zhang, Manager



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## 1. Administrative Data

### 1.1 Testing Laboratory

**Test Site:** CCIC Southern Testing Co., Ltd.

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

**A2LA Lab Code:** CCIC-SET is a third party testing organization accredited by A2LA according to ISO/IEC 17025:2017. The accreditation certificate number is 5721.01..

**FCC Registration:** 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 19, 2023.

**ISED Registration:** 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 April 20, 2023..

**Test Environment** Temperature (°C): 21°C

**Condition:** Relative Humidity (%): 60%

Atmospheric Pressure (kPa): 86KPa-106KPa

## 2. Equipment Under Test (EUT)

### Identification of the Equipment under Test

**Device Type:** Portable

**Exposure Category:** Population/Uncontrolled

**Sample Name:** Cabin Thermal Imaging monocular

**Brand Name:** InfiRay

**Model Name:** CBL19,CBL25

|                             |                                                   |                                                     |
|-----------------------------|---------------------------------------------------|-----------------------------------------------------|
| <b>General description:</b> | Support Band                                      | WIFI 2.4G                                           |
|                             | Test Band                                         | WIFI 2.4G                                           |
|                             | Development Stage                                 | Identical Prototype                                 |
|                             | Accessories                                       | Power Supply                                        |
|                             | Antenna type                                      | Internal Antenna                                    |
|                             | Operation mode                                    | WIFI                                                |
|                             | Modulation mode                                   | WIFI(DSSS)                                          |
|                             | Hardware Version                                  | V1.2                                                |
|                             | Software Version                                  | V1.3                                                |
|                             | Battery options :                                 | Model: IBP-2(36AQ517-01)                            |
|                             |                                                   | Capacitance:3100mAh                                 |
|                             |                                                   | Rated Voltage:3.6V                                  |
|                             |                                                   | Charge Limit:4.2V                                   |
|                             | Manufacturer:DONGGUAN LARGE ELECTRONICS CO., LTD. |                                                     |
|                             | Max. SAR Value                                    | Body-Support:0.196W/Kg(Limit:1.6W/Kg, 0mm distance) |

### NOTE:

- a. The above EUT's information was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

### 3. SAR Summary

#### Highest Standalone SAR Summary

| Exposure Position      | Frequency Band | Scaled 1g-SAR(W/kg) | Highest Scaled 1g-SAR(W/kg) |
|------------------------|----------------|---------------------|-----------------------------|
| Body-Support (0mm Gap) | 2.4G WIFI      | 0.196               | 0.196                       |

### 4. Specific Absorption Rate (SAR)

#### 4.1 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 ( $\rho$ ). The equation description is as below:

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

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

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

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

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

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

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.



## 4.2 Applicable Standards and Limits

### 4.2.1 Applicable Standards

|                 |                                                                                                                                                                                  |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 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)                                                   |
| 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 |
| KDB 865664 D01  | v01r04 SAR Measurement 100MHz to 6GHz                                                                                                                                            |
| KDB 865664 D02  | v01r02 SAR Exposure Reporting                                                                                                                                                    |
|                 |                                                                                                                                                                                  |
|                 |                                                                                                                                                                                  |

### 4.2.2 RF exposure Limits

| <b>Human Exposure</b>                        | <b>Uncontrolled Environment<br/>General Population</b> |
|----------------------------------------------|--------------------------------------------------------|
| <b>Spatial Peak SAR*</b><br>(Brain/Body)     | <b>1.60 mW/g</b>                                       |
| <b>Spatial Average SAR**</b><br>(Whole Body) | 0.08 mW/g                                              |
| <b>Spatial Peak SAR***</b><br>(Limbs)        | 4.00 mW/g                                              |

The limit applied in this test report is shown in bold letters.

Notes:

\* The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time

\*\* The Spatial Average value of the SAR averaged over the whole body.

\*\*\* The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

### 4.3 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.

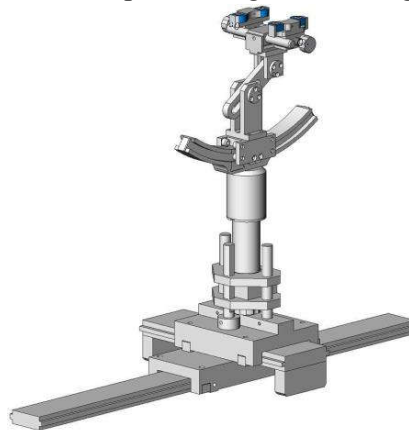


SAM Twin Phantom

### 4.4 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

## 4.5 Probe Specification

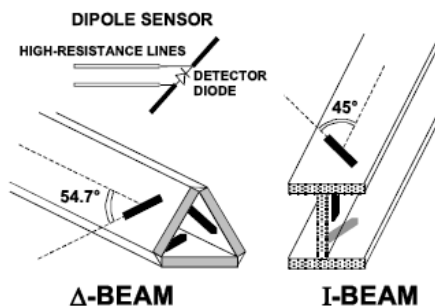


|               |                                                                                                                                                                                    |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Construction  | Symmetrical design with triangular core<br>Interleaved sensors<br>Built-in shielding against static charges<br>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 | $1.5 \mu\text{W/g}$ to $100 \text{ mW/g}$ ;<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                                                                          |
| 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:



## 5. Tissue check and recommend Dielectric Parameters

### 5.1 Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer modelssimulating the highest expected SAR for the dielectric properties and tissue thickness Power drifts in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

Table 1: Recommended Dielectric Performance of Tissue

| Ingredients<br>(% by<br>weight ) | Frequency (MHz) |       |       |      |       |       |       |      |      |      |       |       |
|----------------------------------|-----------------|-------|-------|------|-------|-------|-------|------|------|------|-------|-------|
|                                  | 450             |       | 835   |      | 915   |       | 1900  |      | 2450 |      | 2600  |       |
| Tissue Type                      | Head            | Body  | Head  | Body | Head  | Body  | Head  | Body | Head | Body | Head  | Body  |
| Water                            | 38.56           | 51.16 | 41.46 | 52.4 | 41.05 | 56.0  | 54.9  | 40.4 | 62.7 | 73.2 | 55.24 | 64.49 |
| Salt (NaCl)                      | 3.95            | 1.49  | 1.45  | 1.4  | 1.35  | 0.76  | 0.18  | 0.5  | 0.5  | 0.04 | 0.5   | 0.024 |
| Sugar                            | 56.32           | 46.78 | 56.0  | 45.0 | 56.5  | 41.76 | 0.0   | 58.0 | 0.0  | 0.0  | 0.0   | 0.0   |
| HEC                              | 0.98            | 0.52  | 1.0   | 1.0  | 1.0   | 1.21  | 0.0   | 1.0  | 0.0  | 0.0  | 0.0   | 0.0   |
| Bactericide                      | 0.19            | 0.05  | 0.1   | 0.1  | 0.1   | 0.27  | 0.0   | 0.1  | 0.0  | 0.0  | 0.0   | 0.0   |
| Triton x-100                     | 0.0             | 0.0   | 0.0   | 0.0  | 0.0   | 0.0   | 0.0   | 0.0  | 36.8 | 0.0  | 44.45 | 32.25 |
| DGBE                             | 0.0             | 0.0   | 0.0   | 0.0  | 0.0   | 0.0   | 44.92 | 0.0  | 0.0  | 26.7 | 0.0   | 26.7  |
| Dielectric Constant              | 43.42           | 58.0  | 42.54 | 56.1 | 42.0  | 56.8  | 39.9  | 54.0 | 39.2 | 52.5 | 39.0  | 52.5  |
| Conductivity (s/m)               | 0.85            | 0.83  | 0.91  | 0.95 | 1.0   | 1.07  | 1.42  | 1.45 | 1.80 | 1.78 | 1.96  | 2.16  |

