

FCC SAR EVALUATION REPORT

**In accordance with the requirements of
FCC 47 CFR Part 2(2.1093) and
IEEE Std 1528-2013**

Product Name: Heavy Duty Vehicles Diagnostic Tool

Model No.: HDY9S

Serial Model: N/A

Brand Name: THINKCAR, MUCAR

Report No.: AiTSZ-250609043FW1-M1

FCC ID: 2AUARHDY9S

Prepared for

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TEST RESULT CERTIFICATION

Applicant's name : THINKCAR TECH CO., LTD.
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Manufacturer's Name : THINKCAR TECH CO., LTD.
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Product description

Product name : Heavy Duty Vehicles Diagnostic Tool

Trademark : THINKCAR, MUCAR

Model and/or type reference : HDY9S

Serial Model..... : N/A

FCC 47 CFR Part 2(2.1093)

Standards : IEEE Std 1528-2013

Published RF exposure KDB procedures

This device described above has been tested by Guangdong Asia Hongke Test Technology Limited. In accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 and KDB 865664 D01. Testing has shown that this device is capable of compliance with localized specific absorption rate (SAR) specified in FCC 47 CFR Part 2(2.1093). The test results in this report apply only to the tested sample of the stated device/equipment. Other similar device/equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

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Test Sample Number..... : AiTSZ-250609043-1

Date of Test

Date (s) of performance of tests..... : Jul. 08, 2025 ~ Jul. 10, 2025

Date of Issue..... : Jul. 15, 2025

Test Result..... : **Pass**

Reviewed by:

Ken Zou



Approved by:

Jack Li



※※ **Revision History** ※※

| REV. | DESCRIPTION | ISSUED DATE | REMARK |
|---------|-------------------------------|---------------|---------|
| Rev.1.0 | Initial Test Report Release | Jul. 15, 2025 | Jack Li |
| Rev.2.0 | AiTSZ-250609043FW1 is invalid | Jul. 15, 2025 | Jack Li |
| | | | |
| | | | |

TABLE OF CONTENTS

| | |
|--|----|
| 1. General Information | 6 |
| 1.1. RF exposure limits | 6 |
| 1.2. Statement of Compliance | 7 |
| 1.3. EUT Description | 8 |
| 1.4. Test specification(s) | 9 |
| 1.5. Ambient Condition | 9 |
| 1.6. Test Facility | 9 |
| 2. SAR Measurement System | 10 |
| 2.1. SATIMO SAR Measurement Set-up Diagram | 10 |
| 2.2. Robot | 11 |
| 2.3. Probe | 12 |
| 2.3.1. E-Field Probe Calibration | 12 |
| 2.4. Phantoms | 13 |
| 2.5. Technical Data | 14 |
| 2.6. Device Holder | 15 |
| 2.7. Test Equipment List | 16 |
| 3. SAR Measurement Procedures | 18 |
| 3.1. Power Reference | 18 |
| 3.2. Area scan & Zoom scan | 18 |
| 3.3. Description of interpolation/extrapolation scheme | 20 |
| 3.4. Volumetric Scan | 20 |
| 3.5. Power Drift | 20 |
| 4. System Verification Procedure | 21 |
| 4.1. Tissue Verification | 21 |
| 4.1.1. Tissue Dielectric Parameter Check Results | 22 |
| 4.2. System Verification Procedure | 23 |
| 4.2.1. System Verification Results | 24 |
| 5. SAR measurement variabilit | 25 |
| 6. SAR Measurement Uncertainty | 26 |
| 7. RF Exposure Positions | 27 |
| 7.1. Generic device | 27 |
| 8. RF Output Power | 28 |
| 8.1. Wi-Fi & BT Output Power | 28 |
| 9. Antenna Location | 29 |
| 10. Stand-alone SAR test exclusion | 30 |
| 11. SAR Measurement Results | 31 |
| 12. Simultaneous Transmission Analysis | 32 |
| Appendix A. Photo documentation | 33 |
| Appendix B. System Check Plots | 34 |
| Appendix C. SAR Test Plots | 41 |

| | |
|---|----|
| Appendix D. Calibration Certificate | 48 |
| Appendix E. Justification of the extended calibration | 77 |

1. General Information

1.1. RF exposure limits

(A).Limits for Occupational/Controlled Exposure (W/kg)

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|------------|--------------|--------------------------------|
| 0.4 | 8.0 | 20.0 |

(B).Limits for General Population/Uncontrolled Exposure (W/kg)

| Whole-Body | Partial-Body | Hands, Wrists, Feet and Ankles |
|------------|--------------|--------------------------------|
| 0.08 | 1.6 | 4.0 |

NOTE: **Whole-Body SAR** is averaged over the entire body, **partial-body SAR** is averaged over any 1 gram of tissue defined as a tissue volume in the shape of a cube. **SAR for hands, wrists, feet and ankles** is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

Occupational/Controlled Environments:

Are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure, (i.e. as a result of employment or occupation).

General Population/Uncontrolled Environments:

Are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

NOTE

TRUNK LIMIT

1.6 W/kg

APPLIED TO THIS EUT

1.2. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing as follows.

| Band | Max SAR Value Reported(W/kg) | |
|-------------|--|-------------------|
| | 1-g Body (Separation distance of 0mm) | Max SAR Summation |
| 2.4GHz WLAN | 0.305 | Body: N/A |
| 5.2GHz WLAN | 0.532 | |
| 5.8GHz WLAN | 0.637 | |

NOTE: The Max SAR Summation is calculated based on the same configuration and test position.

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR Part 2(2.1093), and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 & KDB 865664 D01.

1.3. EUT Description

| Device Information | | | |
|---------------------------------|--|-----------|----------|
| Product Name | Heavy Duty Vehicles Diagnostic Tool | | |
| Model Name | HDY9S | | |
| Family Model | N/A | | |
| Model Difference | N/A | | |
| Device Phase | Identical Prototype | | |
| Exposure Category | General population / Uncontrolled environment | | |
| Antenna Type | PIFA antenna | | |
| Battery Information | DC 3.8V 3150mAh 11.97Wh by Rechargeable Li-ion battery | | |
| Hardware version | N/A | | |
| Software version | N/A | | |
| Device Operating Configurations | | | |
| Supporting Mode(s) | WLAN 2.4G/5.2G/5.8G, Bluetooth | | |
| Test Modulation | WLAN(DSSS/OFDM), Bluetooth(GFSK, $\pi/4$ DQPSK, 8DPSK) | | |
| Device Class | B | | |
| Operating Frequency Range(s) | Band | Tx (MHz) | Rx (MHz) |
| | WLAN 2.4G | 2412-2462 | |
| | WLAN 5.2G | 5180-5240 | |
| | WLAN 5.8G | 5745-5825 | |
| | Bluetooth | 2402-2480 | |

1.4. Test specification(s)

| |
|---|
| FCC 47 CFR Part 2(2.1093) |
| IEEE Std 1528-2013 |
| KDB 865664 D01 SAR measurement 100 MHz to 6 GHz |
| KDB 865664 D02 RF Exposure Reporting |
| KDB 447498 D01 General RF Exposure Guidance |
| KDB 248227 D01 802.11 Wi-Fi SAR |

1.5. Ambient Condition

| | |
|---------------------|-------------|
| Ambient temperature | 20°C – 24°C |
| Relative Humidity | 30% – 70% |

1.6. Test Facility

Test Laboratory:

Guangdong Asia Hongke Test Technology Limited

B1/F, Building 11, Junfeng Industrial Park, Chongqing Road, Heping Community, Fuhai Street, Bao'an District, Shenzhen, Guangdong, China

The test facility is recognized, certified or accredited by the following organizations:

FCC-Registration No.: 251906 Designation Number: CN1376

Guangdong Asia Hongke Test Technology Limited 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.

IC —Registration No.: 31737 CAB identifier: CN0165

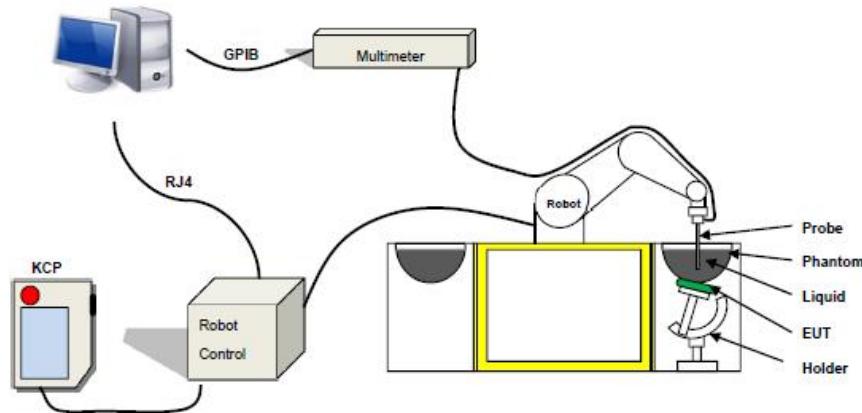
The 3m Semi-anechoic chamber of Guangdong Asia Hongke Test Technology Limited has been registered by Certification and Engineering Bureau of Industry Canada for radio equipment testing with Registration No.: 31737c

A2LA-Lab Cert. No.: 7133.01

Guangdong Asia Hongke Test Technology Limited has been accredited by A2LA for technical competence in the field of electrical testing, and proved to be in compliance with ISO/IEC 17025: 2017 General Requirements for the Competence of Testing and Calibration Laboratories and any additional program requirements in the identified field of testing.

2. SAR Measurement System

2.1. SATIMO SAR Measurement Set-up Diagram



These measurements were performed with the automated near-field scanning system OPENSAR from SATIMO. The system is based on a high precision robot (working range: 901 mm), which positions the probes with a positional repeatability of better than ± 0.03 mm. The SAR measurements were conducted with dosimetric probe (manufactured by SATIMO), designed in the classical triangular configuration and optimized for dosimetric evaluation.

The first step of the field measurement is the evaluation of the voltages induced on the probe by the device under test. Probe diode detectors are nonlinear. Below the diode compression point, the output voltage is proportional to the square of the applied E-field; above the diode compression point, it is linear to the applied E-field. The compression point depends on the diode, and a calibration procedure is necessary for each sensor of the probe.