MSL/HSL750 (Body and Head liquid for 650 – 850 MHz)

|                        |                                                                                                                                                   |                     |                   |                     |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------------------|---------------------|
| Item                   | Head Tissue Simulation Liquid HSL750<br>Muscle(body)Tissue Simulation Liquid MSL750                                                               |                     |                   |                     |
| H2O                    | Water, 35 – 58%                                                                                                                                   |                     |                   |                     |
| Sucrose                | Sugar, white, refined, 40-60%                                                                                                                     |                     |                   |                     |
| NaCl                   | Sodium Chloride, 0-6%                                                                                                                             |                     |                   |                     |
| Hydroxyethyl-cellulose | Medium Viscosity (CAS# 9004-62-0), <0.3%                                                                                                          |                     |                   |                     |
| Preventol-D7           | Preservative: aqueous preparation, (CAS# 55965-84-9), containing 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyl-3(2H)-isothiazolone, 0.1-0.7% |                     |                   |                     |
| Frequency (MHz)        | Head $\epsilon_r$                                                                                                                                 | Head $\sigma$ (S/m) | Body $\epsilon_r$ | Body $\sigma$ (S/m) |
| 750                    | 41.9                                                                                                                                              | 0.89                | 55.2              | 0.97                |

Note: The liquid of 700MHz&2600MHz typical liquid composition is provided by SATIMO.

| Frequency:5200/5400/5600/5800MHz |               |
|----------------------------------|---------------|
| Ingredients                      | (% by weight) |
| Water                            | 78            |
| Mineral oil                      | 11            |
| Emulsifiers                      | 9             |
| Additives and Salt               | 2             |

Table 2 Recommended Tissue Dielectric Parameters

| Frequency (MHz) | Head Tissue  |                | Body Tissue  |                |
|-----------------|--------------|----------------|--------------|----------------|
|                 | $\epsilon_r$ | $\sigma$ (S/m) | $\epsilon_r$ | $\sigma$ (S/m) |
| 150             | 52.3         | 0.76           | 61.9         | 0.80           |
| 300             | 45.3         | 0.87           | 58.2         | 0.92           |
| 450             | 43.5         | 0.87           | 56.7         | 0.94           |
| 835             | 41.5         | 0.90           | 55.2         | 0.97           |
| 900             | 41.5         | 0.97           | 55.0         | 1.05           |
| 915             | 41.5         | 0.98           | 55.0         | 1.06           |
| 1450            | 40.5         | 1.20           | 54.0         | 1.30           |
| 1610            | 40.3         | 1.29           | 53.8         | 1.40           |
| 1800-2000       | 40.0         | 1.40           | 53.3         | 1.52           |
| 2450            | 39.2         | 1.80           | 52.7         | 1.95           |
| 3000            | 38.5         | 2.40           | 52.0         | 2.73           |
| 5800            | 35.3         | 5.27           | 48.2         | 6.00           |

## 5.2 Simulate liquid

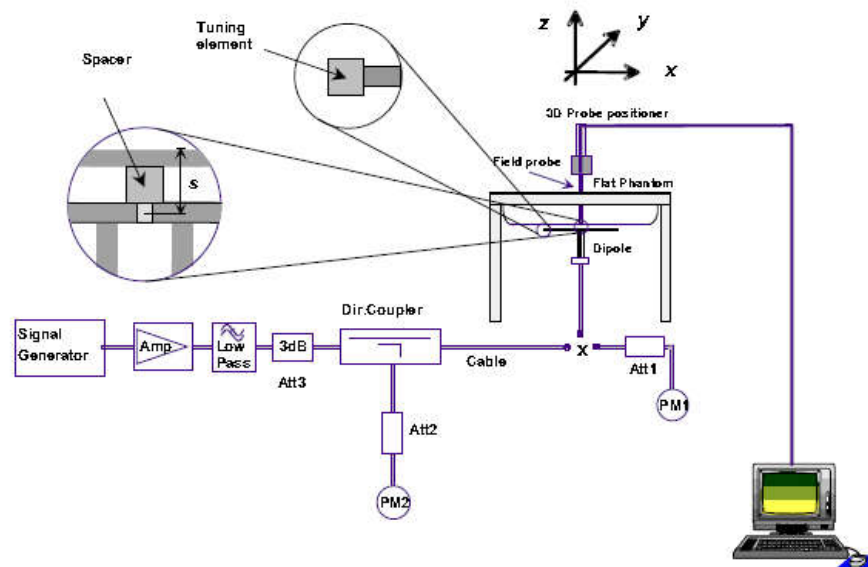
Table 3: Dielectric Performance of Body Tissue Simulating Liquid

| Temperature: 23.2°C; Humidity: 64%; |           |                         |                             |
|-------------------------------------|-----------|-------------------------|-----------------------------|
| /                                   | Frequency | Permittivity $\epsilon$ | Conductivity $\sigma$ (S/m) |
| Target value                        | 2450MHz   | 52.7±5%                 | 1.95±5%                     |
| Validation value<br>(2021-05-12)    | 2450MHz   | 52.65                   | 1.93                        |

### SAR System validation

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.

The measured 1-gram averaged SAR values of the device against the phantom are provided in Tables 5 and Table 6. The humidity and ambient temperature of test facility were 64% and 23.2°C respectively. The body phantom were full of the body tissue simulating liquid. The EUT was supplied with full-charged battery for each measurement.

The distance between the back of the EUT and the bottom of the flat phantom is 10 mm (taking into account of the IEEE 1528 and the place of the antenna).

Table 4: Body SAR system validation (1g)

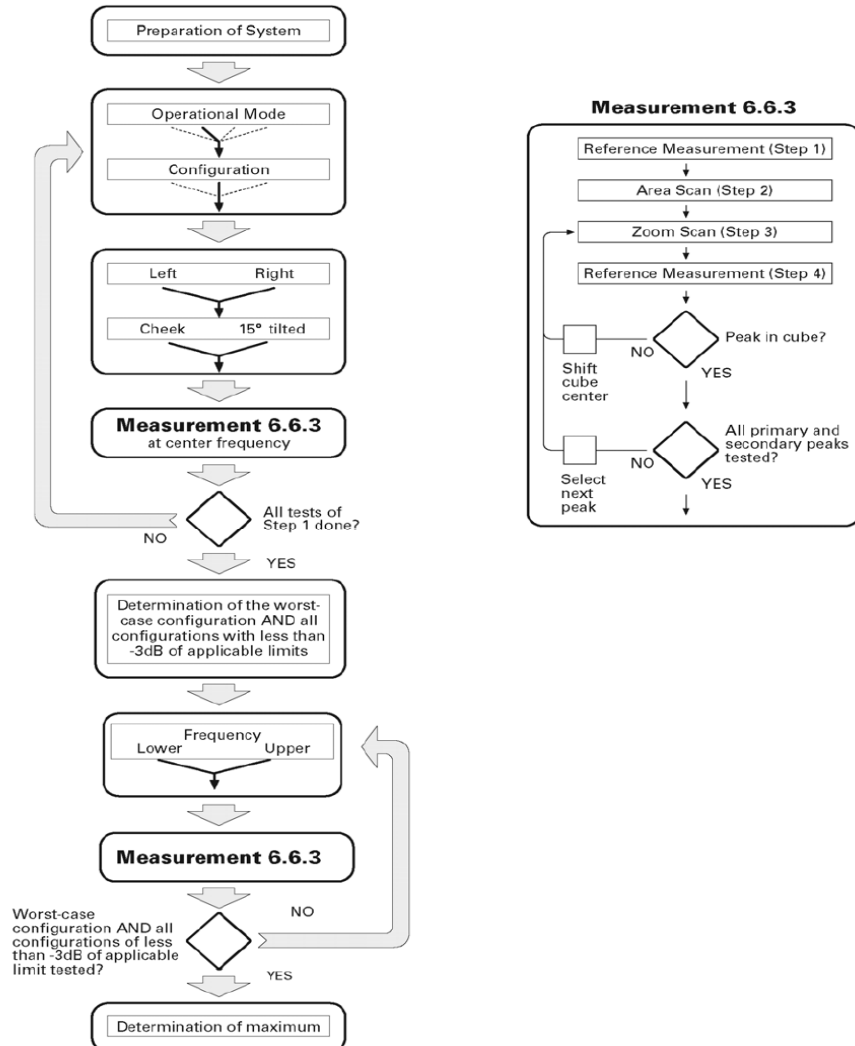
| Frequency           | Duty cycle | Target value<br>(W/kg) | Test value (W/kg) |       |
|---------------------|------------|------------------------|-------------------|-------|
|                     |            |                        | 10 mW             | 1W    |
| 2450MHz(2021-05-12) | 1:1        | 54.83±10%              | 0.5590            | 55.90 |