The Keithley multimeter reads the voltage of each sensor and send these three values to the PC. The corresponding E field value is calculated using the probe calibration factors, which are stored in the working directory. This evaluation includes linearization of the diode characteristics. The field calculation is done separately for each sensor. Each component of the E field is displayed on the "Dipole Area Scan Interface" and the total E field is displayed on the "3D Interface".

2.2. Robot

The SATIMO SAR system uses the high precision robots from KUKA. For the 6-axis controller system, the robot controller version (KUKA) from KUKA is used. The KUKA robot series have many features that are important for our application:



- High precision (repeatability ± 0.03 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

2.3. Probe

This E-field detection probe is composed of three orthogonal dipoles linked to special Schottky diodes with low detection thresholds. The probe allows the measurement of electric fields in liquids such as the one defined in the IEEE and CENELEC standards.

For the measurements the Specific Dosimetric E-Field Probe EPGO 0523-403 with following specifications is used.



- Probe Length: 330 mm
- Length of Individual Dipoles: 2 mm
- Maximum external diameter: 8 mm
- Probe Tip External Diameter: 2.5 mm
- Distance between dipole/probe extremity: 1 mm
- Dynamic range: 0.01-100 W/kg
- Probe linearity: 3%
- Axial Isotropy: < 0.10 dB
- Spherical Isotropy: < 0.10 dB
- Calibration range: 150 MHz to 6 GHz for head & body simulating liquid.
- Angle between probe axis (evaluation axis) and surface normal line: less than 30°

2.3.1. E-Field Probe Calibration

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than $\pm 10\%$. The spherical isotropy shall be evaluated and within $\pm 0.25\text{dB}$. The sensitivity parameters (Norm X, Norm Y, and Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe are tested. The calibration data can be referred to appendix D of this report.

2.4. Phantoms

For the measurements the Elliptical defined by the IEEE SCC-34/SC2 group is used. The phantom is a polyurethane shell integrated in a wooden table. The thickness of the phantom amounts to 2mm +/- 0.2mm. The Elliptical phantom has elliptic shape. The Elliptical phantom provide one reference point on its top part to position the probe tip correctly. The phantom set-up includes a cover, which prevents the evaporation of the liquid.



Elliptical

2.5. Technical Data

| | |
|--|---------------------------------------|
| Overall thickness | 2±0.2mm |
| Internal Dimensions (Bottom part) | 600 mm (L) x 400 mm (W) 170 mm (H) |
| External Dimensions | 1000 mm (L) x 500 mm (W) x 280 mm (H) |
| Maximum volume | 35 L |
| Material | Fiberglass based |
| Relative permittivity | 3.4 |
| Loss tangent | 0.02 |

The test, based on ultrasonic system, allows measuring the thickness with an accuracy of 10 µm.

2.6. Device Holder



The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface.

Material properties: the positioning system is made of PETP. This material offers a low permittivity of 3.2 and low loss, with a loss tangent of 0.005 to minimize the influence of the DUT on measurement results.

Mechanical properties: 2 rows of rail to cover easily the surface of the phantom. The fixing plate is perfectly adapted to larger devices, such as a PC which can be positioned in all configurations.

Accuracy and precision: graduated scale available on each axis. The DUT is fixed with a specific adaptable grip.

2.7. Test Equipment List

This table gives a complete overview of the SAR measurement equipment.

Devices used during the test described are marked

| | Manufacturer | Name of Equipment | Type/Model | Serial Number | Calibration | |
|-------------------------------------|--------------|-------------------------------------|------------|-------------------------|---------------|---------------|
| | | | | | Last Cal. | Due Date |
| <input checked="" type="checkbox"/> | MVG | E FIELD PROBE | SSE2 | EPGO 0523-403 | Sep. 11, 2024 | Sep. 10, 2025 |
| <input type="checkbox"/> | MVG | 750 MHz Dipole | SID750 | SN 03/15 DIP 0G750-355 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input type="checkbox"/> | MVG | 835 MHz Dipole | SID835 | SN 03/15 DIP 0G835-347 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input type="checkbox"/> | MVG | 900 MHz Dipole | SID900 | SN 03/15 DI P 0G900-348 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input type="checkbox"/> | MVG | 1800 MHz Dipole | SID1800 | SN 03/15 DIP 1G800-349 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input type="checkbox"/> | MVG | 1900 MHz Dipole | SID1900 | SN 03/15 DIP 1G900-350 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input type="checkbox"/> | MVG | 2000 MHz Dipole | SID2000 | SN 03/15 DIP 2G000-351 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input type="checkbox"/> | MVG | 2300 MHz Dipole | SID2300 | SN 03/16 DIP 2G300-358 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input checked="" type="checkbox"/> | MVG | 2450 MHz Dipole | SID2450 | SN 03/15 DIP 2G450-352 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input type="checkbox"/> | MVG | 2600 MHz Dipole | SID2600 | SN 03/15 DIP 2G600-356 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input checked="" type="checkbox"/> | MVG | 5000 MHz Dipole | SWG5500 | SN 13/14 WGA 33 | Feb. 21, 2024 | Feb. 20, 2027 |
| <input checked="" type="checkbox"/> | MVG | Liquid measurement Kit | SCLMP | SN 21/15 OCPG 72 | Sep. 23, 2024 | Sep. 22, 2025 |
| <input checked="" type="checkbox"/> | SCHAFFNER | Power Amplifier | CBA9429 | T43605 | NCR | NCR |
| <input checked="" type="checkbox"/> | KEITHLEY | Millivoltmeter | 2000 | 4072790 | Sep. 23, 2024 | Sep. 22, 2025 |
| <input type="checkbox"/> | R&S | Wideband radio communication tester | CMW500 | 116581 | Sep. 23, 2024 | Sep. 22, 2025 |
| <input checked="" type="checkbox"/> | HP | Network Analyzer | 8753D | 3410J01136 | Sep. 23, 2024 | Sep. 22, 2025 |
| <input checked="" type="checkbox"/> | Agilent | PSG Analog Signal Generator | N5182A | MY50143009 | Sep. 23, 2024 | Sep. 22, 2025 |
| <input checked="" type="checkbox"/> | Agilent | Power meter | E4419B | MY45102079 | Sep. 25, | Sep. 24, |

| | | | | | 2024 | 2025 |
|-------------------------------------|----------|---------------------|---------|-----------------|---------------|---------------|
| <input checked="" type="checkbox"/> | Agilent | Power sensor | 8481A | MY41097697 | Sep. 25, 2024 | Sep. 24, 2025 |
| <input checked="" type="checkbox"/> | Agilent | Power sensor | 8481A | MY41097696 | Sep. 25, 2024 | Sep. 24, 2025 |
| <input checked="" type="checkbox"/> | MCLI/USA | Directional Coupler | CB11-20 | 0D2L51502 | Sep. 23, 2024 | Sep. 22, 2025 |
| <input checked="" type="checkbox"/> | MVG | Elliptical Phantom | SSM2 | SN 20/11 ELLI20 | NCR | NCR |
| <input checked="" type="checkbox"/> | MVG | Device Holder | SMPPD | SN 24/11 LSH15 | NCR | NCR |

3. SAR Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

- (a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
- (b) Read the WWAN RF power level from the base station simulator.
- (c) For Wi-Fi/BT power measurement, use engineering software to configure EUT Wi-Fi/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band.
- (d) Connect EUT RF port through RF cable to the power meter, and measure Wi-Fi/BT output power.

<SAR measurement>

- (a) Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT Wi-Fi/BT continuously transmission, at maximum RF power, in the highest power channel.
- (b) Place the EUT in the positions as Appendix A demonstrates.
- (c) Set scan area, grid size and other setting on the OPENSAR software.
- (d) Measure SAR results for the highest power channel on each testing position.
- (e) Find out the largest SAR result on these testing positions of each band.
- (f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of highest power channel is larger than 0.8 W/kg.

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- (a) Power reference measurement
- (b) Area scan
- (c) Zoom scan
- (d) Power drift measurement

3.1. Power Reference

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

3.2. Area scan & Zoom scan

The area scan is a 2D scan to find the hot spot location on the DUT. The zoom scan is a 3D scan

above the hot spot to calculate the 1g and 10g SAR value.

Measurement of the SAR distribution with a grid of 8 to 16 mm * 8 to 16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme. Around this point, a cube of 30 * 30 * 30 mm or 32 * 32 * 32 mm is assessed by measuring 5 or 8 * 5 or 8 * 4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that will not be within the zoom scan of other peaks; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR compliance limit (e.g., 1 W/kg for 1,6 W/kg 1 g limit, or 1,26 W/kg for 2 W/kg, 10 g limit).

Area scan & Zoom scan scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

| | | ≤ 3 GHz | > 3 GHz |
|---|---|--|--|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | | 5 ± 1 mm | $\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm |
| Maximum probe angle from probe axis to phantom surface normal at the measurement location | | $30^\circ \pm 1^\circ$ | $20^\circ \pm 1^\circ$ |
| | | ≤ 2 GHz: ≤ 15 mm $2 - 3$ GHz: ≤ 12 mm | $3 - 4$ GHz: ≤ 12 mm $4 - 6$ GHz: ≤ 10 mm |
| Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$ | | When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device. | |
| Maximum zoom scan spatial resolution: $\Delta x_{\text{Zoom}}, \Delta y_{\text{Zoom}}$ | | ≤ 2 GHz: ≤ 8 mm $2 - 3$ GHz: ≤ 5 mm* | $3 - 4$ GHz: ≤ 5 mm* $4 - 6$ GHz: ≤ 4 mm* |
| Maximum zoom scan spatial resolution, normal to phantom surface | uniform grid: $\Delta z_{\text{Zoom}}(n)$ | | $3 - 4$ GHz: ≤ 4 mm $4 - 5$ GHz: ≤ 3 mm $5 - 6$ GHz: ≤ 2 mm |
| | graded grid | $\Delta z_{\text{Zoom}}(1)$: between 1 st two points closest to phantom surface $\Delta z_{\text{Zoom}}(n>1)$: between subsequent points | $3 - 4$ GHz: ≤ 3 mm $4 - 5$ GHz: ≤ 2.5 mm $5 - 6$ GHz: ≤ 2 mm $\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1)$ |
| Minimum zoom scan volume | x, y, z | ≥ 30 mm | $3 - 4$ GHz: ≥ 28 mm $4 - 5$ GHz: ≥ 25 mm $5 - 6$ GHz: ≥ 22 mm |
| Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details. | | | |
| * When zoom scan is required and the <u>reported</u> SAR from the <i>area scan based 1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz. | | | |

3.3. Description of interpolation/extrapolation scheme

The local SAR inside the phantom is measured using small dipole sensing elements inside a probe body. The probe tip must not be in contact with the phantom surface in order to minimise measurements errors, but the highest local SAR will occur at the surface of the phantom.