\* Note: Target value was referring to the measured value in the calibration certificate of reference dipole.

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:



Establish a call with the maximum output power with a base station simulator, the connection between the EUT and the base station simulator is established via air interface.

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 IEEE p1528 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. Conducted RF Output Power

### 7.1 WIFI Conducted Power

#### WLAN 2.4GHz Band Conducted Power

| Channel/Freq.(MHz) | Maximum Conducted Out Power (dBm) |         |               |
|--------------------|-----------------------------------|---------|---------------|
|                    | 802.11b                           | 802.11g | 802.11n(HT20) |
| 1(2412)            | 16.62                             | 14.36   | 11.54         |
| 6(2437)            | 16.54                             | 15.43   | 11.56         |
| 11(2462)           | 16.46                             | 15.32   | 11.63         |

## 8. Scaling Factor calculation

| Operation Mode       | Channel /Frequency | Output Power(dBm) | Tune up Power in tolerance (dBm) | Max. Tune up(dBm) | Scaling Factor |
|----------------------|--------------------|-------------------|----------------------------------|-------------------|----------------|
| WIFI 2.4G<br>802.11b | 1/2412             | 16.62             | 15.7 ± 1.0                       | 16.70             | 1.019          |
|                      | 6/2437             | 16.54             | 15.7 ± 1.0                       | 16.70             | 1.038          |
|                      | 11/2462            | 16.46             | 15.7 ± 1.0                       | 16.70             | 1.057          |

## 9. Antenna-to-User (Edge Side) distance (mm):

| Antenna      | Front | Bottom | Edge A | Edge B | Edge C | Edge D |
|--------------|-------|--------|--------|--------|--------|--------|
| WIFI Antenna | 45    | 62     | 2      | 16     | 70     | 16     |

| Antenna           | Front | Back | Edge A | Edge B | Edge C | Edge D |
|-------------------|-------|------|--------|--------|--------|--------|
| WIFI Antenna Body | No    | No   | Yes    | Yes    | No     | Yes    |

Note: According to KDB 941225 D06 v02r01, when antenna-to-edge>2.5cm, SAR is not required.

## 10. Test Results

### Results overview of WIFI2.4G 802.11b

| Body-worn(0mm) | Channel /Frequency | Mode | SAR Value (W/kg)1-g | Power drift(%) | Scaled Factor | Scaled SAR (W/Kg)1-g | SAR Plot. |
|----------------|--------------------|------|---------------------|----------------|---------------|----------------------|-----------|
| Edge A         | 6/2437             | DSSS | <b>0.189</b>        | -1.34          | 1.038         | <b>0.196</b>         | Yes       |
| Edge B         | 6/2437             | DSSS | 0.112               | -1.95          | 1.038         | 0.116                | /         |
| Edge D         | 6/2437             | DSSS | 0.105               | -3.32          | 1.038         | 0.109                | /         |

Note:

When the 1-g SAR for the mid-band channel or the channel with the highest output power satisfy the following conditions, testing of the other channels in the band is not required. (Per KDB 447498 D01 General RF Exposure Guidance v06)

- $\leq 0.8$  W/kg, when the transmission band is  $\leq 100$  MHz
- $\leq 0.6$  W/kg, when the transmission band is between 100 MHz and 200 MHz
- $\leq 0.4$  W/kg, when the transmission band is  $\geq 200$  MHz

## 11.Measurement Uncertainty

| No.                      | Uncertainty Component                                                             | Type | Uncertainty Value (%) | Probability Distribution | k          | ci  | Standard Uncertainty (%) $u_i(\%)$ | Degree of freedom $\nu_{eff}$ or $\nu_i$ |
|--------------------------|-----------------------------------------------------------------------------------|------|-----------------------|--------------------------|------------|-----|------------------------------------|------------------------------------------|
| Measurement System       |                                                                                   |      |                       |                          |            |     |                                    |                                          |
| 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                               | $\infty$                                 |
| Uncertainties of the DUT |                                                                                   |      |                       |                          |            |     |                                    |                                          |

|                                                              |                                                                               |   |     |     |            |     |       |          |
|--------------------------------------------------------------|-------------------------------------------------------------------------------|---|-----|-----|------------|-----|-------|----------|
| 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  | $\infty$ |
| <b>Phantom and Tissue Parameters</b>                         |                                                                               |   |     |     |            |     |       |          |
| 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 | $\infty$ |
| Uncertainties of the DUT      |                                                                                   |   |      |   |            |     |      |          |
| 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                                                       | B | 4    | R | $\sqrt{3}$ | 1   | 2.31 | $\infty$ |



|                                                              |                                                                               |   |     |     |            |     |       |          |
|--------------------------------------------------------------|-------------------------------------------------------------------------------|---|-----|-----|------------|-----|-------|----------|
|                                                              | and thickness tolerances)                                                     |   |     |     |            |     |       |          |
| 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 |          |



## 12. Equipment List

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 EPGO261        | 2020/06/25       | 2021/06/24 |
| <input checked="" type="checkbox"/> | Dipole                             | SID2450       | SN_09/13_DIP2G450-220  | 2020/06/25       | 2021/06/24 |
| <input checked="" type="checkbox"/> | Multimeter                         | Keithley-2000 | 4014020                | 2021/04/26       | 2022/04/25 |
| <input checked="" type="checkbox"/> | System Simulator(R&S)              | CMW500        | 130805                 | 2020/07/26       | 2021/07/25 |
| <input checked="" type="checkbox"/> | KEYSIGHT                           | E7515A        | MY56040357             | 2021/04/26       | 2022/04/25 |
| <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                 | 2020/11/26       | 2021/11/25 |
| <input checked="" type="checkbox"/> | Dielectric Probe Kit               | SCLMP         | SN 09/13 OCPG51        | 2020/11/26       | 2021/11/25 |
| <input checked="" type="checkbox"/> | Signal Generator                   | SMU200A       | A140801888             | 2021/03/12       | 2022/03/11 |
| <input checked="" type="checkbox"/> | Amplifier                          | Nucleudes     | 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 |

## ANNEX A: Appendix A: SAR System performance Check Plots

### System Performance Check (Body, 2450MHz)

Type: Phone measurement

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

Zoom scan resolution: dx=5mm, dy=5mm, dz=4mm

Date of measurement: 05/12/2021

Measurement duration: 22 minutes 09 seconds

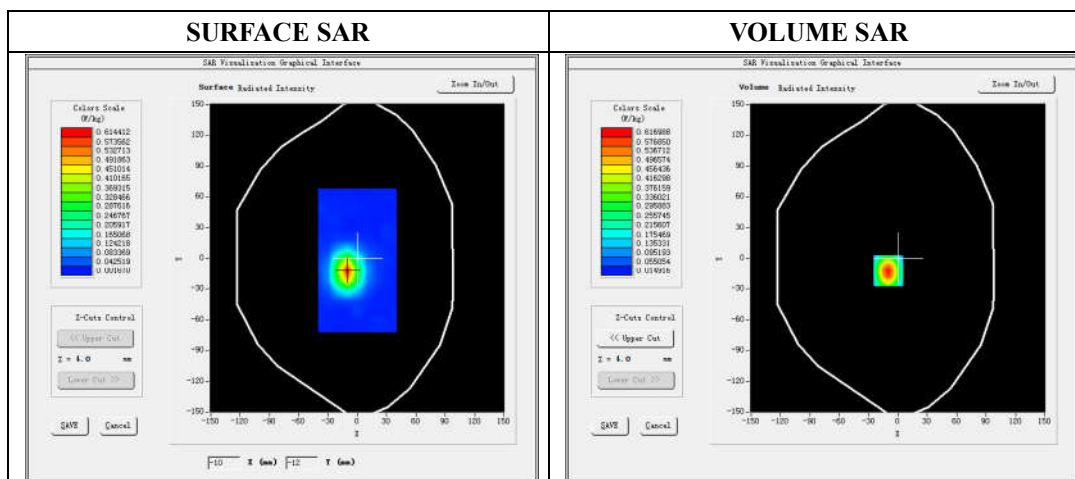
#### A. Experimental conditions.

|                 |                            |
|-----------------|----------------------------|
| Phantom File    | dx=8mm dy=8mm              |
| Phantom         | 7x7x8,dx=5mm dy=5mm dz=4mm |
| Device Position | Dipole                     |
| Band            | 2450MHz                    |
| Channels        |                            |
| Signal          | CW                         |

#### B. SAR Measurement Results

##### Band SAR

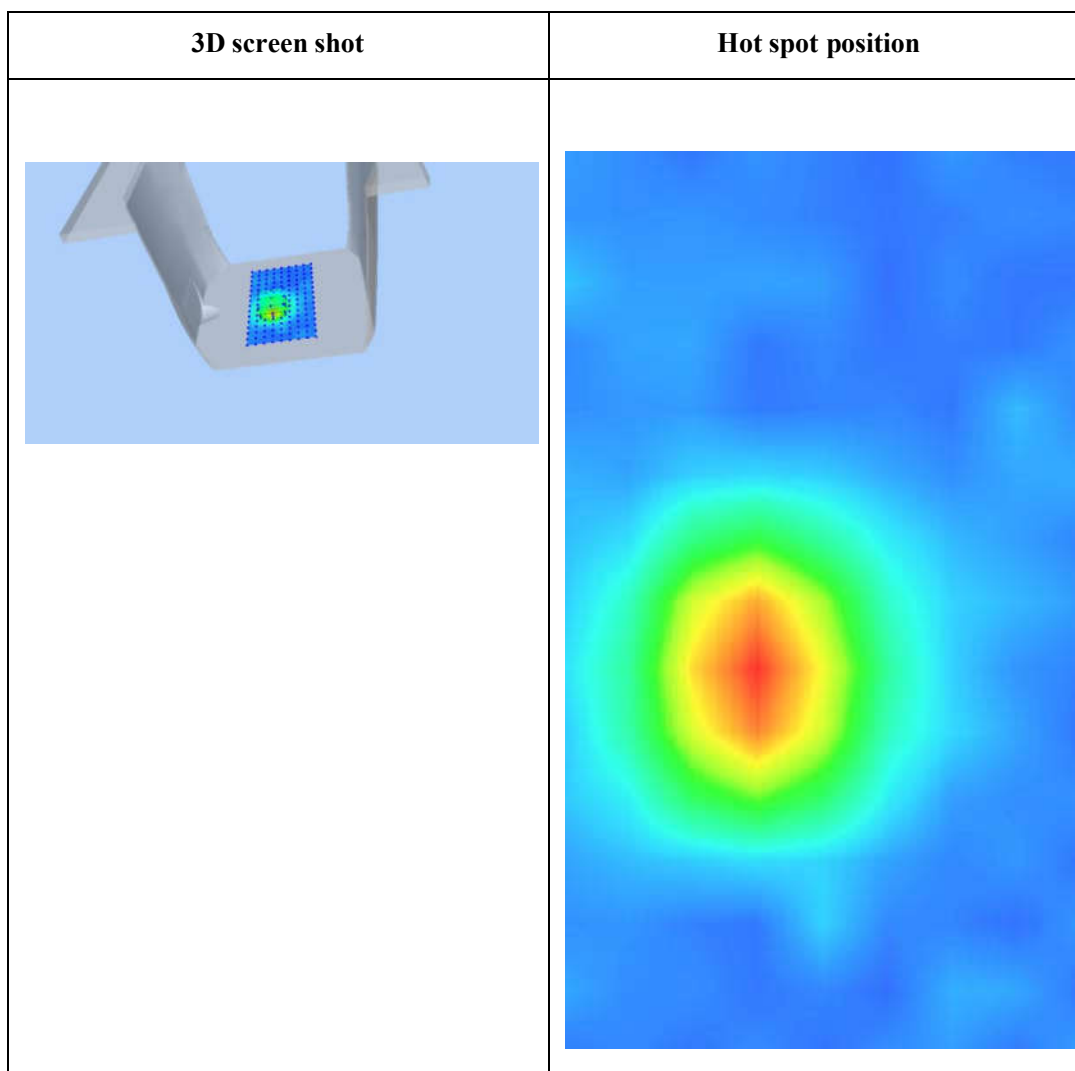
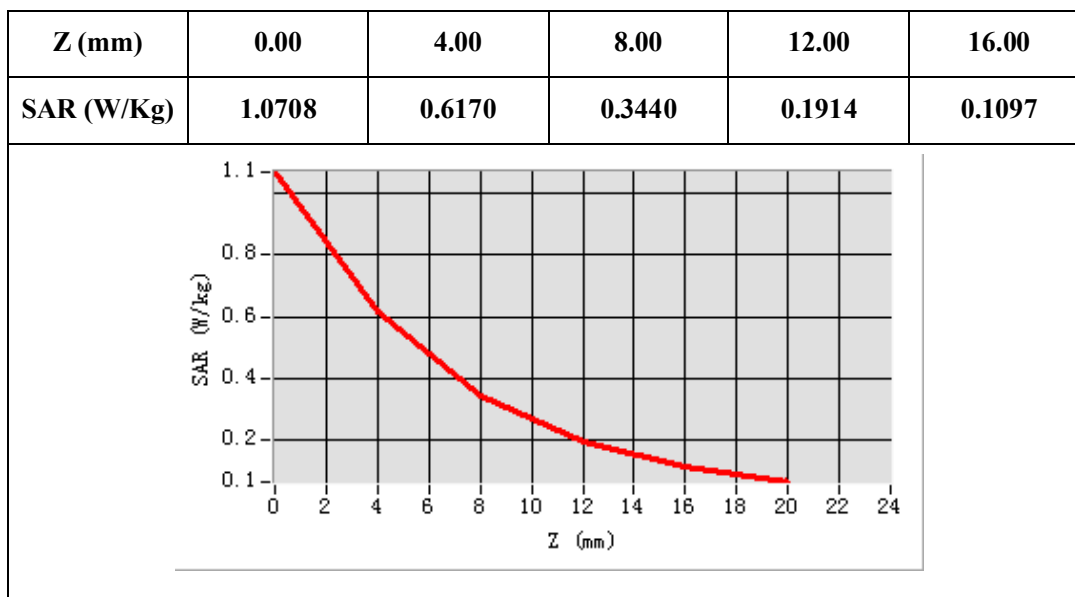
|                                   |                         |
|-----------------------------------|-------------------------|
| E-Field Probe                     | SATIMO SN_27/15_EPG0261 |
| Frequency (MHz)                   | 2450                    |
| Relative permittivity (real part) | 52.65                   |
| Relative permittivity             | 14.18                   |
| Conductivity (S/m)                | 1.93                    |
| Power Drift (%)                   | -1.56                   |
| Ambient Temperature:              | 22.1°C                  |
| Liquid Temperature:               | 22.6°C                  |
| ConvF:                            | 2.47                    |
| Duty factor:                      | 1:1                     |