An extrapolation is used to determinate this highest local SAR values. The extrapolation is based on a fourth-order least-square polynomial fit of measured data. The local SAR value is then extrapolated from the liquid surface with a 1 mm step.

The measurements have to be performed over a limited time (due to the duration of the battery) so the step of measurement is high. It could vary between 5 and 8 mm. To obtain an accurate assessment of the maximum SAR averaged over 10 grams and 1 gram requires a very fine resolution in the three dimensional scanned data array.

3.4. Volumetric Scan

The volumetric scan consists to a full 3D scan over a specific area. This 3D scan is useful for multi Tx SAR measurement. Indeed, it is possible with OpenSAR to add, point by point, several volumetric scan to calculate the SAR value of the combined measurement as it is defined in the standard IEEE1528 and IEC62209.

3.5. Power Drift

All SAR testing is under the EUT installed full charged battery and transmit maximum output power. In OpenSAR measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in V/m. If the power drifts more than $\pm 5\%$, the SAR will be retested.

4. System Verification Procedure

4.1. Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

| Ingredients (% of weight) | Head Tissue | | | | | | | | | |
|---------------------------|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 750 | 835 | 900 | 1800 | 1900 | 2000 | 2450 | 2600 | 5200 | 5800 |
| Water | 34.40 | 34.40 | 34.40 | 55.36 | 55.36 | 57.87 | 57.87 | 57.87 | 65.53 | 65.53 |
| NaCl | 0.79 | 0.79 | 0.79 | 0.35 | 0.35 | 0.16 | 0.16 | 0.16 | 0.00 | 0.00 |
| 1,2-Propanediol | 64.81 | 64.81 | 64.81 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Triton X-100 | 0.00 | 0.00 | 0.00 | 30.45 | 30.45 | 19.97 | 19.97 | 19.97 | 24.24 | 24.24 |
| DGBE | 0.00 | 0.00 | 0.00 | 13.84 | 13.84 | 22.00 | 22.00 | 22.00 | 10.23 | 10.23 |

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. For head SAR testing, the liquid depth from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm.



4.1.1. Tissue Dielectric Parameter Check Results

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine if the dielectric parameter are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within $\pm 5\%$ of the target values.

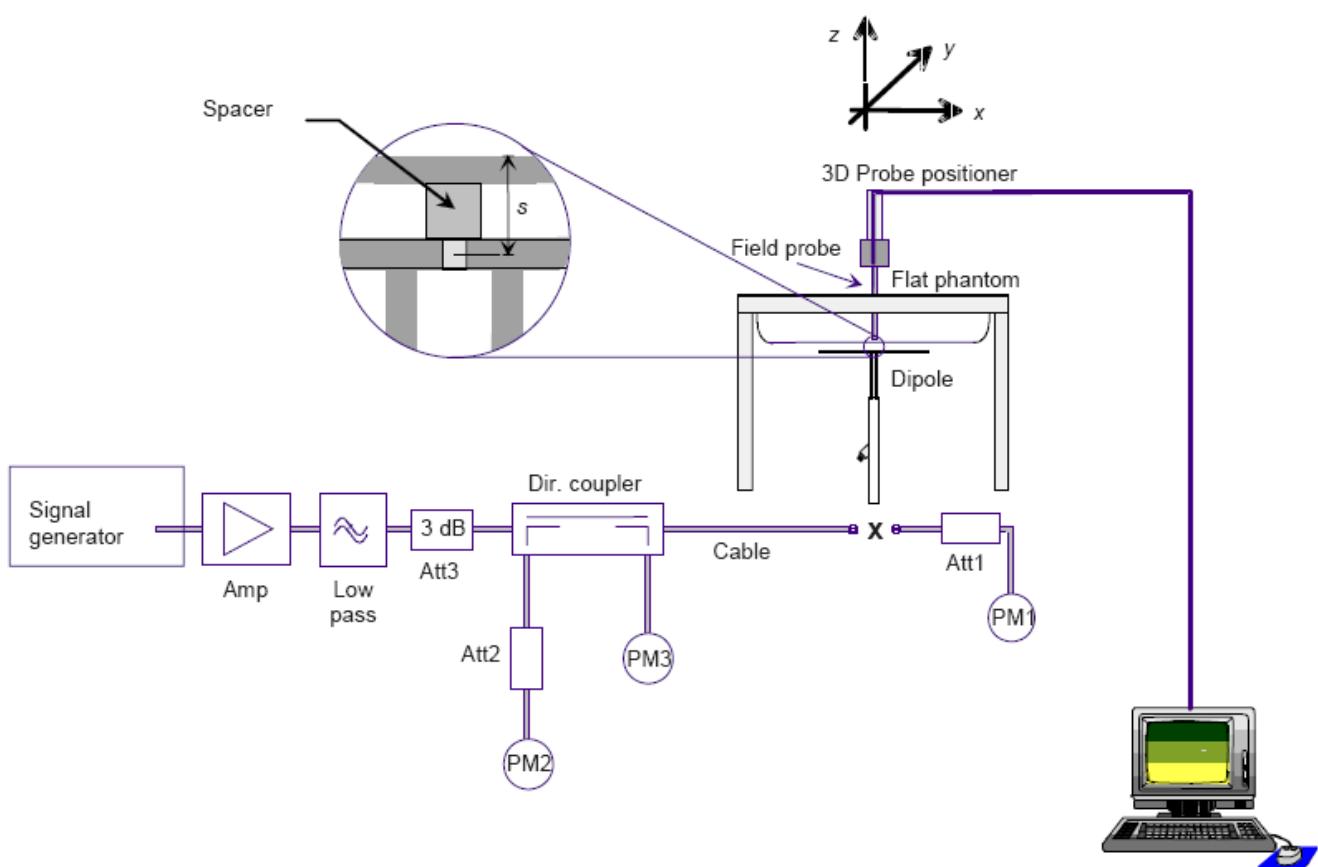
| Tissue Type | Measured Frequency (MHz) | Target Tissue | | Measured Tissue | | Liquid Temp. | Test Date |
|-------------|--------------------------|----------------------------|------------------------------|-----------------|----------------|--------------|---------------|
| | | ϵ_r ($\pm 5\%$) | σ (S/m) ($\pm 5\%$) | ϵ_r | σ (S/m) | | |
| Head 2450 | 2450 | 39.20 (37.24~41.16) | 1.80 (1.71~1.89) | 40.41 | 1.82 | 21.1 °C | Jul. 08, 2025 |
| Head 5200 | 5200 | 36.00 (34.20~37.80) | 4.66 (4.43~4.89) | 37.40 | 4.51 | 21.4 °C | Jul. 09, 2025 |
| Head 5800 | 5800 | 35.30 (33.54~37.07) | 5.27 (5.01~5.53) | 35.30 | 5.27 | 21.7 °C | Jul. 10, 2025 |

NOTE: The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.

4.2. System Verification Procedure

The system verification is performed for verifying the accuracy of the complete measurement system and performance of the software. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 100mW (below 5GHz) or 100mW (above 5GHz). To adjust this power a power meter is used. The power sensor is connected to the cable before the system verification to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the system verification to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test (result on plot).

The system verification is shown as below picture:



4.2.1. System Verification Results

Comparing to the original SAR value provided by SATIMO, the verification data should be within its specification of $\pm 10\%$. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance verification can meet the variation criterion and the plots can be referred to Appendix B of this report.

| System Verification | Power fed to reference dipole (mW) | Measured SAR Value | | Measured SAR (Normalized to 1W) | | Target SAR Value (1W) | | Deviation (%) | | Test Date |
|---------------------|------------------------------------|--------------------|-------------|---------------------------------|-------------|-----------------------|-------------|---------------|-------------|---------------|
| | | 1-g (W/Kg) | 10-g (W/Kg) | 1-g (W/Kg) | 10-g (W/Kg) | 1-g (W/Kg) | 10-g (W/Kg) | 1-g (W/Kg) | 10-g (W/Kg) | |
| 2450MHz | 100 | 5.184 | 2.359 | 51.84 | 23.59 | 50.05 | 23.80 | 3.58% | -0.88% | Jul. 08, 2025 |
| 5200MHz | 100 | 14.712 | 5.212 | 147.12 | 52.12 | 162.59 | 56.21 | -9.51% | -7.28% | Jul. 09, 2025 |
| 5800MHz | 100 | 16.421 | 5.623 | 164.21 | 56.23 | 182.2 | 61.32 | -9.87% | -8.30% | Jul. 10, 2025 |

5. SAR measurement variabilit

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

- 1) Repeated measurement is not required when the original highest measured SAR is $< 0.80 \text{ W/kg}$; steps 2) through 4) do not apply.
- 2) When the original highest measured SAR is $\geq 0.80 \text{ W/kg}$, repeat that measurement once.
- 3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is $\geq 1.45 \text{ W/kg}$ ($\sim 10\%$ from the 1-g SAR limit).
- 4) Perform a third repeated measurement only if the original, first or second repeated measurement is $\geq 1.5 \text{ W/kg}$ and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20 .

6. SAR Measurement Uncertainty

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

7. RF Exposure Positions

7.1. Generic device

The SAR evaluation shall be performed for surface of the DUT that are accessible during intended use, as indicated in Figure 7.1. Adjust the distance between the device surface and the flat phantom to 0mm.

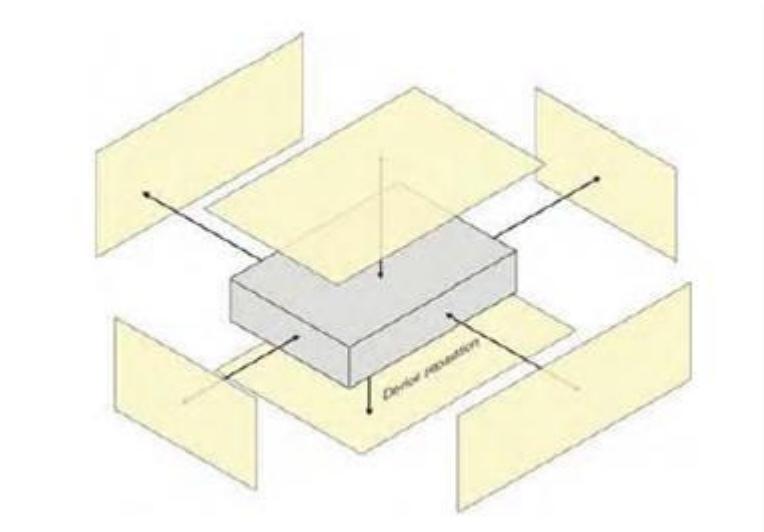


Figure 7.1 – Test positions for generic device

8. RF Output Power

8.1. Wi-Fi & BT Output Power

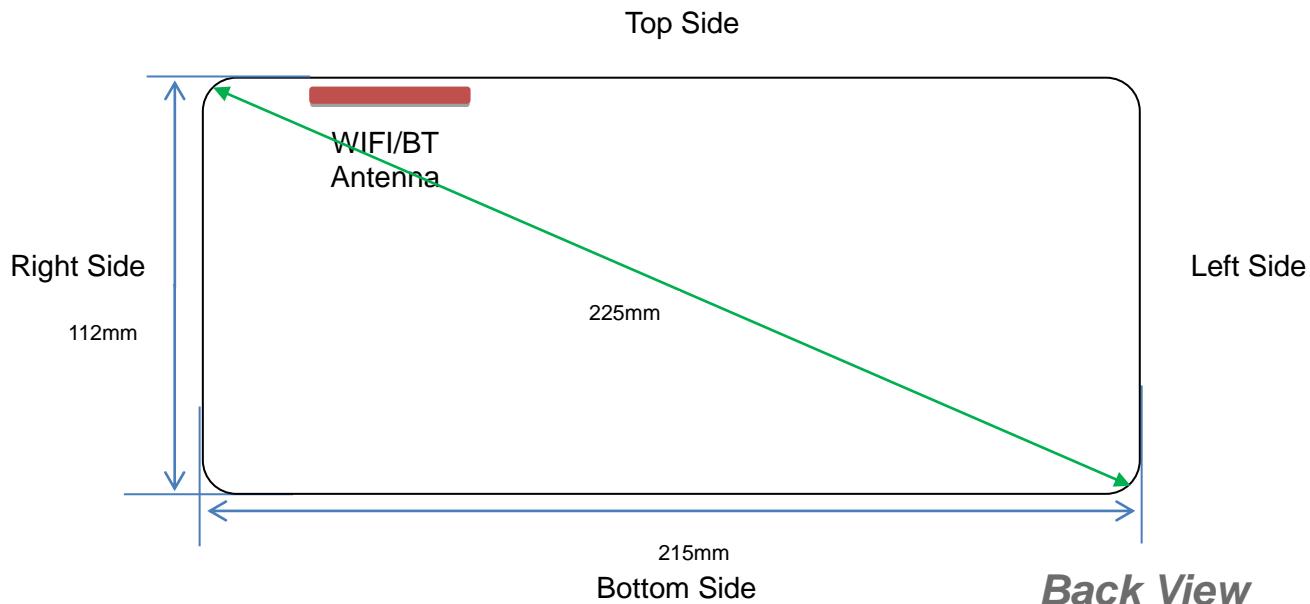
| Mode | Channel | Frequency (MHz) | Output Power (dBm) | Tune-Up |
|----------------|---------|-----------------|--------------------|---------|
| 802.11b | 1 | 2412 | 12.88 | 13.00 |
| | 6 | 2437 | 12.32 | 13.00 |
| | 11 | 2462 | 12.18 | 13.00 |
| 802.11g | 1 | 2412 | 12.93 | 13.00 |
| | 6 | 2437 | 12.50 | 13.00 |
| | 11 | 2462 | 12.48 | 13.00 |
| 802.11n (HT20) | 1 | 2412 | 12.57 | 13.00 |
| | 6 | 2437 | 12.41 | 13.00 |
| | 11 | 2462 | 12.32 | 13.00 |
| 802.11n (H40) | 3 | 2422 | 12.95 | 13.00 |
| | 6 | 2437 | 12.60 | 13.00 |
| | 9 | 2452 | 12.48 | 13.00 |

| Mode | Frequency (MHz) | Output Power(dBm) | Tune-up |
|----------------|-----------------|-------------------|---------|
| 802.11A | 5180 | 12.88 | 13.00 |
| | 5200 | 13.05 | 14.00 |
| | 5240 | 13.87 | 14.00 |
| 802.11N20SISO | 5180 | 12.78 | 13.00 |
| | 5200 | 12.97 | 13.00 |
| | 5240 | 13.80 | 14.00 |
| 802.11N40SISO | 5190 | 12.62 | 13.00 |
| | 5230 | 13.37 | 14.00 |
| 802.11AC20SISO | 5180 | 12.78 | 13.00 |
| | 5200 | 12.96 | 13.00 |
| | 5240 | 13.80 | 14.00 |
| 802.11AC40SISO | 5190 | 12.60 | 13.00 |
| | 5230 | 13.39 | 14.00 |
| 802.11AC80SISO | 5210 | 12.36 | 13.00 |

| Mode | Frequency (MHz) | Output Power (dBm) | Tune-up |
|----------------|-----------------|--------------------|---------|
| 802.11A | 5745 | 12.64 | 13.00 |
| | 5785 | 12.79 | 13.00 |
| | 5825 | 13.03 | 14.00 |
| 802.11N20SISO | 5745 | 12.63 | 13.00 |
| | 5785 | 12.83 | 13.00 |
| | 5825 | 13.05 | 14.00 |
| 802.11N40SISO | 5755 | 12.69 | 13.00 |
| | 5795 | 12.92 | 13.00 |
| 802.11AC20SISO | 5745 | 12.61 | 13.00 |
| | 5785 | 12.83 | 13.00 |
| | 5825 | 13.05 | 14.00 |
| 802.11AC40SISO | 5755 | 12.69 | 13.00 |
| | 5795 | 12.94 | 13.00 |
| 802.11AC80SISO | 5775 | 13.56 | 14.00 |

| Mode | Channel | Output Power (dBm) | Tune-up |
|-------|---------|--------------------|---------|
| DH5 | Hop | -0.53 | 0.00 |
| 2DH5 | Hop | -1.77 | -1.00 |
| 3DH5 | Hop | -1.27 | -1.00 |
| BLE1M | 00 | -1.14 | -1.00 |
| | 19 | -0.35 | 0.00 |
| | 39 | -0.53 | 0.00 |

9. Antenna Location



Antenna information:

| Distance of The Antenna to the EUT surface and edge (mm) | | | | | | |
|--|------------|-----------|-----------|------------|----------|-------------|
| Antennas | Front Side | Back Side | Left Side | Right Side | Top Side | Bottom Side |
| BT/WLAN | 5mm | ≤5mm | 160mm | 25mm | 5mm | 98mm |

10. Stand-alone SAR test exclusion

Refer to FCC KDB 447498D01, the 1-g SAR and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where:}$

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

| Mode | P _{max} (dBm) | P _{max} (mW) | Distance (mm) | f (GHz) | Calculation Result | SAR Exclusion threshold | SAR test exclusion |
|-----------|---------------------------|--------------------------|------------------|---------|-----------------------|-------------------------------|-----------------------|
| Bluetooth | 0.00 | 1.00 | 5 | 2.480 | 0.3 | 3 | Yes |

NOTE: Standalone SAR test exclusion for Bluetooth.

When standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] * [\sqrt{f(\text{GHz})/x}] \text{ W/kg}$ for test separation distances ≤ 50 mm, where $x = 7.5$ for 1-g SAR and $x = 18.75$ for 10-g SAR.

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

| Mode | Position | P _{max} (dBm) | P _{max} (mW) | Distance (mm) | f (GHz) | x | Estimated SAR (W/kg) |
|-----------|----------|---------------------------|--------------------------|------------------|---------|-----|----------------------------|
| Bluetooth | Body | 0.00 | 1.00 | 5 | 2.48 | 7.5 | 0.042 |

NOTE: Estimated SAR calculation for Bluetooth

11. SAR Measurement Results

< WLAN 2.4G >

| Test Position of Body with 0mm | Test channel /Freq. | Mode | SAR Value (W/kg) | | Power Drift (±5%) | Conducted power (dBm) | Tune-up power (dBm) | Scaled SAR 1g (W/Kg) | Date | Plot |
|-----------------------------------|------------------------|------------------|---------------------|-------|-------------------------|-----------------------------|---------------------------|-------------------------------|----------|------|
| | | | 1g | 10g | | | | | | |
| Front Side | 1/2412 | 802.11b | 0.198 | 0.116 | 0.12 | 12.88 | 13.00 | 0.204 | 2025/7/8 | |
| Back Side | 1/2412 | 802.11b | 0.297 | 0.181 | 4.69 | 12.88 | 13.00 | 0.305 | 2025/7/8 | 3# |
| Back Side | 3/2422 | 802.11n (H40) | 0.274 | 0.170 | 0.14 | 12.95 | 13.00 | 0.277 | 2025/7/8 | |
| Left Side | 1/2412 | 802.11b | 0.061 | 0.021 | 2.10 | 12.88 | 13.00 | 0.063 | 2025/7/8 | |
| Right Side | 1/2412 | 802.11b | 0.142 | 0.087 | -3.54 | 12.88 | 13.00 | 0.146 | 2025/7/8 | |
| Top Side | 1/2412 | 802.11b | 0.165 | 0.101 | -1.00 | 12.88 | 13.00 | 0.170 | 2025/7/8 | |
| Bottom Side | 1/2412 | 802.11b | 0.112 | 0.059 | 3.00 | 12.88 | 13.00 | 0.115 | 2025/7/8 | |