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

SAR Peak: 1.07 W/kg

|                |          |
|----------------|----------|
| SAR 10g (W/Kg) | 0.258635 |
| SAR 1g (W/Kg)  | 0.559002 |



## ANNEX B: Appendix B: SAR Measurement results Plots

### Plot 1: Wi-Fi 802.11b, Edge A ,Middle, 5mm

Type: Phone measurement

Date of measurement: 05/12/2021

Measurement duration: 22 minutes 06 seconds

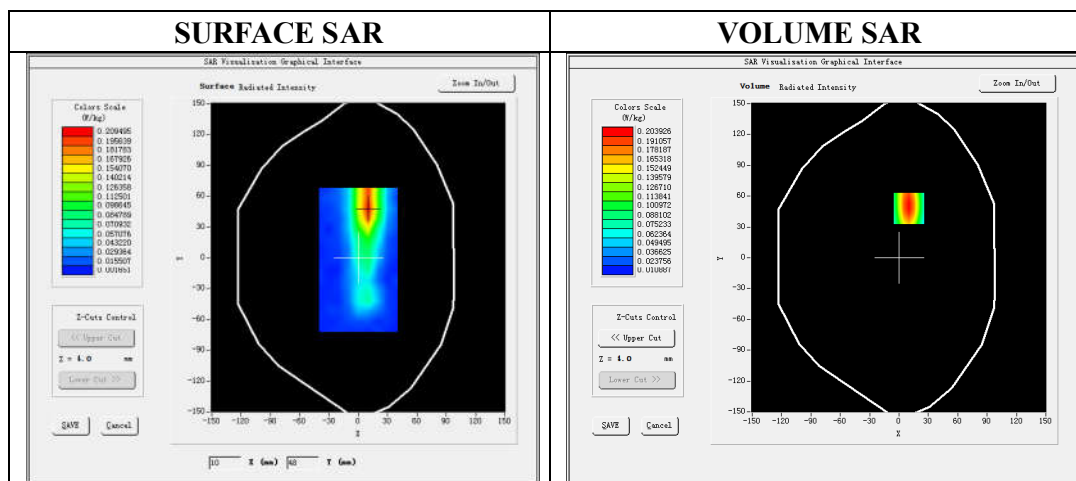
Mobile Phone IMEI number: --

#### A. Experimental conditions.

|                 |                            |
|-----------------|----------------------------|
| Area Scan       | dx=5mm,dy=5mm              |
| ZoomScan        | 7x7x8,dx=5mm dy=5mm dz=4mm |
| Phantom         | Validation plane           |
| Device Position | Edge A                     |
| Band            | WIFI                       |
| Channels        | 6                          |
| Signal          | DSSS (Duty cycle: 1:1)     |

#### B. SAR Measurement Results

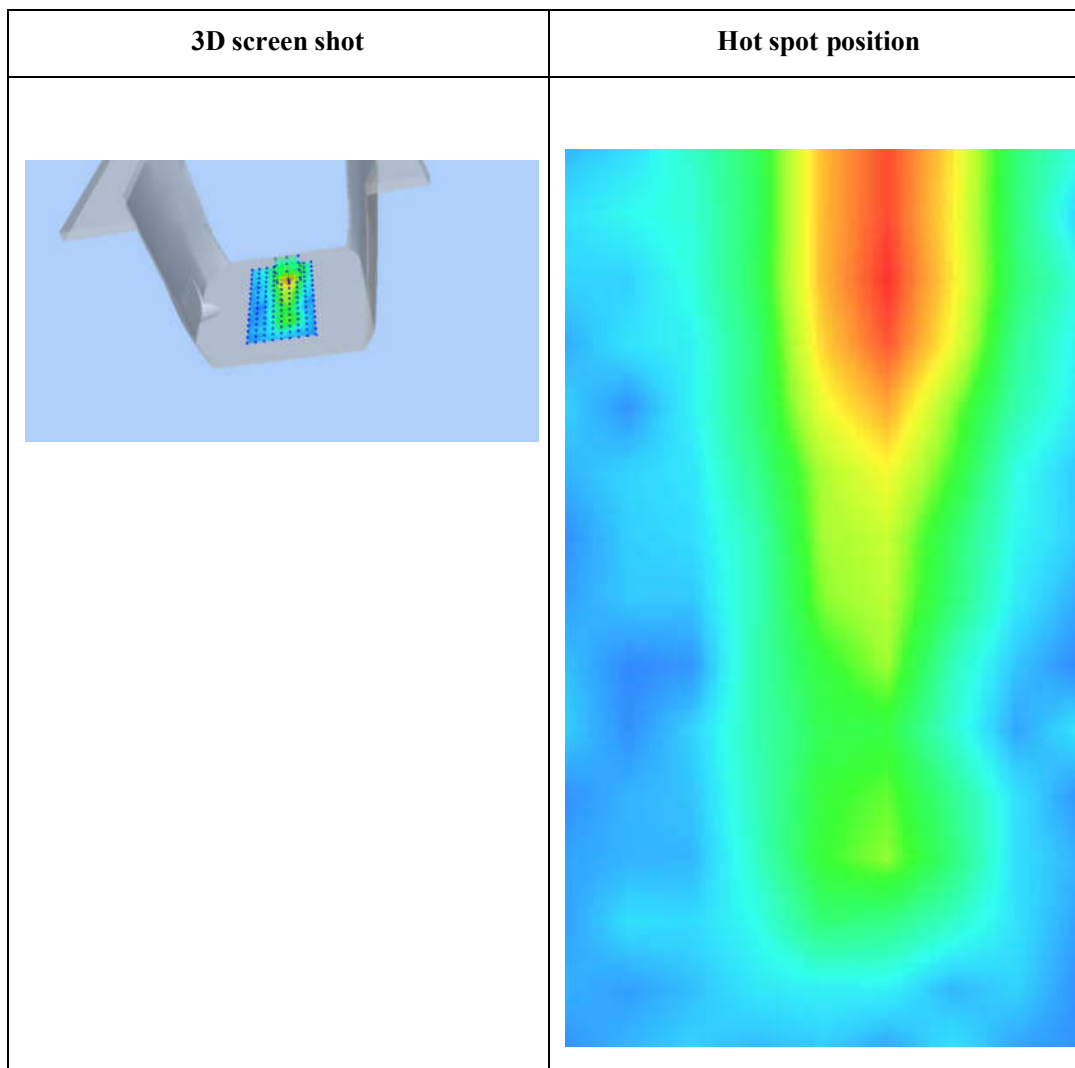
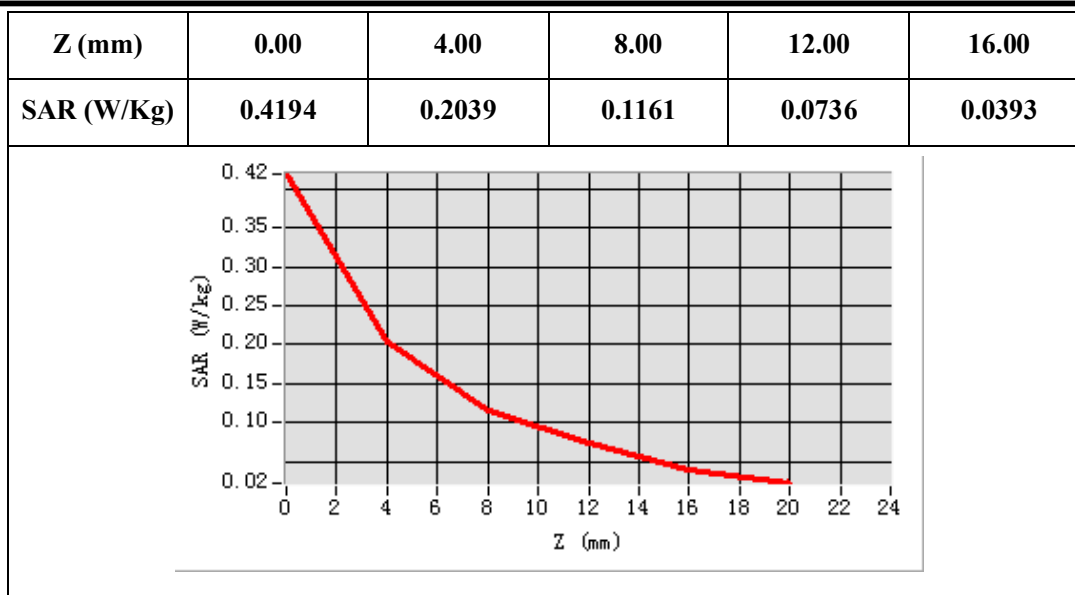
|                                   |                         |
|-----------------------------------|-------------------------|
| E-Field Probe                     | SATIMO SN_27/15_EPG0261 |
| Frequency (MHz)                   | 2437                    |
| Relative permittivity (real part) | 52.65                   |
| Relative permittivity             | 14.18                   |
| Conductivity (S/m)                | 1.93                    |
| Variation (%)                     | -1.34                   |
| ConvF:                            | 2.47                    |