< WLAN 5.2G >

| Test Position of Body with 0mm | Test channel /Freq. | Mode | SAR Value (W/kg) | | Power Drift (±5%) | Conducted power (dBm) | Tune-up power (dBm) | Scaled SAR 1g (W/Kg) | Date | Plot |
|-----------------------------------|------------------------|---------|---------------------|-------|-------------------------|-----------------------------|---------------------------|-------------------------------|----------|------|
| | | | 1g | 10g | | | | | | |
| Front Side | 48/5240 | 802.11a | 0.312 | 0.159 | -3.89 | 13.87 | 14.00 | 0.321 | 2025/7/9 | |
| Back Side | 48/5240 | 802.11a | 0.516 | 0.263 | 4.36 | 13.87 | 14.00 | 0.532 | 2025/7/9 | 1# |
| Left Side | 48/5240 | 802.11a | 0.075 | 0.040 | 1.54 | 13.87 | 14.00 | 0.077 | 2025/7/9 | |
| Right Side | 48/5240 | 802.11a | 0.258 | 0.112 | 3.69 | 13.87 | 14.00 | 0.266 | 2025/7/9 | |
| Top Side | 48/5240 | 802.11a | 0.280 | 0.137 | 0.46 | 13.87 | 14.00 | 0.289 | 2025/7/9 | |
| Bottom Side | 48/5240 | 802.11a | 0.213 | 0.088 | 1.55 | 13.87 | 14.00 | 0.219 | 2025/7/9 | |

< WLAN 5.8G >

| Test Position of Body with 0mm | Test channel /Freq. | Mode | SAR Value (W/kg) | | Power Drift (±5%) | Conducted power (dBm) | Tune-up power (dBm) | Scaled SAR 1g (W/Kg) | Date | Plot |
|-----------------------------------|------------------------|------------|---------------------|-------|-------------------------|-----------------------------|---------------------------|-------------------------------|-----------|------|
| | | | 1g | 10g | | | | | | |
| Front Side | 155/5775 | 802.11AC80 | 0.348 | 0.169 | 2.83 | 13.56 | 14.00 | 0.385 | 2025/7/10 | |
| Back Side | 155/5775 | 802.11AC80 | 0.576 | 0.294 | 4.70 | 13.56 | 14.00 | 0.637 | 2025/7/10 | 2# |
| Left Side | 155/5775 | 802.11AC80 | 0.100 | 0.063 | 1.14 | 13.56 | 14.00 | 0.111 | 2025/7/10 | |
| Right Side | 155/5775 | 802.11AC80 | 0.271 | 0.127 | 2.33 | 13.56 | 14.00 | 0.300 | 2025/7/10 | |
| Top Side | 155/5775 | 802.11AC80 | 0.300 | 0.153 | -0.98 | 13.56 | 14.00 | 0.332 | 2025/7/10 | |
| Bottom Side | 155/5775 | 802.11AC80 | 0.242 | 0.085 | -1.58 | 13.56 | 14.00 | 0.268 | 2025/7/10 | |

12. Simultaneous Transmission Analysis

N/A

Appendix A. Photo documentation

Refer to appendix Test Setup photo-SAR

Appendix B. System Check Plots

Table of contents

MEASUREMENT 1 System Performance Check - 2450MHz

MEASUREMENT 2 System Performance Check - 5200MHz

MEASUREMENT 3 System Performance Check - 5800MHz

MEASUREMENT 1

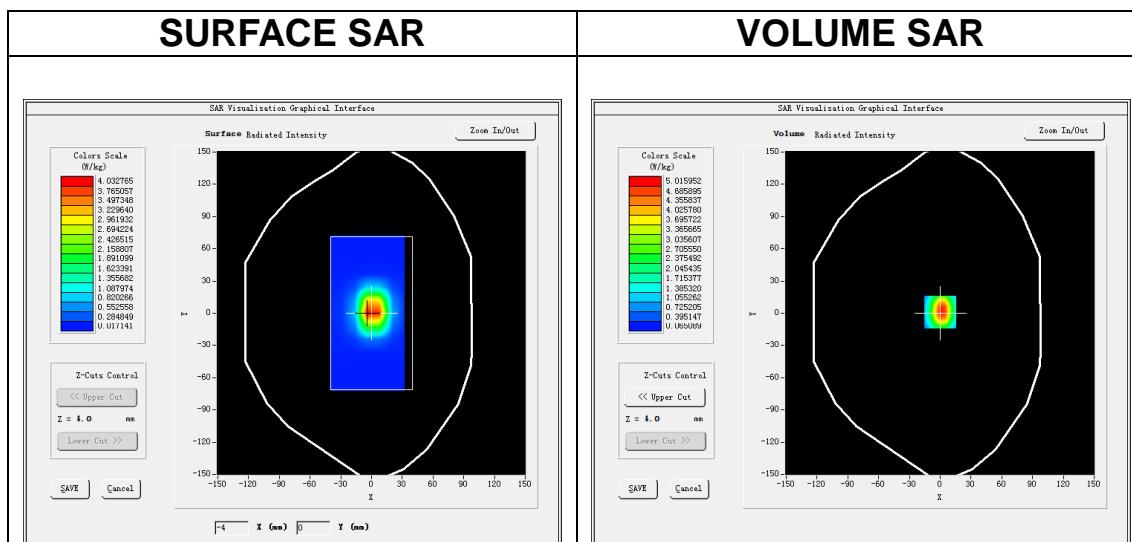
Date of measurement: 8/7/2025

A. Experimental conditions.

| | |
|------------------------|---|
| <u>Area Scan</u> | <u>$dx=12\text{mm}$ $dy=12\text{mm}$, $h= 5.00\text{ mm}$</u> |
| <u>ZoomScan</u> | <u>$7\times 7\times 7$, $dx=5\text{mm}$ $dy=5\text{mm}$ $dz=5\text{mm}$</u> |
| <u>Phantom</u> | <u>Validation plane</u> |
| <u>Device Position</u> | <u>Dipole</u> |
| <u>Band</u> | <u>CW2450</u> |
| <u>Channels</u> | <u>Middle</u> |
| <u>Signal</u> | <u>CW (Crest factor: 1.0)</u> |
| <u>ConvF</u> | <u>2.38</u> |

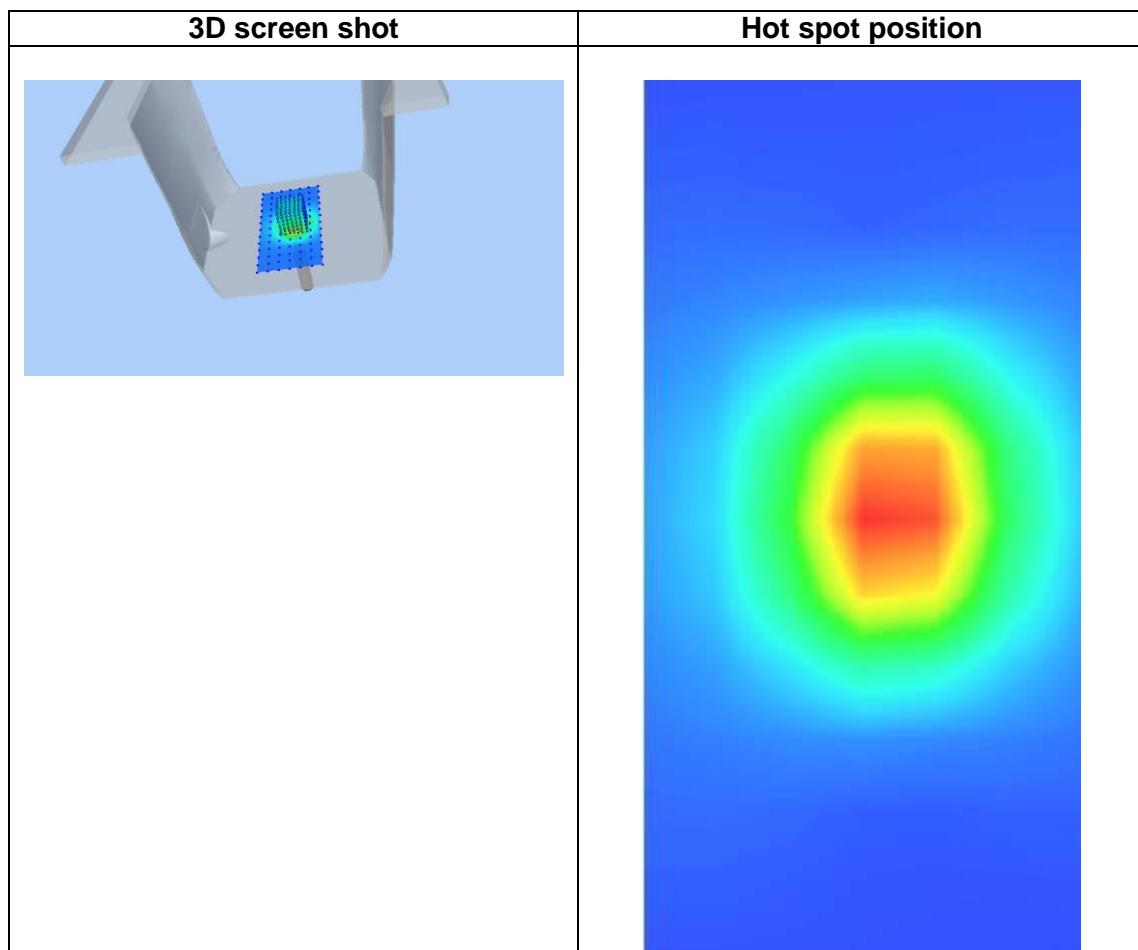
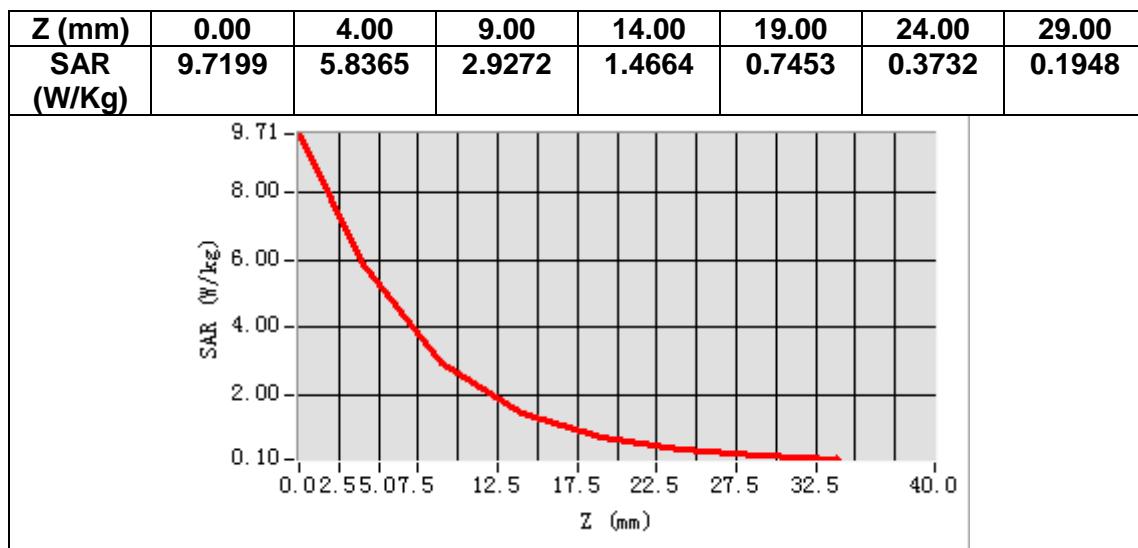
B. SAR Measurement Results

| | |
|---|-------------|
| Frequency (MHz) | 2450.000000 |
| Relative permittivity (real part) | 40.408511 |
| Relative permittivity (imaginary part) | 13.399264 |
| Conductivity (S/m) | 1.823789 |
| Variation (%) | -1.250000 |



Maximum location: X=0.00, Y=1.00
SAR Peak: 8.14 W/kg

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 2.359425 |
| SAR 1g (W/Kg) | 5.183642 |



MEASUREMENT 2

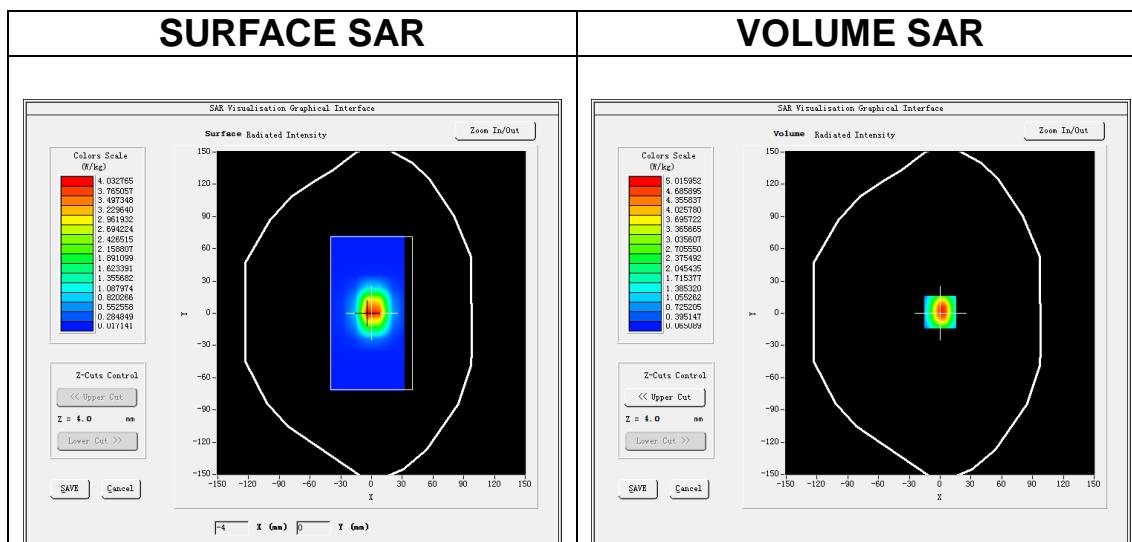
Date of measurement: 9/7/2025

A. Experimental conditions.

| | |
|------------------------|---|
| <u>Area Scan</u> | <u>$dx=10\text{mm}$ $dy=10\text{mm}$, $h= 2.00 \text{ mm}$</u> |
| <u>ZoomScan</u> | <u>$7 \times 7 \times 12, dx=4\text{mm}$ $dy=4\text{mm}$ $dz=2\text{mm}$</u> |
| <u>Phantom</u> | <u>Validation plane</u> |
| <u>Device Position</u> | <u>Dipole</u> |
| <u>Band</u> | <u>CW5200</u> |
| <u>Channels</u> | <u>Middle</u> |
| <u>Signal</u> | <u>CW (Crest factor: 1.0)</u> |
| <u>ConvF</u> | <u>2.30</u> |

B. SAR Measurement Results

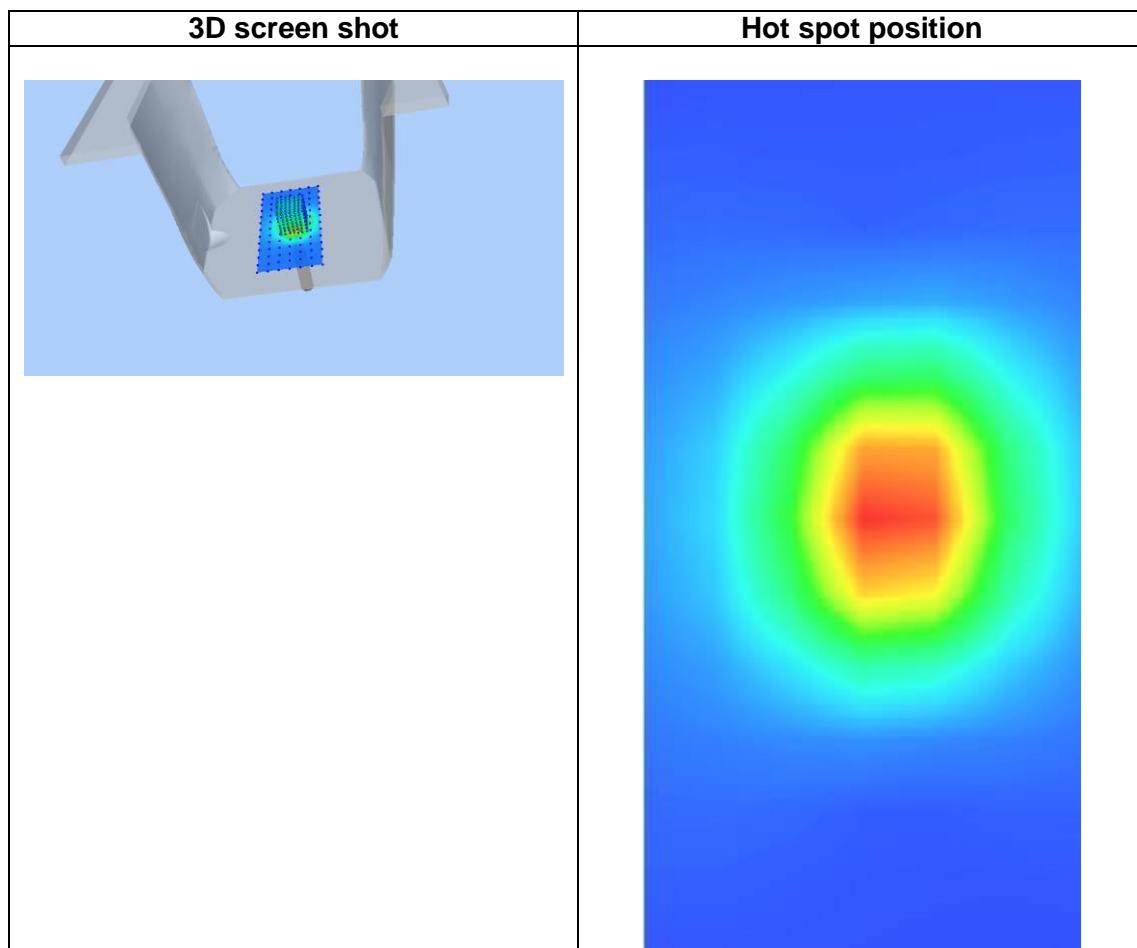
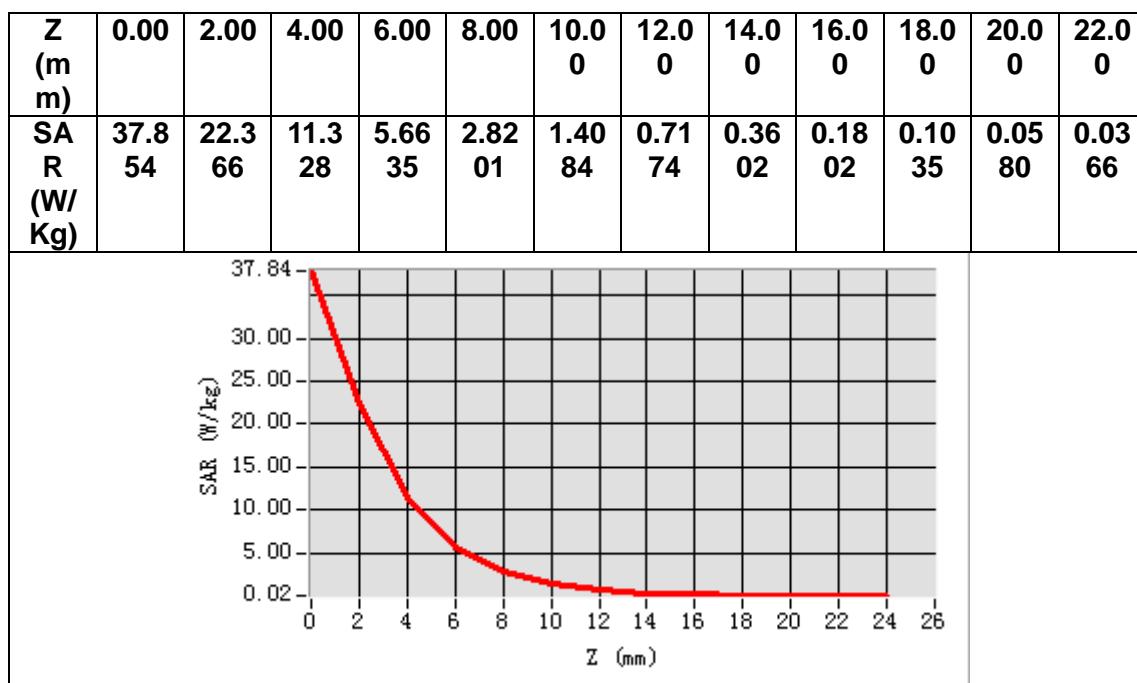
| | |
|---|-------------|
| Frequency (MHz) | 5200.000000 |
| Relative permittivity (real part) | 37.400000 |
| Relative permittivity (imaginary part) | 16.129999 |
| Conductivity (S/m) | 4.510778 |
| Variation (%) | -4.570000 |