Maximum location: X=10.00, Y=48.00

SAR Peak: 0.33W/kg

|                |          |
|----------------|----------|
| SAR 10g (W/Kg) | 0.098827 |
| SAR 1g (W/Kg)  | 0.188762 |



## ANNEX C: Appendix C: Calibration reports

**COMOSAR E-Field Probe Calibration Report**

Ref : ACR.178.1.20.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 27/15 EPG0261**

**Calibrated at 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 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).

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## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.178.1.20.MVGB.A

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

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

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

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## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.178.1.20.MVGB.A

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## COMOSAR E-FIELD PROBE CALIBRATION REPORT

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### 1 DEVICE UNDER TEST

| Device Under Test                        |                                                                         |
|------------------------------------------|-------------------------------------------------------------------------|
| Device Type                              | COMOSAR DOSIMETRIC E FIELD PROBE                                        |
| Manufacturer                             | MVG                                                                     |
| Model                                    | SSE2                                                                    |
| Serial Number                            | SN 27/15 EPGO261                                                        |
| Product Condition (new / used)           | Used                                                                    |
| Frequency Range of Probe                 | 0.15 GHz-6GHz                                                           |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.216 MΩ<br>Dipole 2: R2=0.218 MΩ<br>Dipole 3: R3=0.222 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.

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### 3.2 SENSITIVITY

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

### 3.3 LOWER DETECTION LIMIT

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

### 3.4 ISOTROPY

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

### 3.1 BOUNDARY EFFECT

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

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

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

where

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



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

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

### 4 MEASUREMENT UNCERTAINTY

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

| Uncertainty analysis of the probe calibration in waveguide |                       |                          |         |    |                          |
|------------------------------------------------------------|-----------------------|--------------------------|---------|----|--------------------------|
| ERROR SOURCES                                              | Uncertainty value (%) | Probability Distribution | Divisor | ci | Standard Uncertainty (%) |
| Expanded uncertainty<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           | 30-70 %     |

#### 5.1 SENSITIVITY IN AIR

| Normx dipole<br>1 (μV/(V/m) <sup>2</sup> ) | Normy dipole<br>2 (μV/(V/m) <sup>2</sup> ) | Normz dipole<br>3 (μV/(V/m) <sup>2</sup> ) |
|--------------------------------------------|--------------------------------------------|--------------------------------------------|
| 0.77                                       | 0.70                                       | 0.81                                       |

| DCP dipole 1<br>(mV) | DCP dipole 2<br>(mV) | DCP dipole 3<br>(mV) |
|----------------------|----------------------|----------------------|
| 116                  | 114                  | 126                  |

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

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

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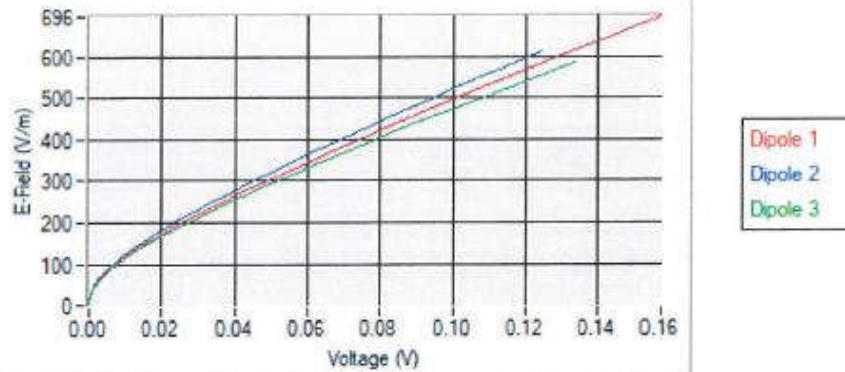
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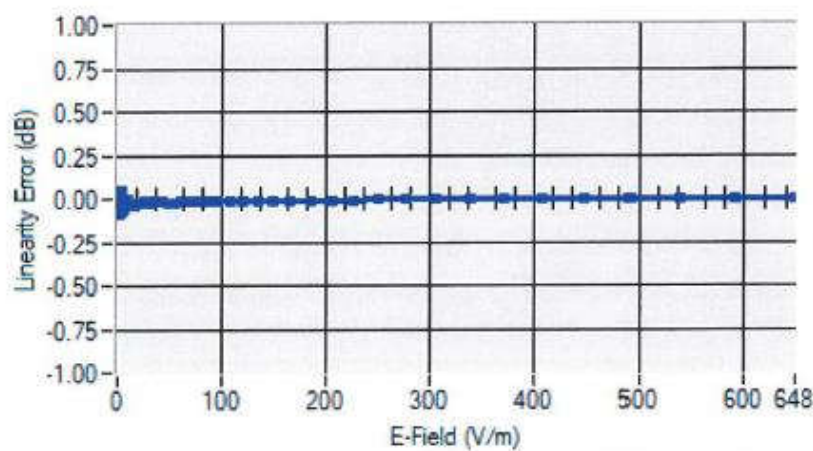
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## Calibration curves