Maximum location: X=0.00, Y=1.00

SAR Peak: 15.14 W/kg

| | |
|-----------------------|-----------|
| SAR 10g (W/Kg) | 5.212361 |
| SAR 1g (W/Kg) | 14.712032 |



MEASUREMENT 3

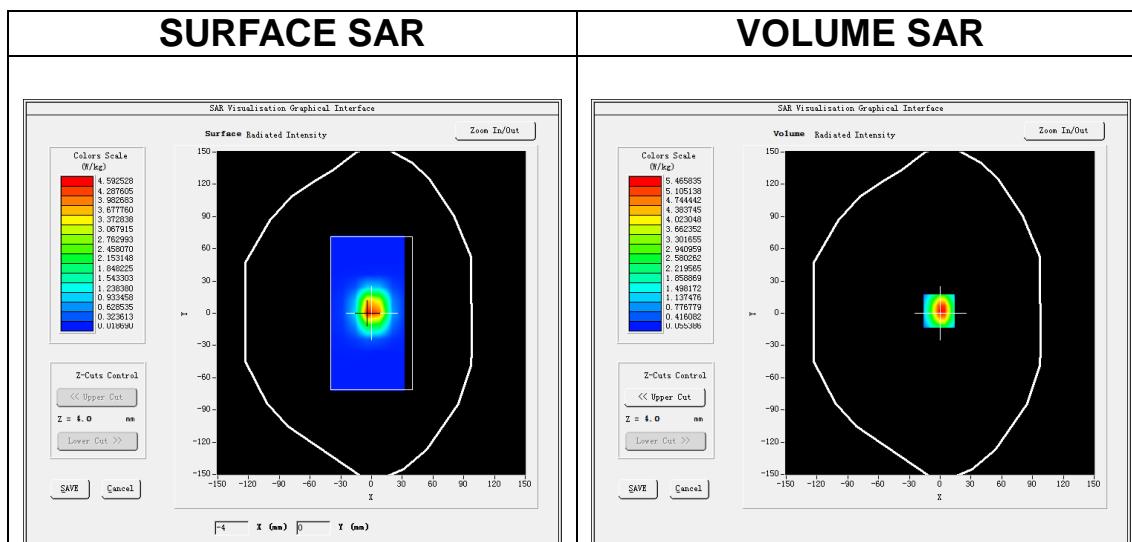
Date of measurement: 10/7/2025

A. Experimental conditions.

| | |
|------------------------|---|
| <u>Area Scan</u> | <u>$dx=10\text{mm}$ $dy=10\text{mm}$, $h= 2.00 \text{ mm}$</u> |
| <u>ZoomScan</u> | <u>$7 \times 7 \times 12, dx=4\text{mm}$ $dy=4\text{mm}$ $dz=2\text{mm}$</u> |
| <u>Phantom</u> | <u>Validation plane</u> |
| <u>Device Position</u> | <u>Dipole</u> |
| <u>Band</u> | <u>CW5800</u> |
| <u>Channels</u> | <u>Middle</u> |
| <u>Signal</u> | <u>CW (Crest factor: 1.0)</u> |
| <u>ConvF</u> | <u>2.27</u> |

B. SAR Measurement Results

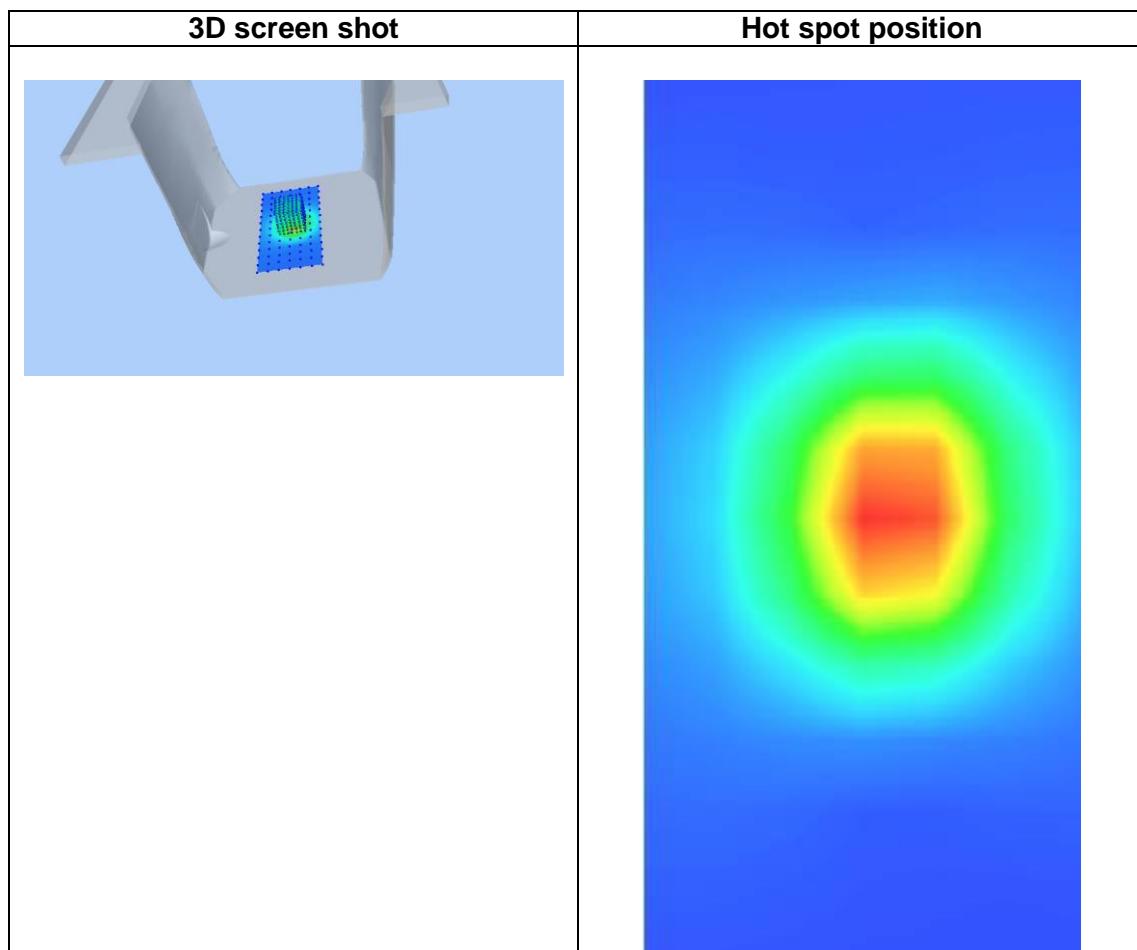
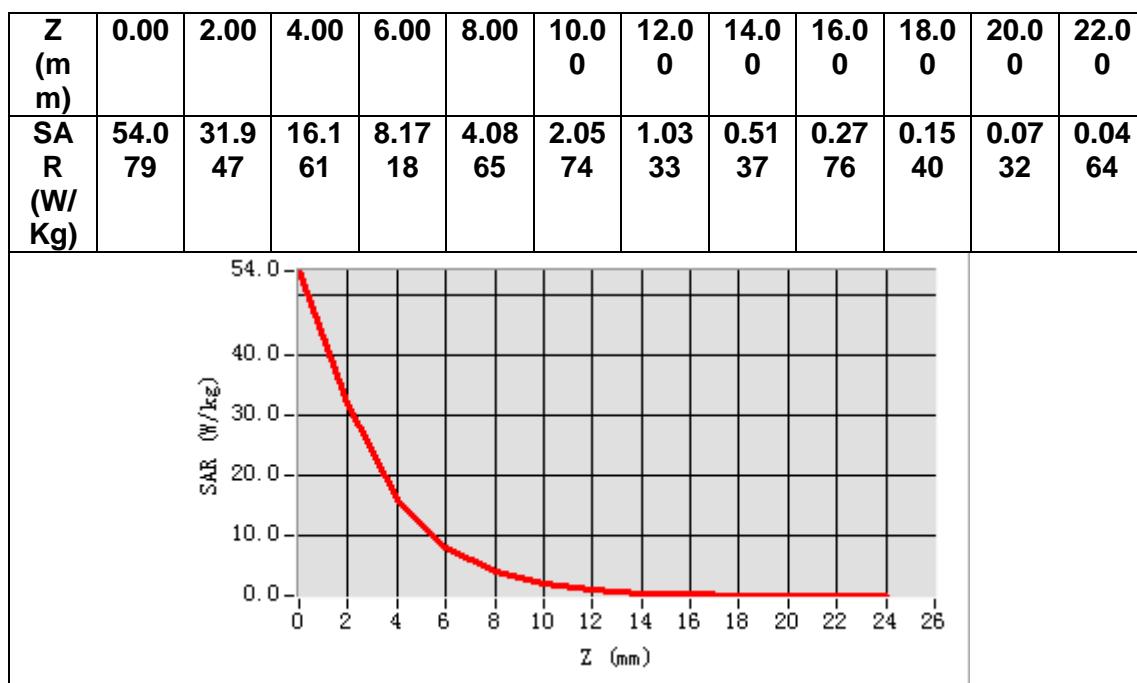
| | |
|---|-------------|
| Frequency (MHz) | 5800.000000 |
| Relative permittivity (real part) | 35.299999 |
| Relative permittivity (imaginary part) | 16.360001 |
| Conductivity (S/m) | 5.271556 |
| Variation (%) | -2.480000 |