## 5.2 LINEARITY

### Linearity



**Linearity: +/-1.84% (+/-0.08dB)**

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## 5.3 SENSITIVITY IN LIQUID

| Liquid | Frequency<br>(MHz +/-<br>100MHz) | ConvF |
|--------|----------------------------------|-------|
| HL750  | 750                              | 1.78  |
| BL750  | 750                              | 1.88  |
| HL850  | 835                              | 1.86  |
| BL850  | 835                              | 1.90  |
| HL900  | 900                              | 1.84  |
| BL900  | 900                              | 1.92  |
| HL1800 | 1800                             | 2.04  |
| BL1800 | 1800                             | 2.09  |
| HL1900 | 1900                             | 2.20  |
| BL1900 | 1900                             | 2.26  |
| HL2000 | 2000                             | 2.21  |
| BL2000 | 2000                             | 2.22  |
| HL2300 | 2300                             | 2.23  |
| BL2300 | 2300                             | 2.47  |
| HL2450 | 2450                             | 2.18  |
| BL2450 | 2450                             | 2.47  |
| HL2600 | 2600                             | 2.07  |
| BL2600 | 2600                             | 2.25  |
| HL5200 | 5200                             | 2.02  |
| BL5200 | 5200                             | 2.09  |
| HL5400 | 5400                             | 2.12  |
| BL5400 | 5400                             | 2.22  |
| HL5600 | 5600                             | 2.28  |
| BL5600 | 5600                             | 2.39  |
| HL5800 | 5800                             | 2.24  |
| BL5800 | 5800                             | 2.34  |

LOWER DETECTION LIMIT: 7mW/kg

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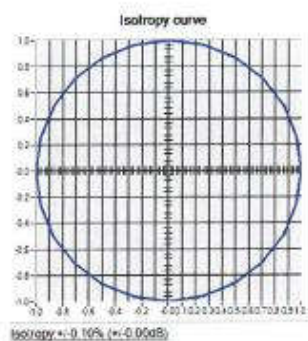


## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.178.1.20.MVGB.A

### 5.4 ISOTROPY

#### HL1800 MHz



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## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.178.1.20.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      | Control Company         | 150798832          | 11/2017                                       | 11/2020                                       |

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## 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.

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.178.8.20.MVGB.A

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

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

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

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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.178.8.20.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**

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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. 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 |
|-------------|----------------------|
|-------------|----------------------|

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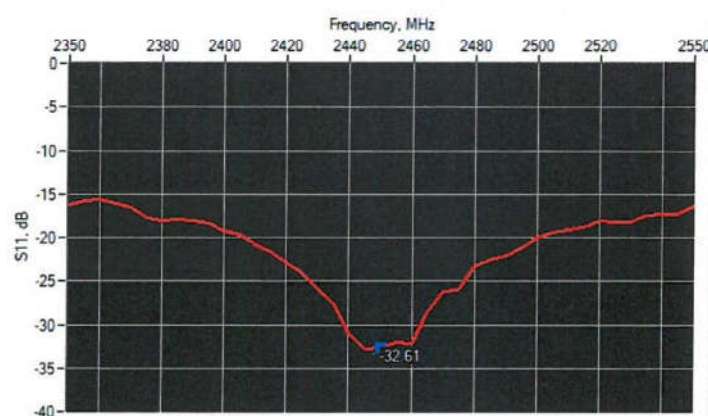
# SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.178.8.20.MVGB.A

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

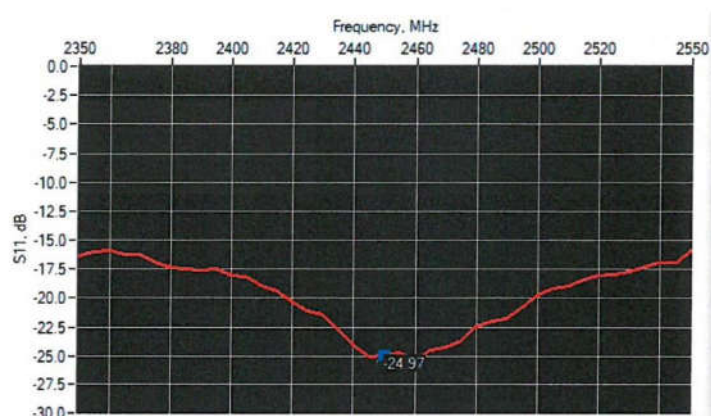
## 6 CALIBRATION MEASUREMENT RESULTS

### 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 |

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|      |             |   |             |   |            |   |
|------|-------------|---|-------------|---|------------|---|
| 300  | 420.0 ±1 %. |   | 250.0 ±1 %. |   | 6.35 ±1 %. |   |
| 450  | 290.0 ±1 %. |   | 166.7 ±1 %. |   | 6.35 ±1 %. |   |
| 750  | 176.0 ±1 %. |   | 100.0 ±1 %. |   | 6.35 ±1 %. |   |
| 835  | 161.0 ±1 %. |   | 89.8 ±1 %.  |   | 3.6 ±1 %.  |   |
| 900  | 149.0 ±1 %. |   | 83.3 ±1 %.  |   | 3.6 ±1 %.  |   |
| 1450 | 89.1 ±1 %.  |   | 51.7 ±1 %.  |   | 3.6 ±1 %.  |   |
| 1500 | 80.5 ±1 %.  |   | 50.0 ±1 %.  |   | 3.6 ±1 %.  |   |
| 1640 | 79.0 ±1 %.  |   | 45.7 ±1 %.  |   | 3.6 ±1 %.  |   |
| 1750 | 75.2 ±1 %.  |   | 42.9 ±1 %.  |   | 3.6 ±1 %.  |   |
| 1800 | 72.0 ±1 %.  |   | 41.7 ±1 %.  |   | 3.6 ±1 %.  |   |
| 1900 | 68.0 ±1 %.  |   | 39.5 ±1 %.  |   | 3.6 ±1 %.  |   |
| 1950 | 66.3 ±1 %.  |   | 38.5 ±1 %.  |   | 3.6 ±1 %.  |   |
| 2000 | 64.5 ±1 %.  |   | 37.5 ±1 %.  |   | 3.6 ±1 %.  |   |
| 2100 | 61.0 ±1 %.  |   | 35.7 ±1 %.  |   | 3.6 ±1 %.  |   |
| 2300 | 55.5 ±1 %.  |   | 32.6 ±1 %.  |   | 3.6 ±1 %.  |   |
| 2450 | 51.5 ±1 %.  | - | 30.4 ±1 %.  | - | 3.6 ±1 %.  | - |
| 2600 | 48.5 ±1 %.  |   | 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 ±10 %                              |          | 0.87 ±10 %                    |          |
| 450              | 43.5 ±10 %                              |          | 0.87 ±10 %                    |          |
| 750              | 41.9 ±10 %                              |          | 0.89 ±10 %                    |          |
| 835              | 41.5 ±10 %                              |          | 0.90 ±10 %                    |          |
| 900              | 41.5 ±10 %                              |          | 0.97 ±10 %                    |          |
| 1450             | 40.5 ±10 %                              |          | 1.20 ±10 %                    |          |
| 1500             | 40.4 ±10 %                              |          | 1.23 ±10 %                    |          |
| 1640             | 40.2 ±10 %                              |          | 1.31 ±10 %                    |          |

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|      |            |      |            |      |
|------|------------|------|------------|------|
| 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: $\epsilon_{ps}^*$ : 41.9 sigma : 1.88 |
| Distance between dipole center and liquid | 10.0 mm                                                   |
| Area scan resolution                      | $dx=8mm/dy=8mm$                                           |
| Zoon Scan Resolution                      | $dx=5mm/dy=5mm/dz=5mm$                                    |
| Frequency                                 | 2450 MHz                                                  |
| Input power                               | 20 dBm                                                    |
| Liquid Temperature                        | 20 +/- 1 °C                                               |
| Lab Temperature                           | 20 +/- 1 °C                                               |
| Lab Humidity                              | 30-70 %                                                   |

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

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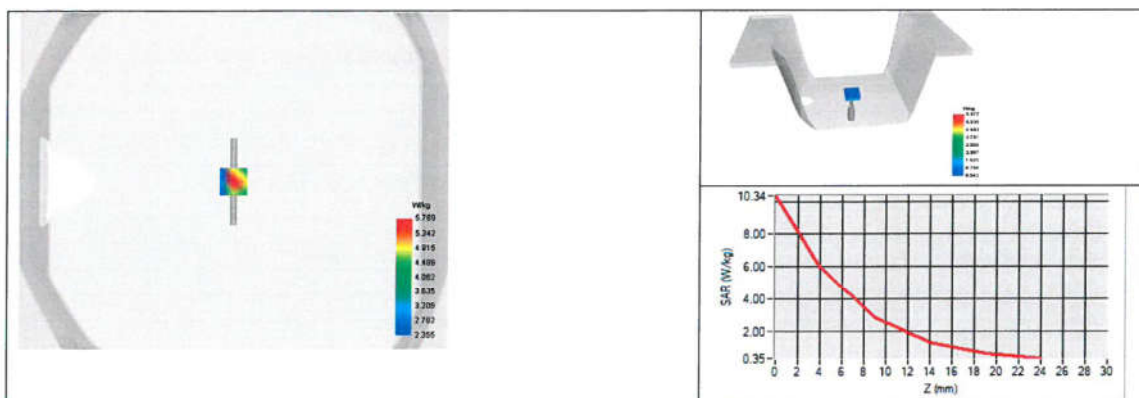
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|      |      |              |      |              |
|------|------|--------------|------|--------------|
| 1800 | 38.4 |              | 20.1 |              |
| 1900 | 39.7 |              | 20.5 |              |
| 1950 | 40.5 |              | 20.9 |              |
| 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 $\pm$ 10 %                         |          | 0.80 $\pm$ 10 %               |          |
| 300              | 58.2 $\pm$ 10 %                         |          | 0.92 $\pm$ 10 %               |          |
| 450              | 56.7 $\pm$ 10 %                         |          | 0.94 $\pm$ 10 %               |          |
| 750              | 55.5 $\pm$ 10 %                         |          | 0.96 $\pm$ 10 %               |          |
| 835              | 55.2 $\pm$ 10 %                         |          | 0.97 $\pm$ 10 %               |          |
| 900              | 55.0 $\pm$ 10 %                         |          | 1.05 $\pm$ 10 %               |          |
| 915              | 55.0 $\pm$ 10 %                         |          | 1.06 $\pm$ 10 %               |          |
| 1450             | 54.0 $\pm$ 10 %                         |          | 1.30 $\pm$ 10 %               |          |
| 1610             | 53.8 $\pm$ 10 %                         |          | 1.40 $\pm$ 10 %               |          |
| 1800             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 1900             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 2000             | 53.3 $\pm$ 10 %                         |          | 1.52 $\pm$ 10 %               |          |
| 2100             | 53.2 $\pm$ 10 %                         |          | 1.62 $\pm$ 10 %               |          |

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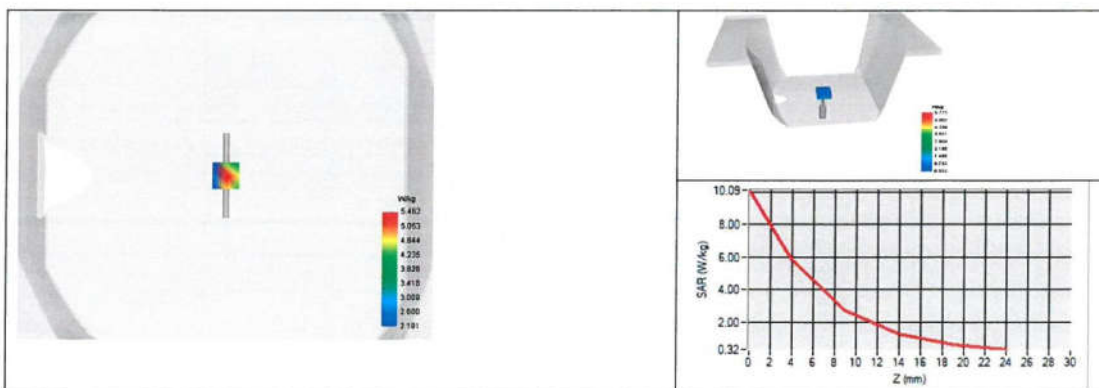
Ref: ACR.178.8.20.MVGB.A

|      |            |      |            |      |
|------|------------|------|------------|------|
| 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 EPG0333                                         |
| Liquid                                    | Body Liquid Values: $\epsilon_{ps}'$ : 53.4 sigma : 2.14 |
| Distance between dipole center and liquid | 10.0 mm                                                  |
| Area scan resolution                      | dx=8mm/dy=8mm                                            |
| Zoon Scan Resolution                      | dx=5mm/dy=5mm/dz=5mm                                     |
| Frequency                                 | 2450 MHz                                                 |
| Input power                               | 20 dBm                                                   |
| Liquid Temperature                        | 20 +/- 1 °C                                              |
| Lab Temperature                           | 20 +/- 1 °C                                              |
| Lab Humidity                              | 30-70 %                                                  |

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



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## SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.178.8.20.MVGB.A

## 8 LIST OF EQUIPMENT

| Equipment Summary Sheet            |                         |                    |                                               |                                               |
|------------------------------------|-------------------------|--------------------|-----------------------------------------------|-----------------------------------------------|
| Equipment Description              | Manufacturer / Model    | Identification No. | Current Calibration Date                      | Next Calibration Date                         |
| SAM Phantom                        | MVG                     | SN-13/09-SAM68     | Validated. No cal required.                   | Validated. No cal required.                   |
| COMOSAR Test Bench                 | Version 3               | NA                 | Validated. No cal required.                   | Validated. No cal required.                   |
| Network Analyzer                   | Rohde & Schwarz ZVM     | 100203             | 05/2019                                       | 05/2022                                       |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223             | 05/2019                                       | 05/2022                                       |
| Calipers                           | Mitutoyo                | SN 0009732         | 10/2019                                       | 10/2022                                       |
| Reference Probe                    | MVG                     | EPGO333 SN 41/18   | 05/2020                                       | 05/2021                                       |
| Multimeter                         | Keithley 2000           | 1160271            | 02/2020                                       | 02/2023                                       |
| Signal Generator                   | Rohde & Schwarz SMB     | 106589             | 04/2019                                       | 04/2022                                       |
| Amplifier                          | Aethercomm              | SN 046             | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter                        | NI-USB 5680             | 170100013          | 05/2019                                       | 05/2022                                       |
| Directional Coupler                | Narda 4216-20           | 01386              | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor      | Control Company         | 150798832          | 11/2017                                       | 11/2020                                       |

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## ANNEX D: Appendix D: SAR Test Setup

Photo 1: Measurement System SATIMO



Photo 2: Liquid deep(15cm)



Photo 3: Edge D 0mm



Photo 4: Edge B 0mm



Photo 5: Edge A 0mm



EUT Front View



EUT Back View



—End of the Report—