Maximum location: X=-1.00, Y=2.00

SAR Peak: 17.07 W/kg

| | |
|-----------------------|-----------|
| SAR 10g (W/Kg) | 5.623106 |
| SAR 1g (W/Kg) | 16.421035 |



Appendix C. SAR Test Plots

Table of contents

MEASUREMENT 1 WLAN 5.2G Body

MEASUREMENT 2 WLAN 5.8G Body

MEASUREMENT 3 WLAN 2.4G Body

MEASUREMENT 1

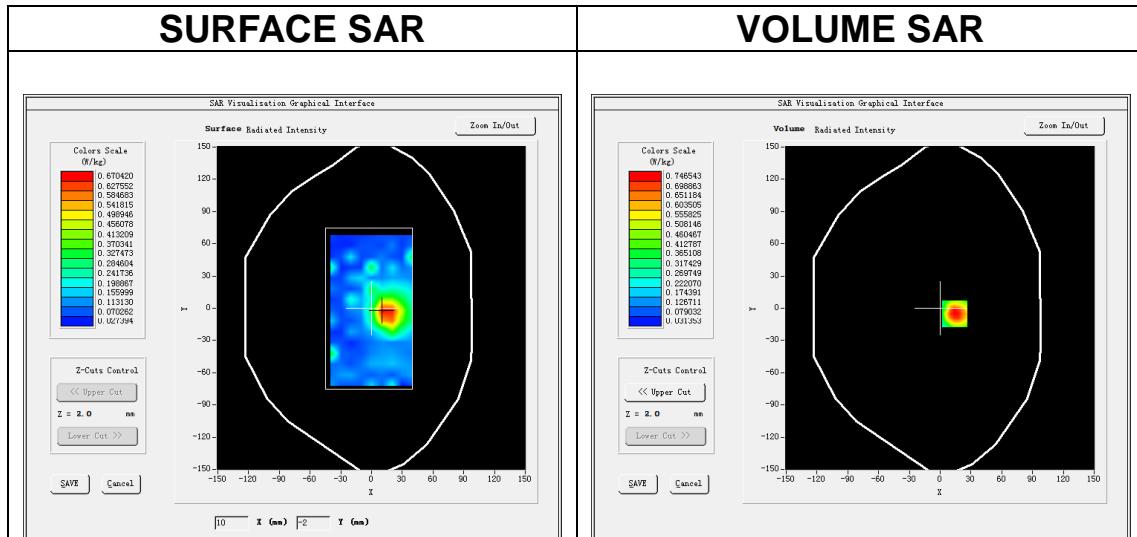
Date of measurement: 9/7/2025

A. Experimental conditions.

| | |
|------------------------|---|
| <u>Area Scan</u> | <u>$dx=10\text{mm}$ $dy=10\text{mm}$, $h= 2.00 \text{ mm}$</u> |
| <u>ZoomScan</u> | <u>$7\times 7\times 12, dx=4\text{mm}$ $dy=4\text{mm}$ $dz=2\text{mm}$</u> |
| <u>Phantom</u> | <u>Validation plane</u> |
| <u>Device Position</u> | <u>Body</u> |
| <u>Band</u> | <u>IEEE 802.11a U-NII</u> |
| <u>Channels</u> | <u>High</u> |
| <u>Signal</u> | <u>IEEE802.11a (Crest factor: 1.0)</u> |
| <u>ConvF</u> | <u>2.30</u> |

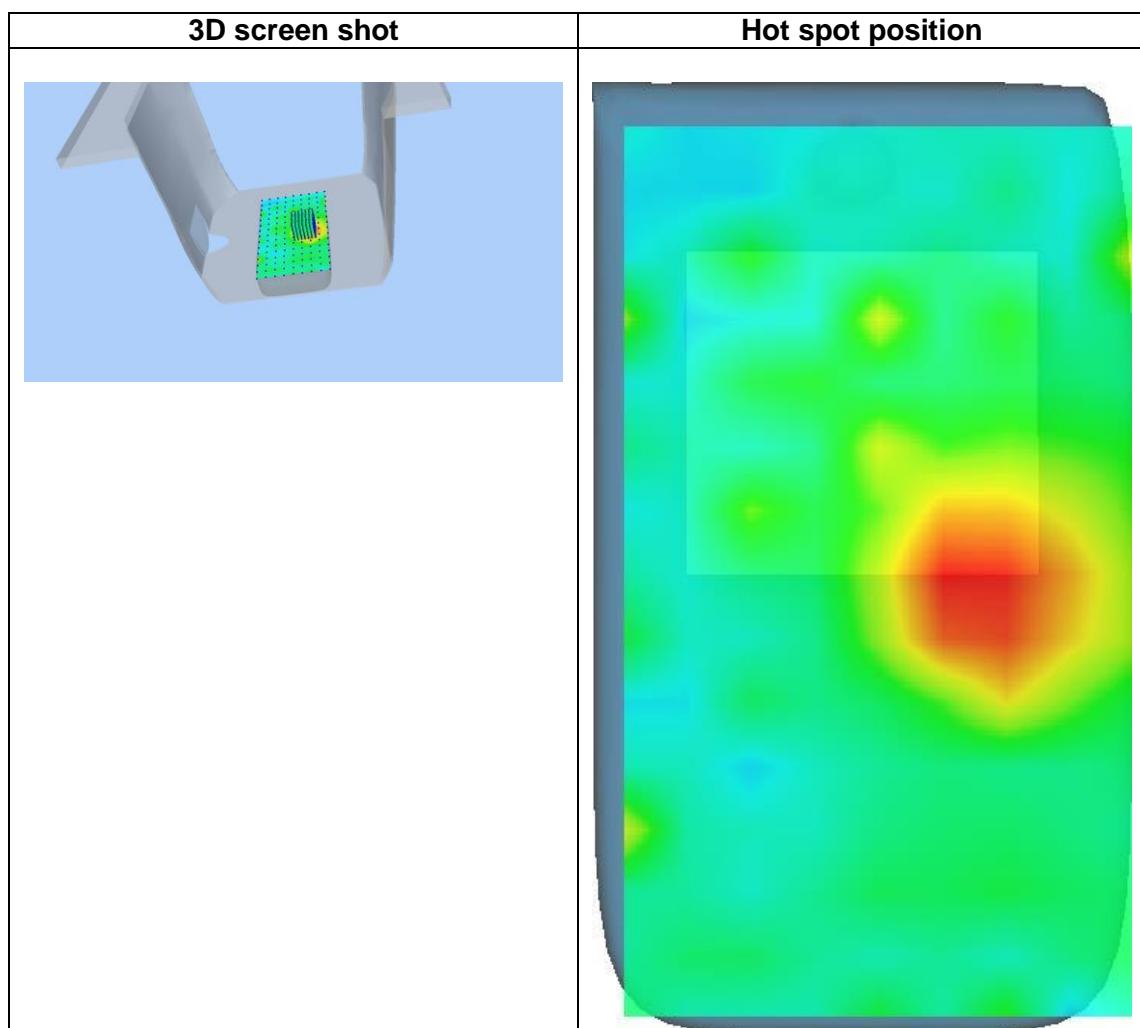
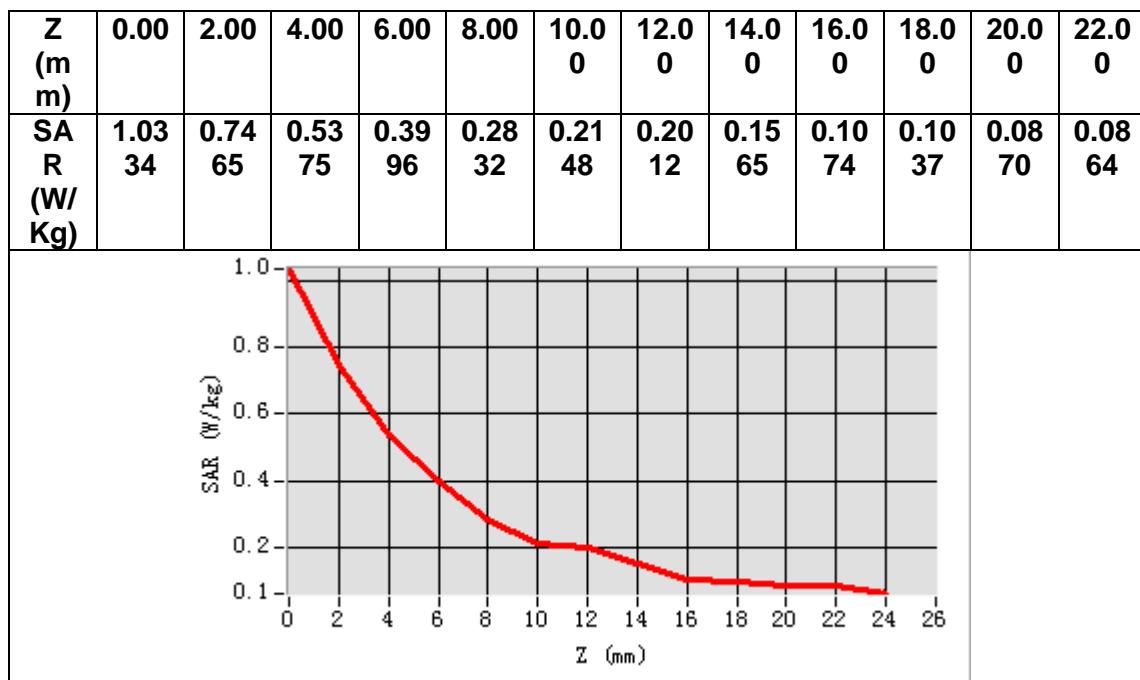
B. SAR Measurement Results

| | |
|---|-------------|
| Frequency (MHz) | 5240.000000 |
| Relative permittivity (real part) | 36.000000 |
| Relative permittivity (imaginary part) | 16.128888 |
| Conductivity (S/m) | 4.695299 |
| Variation (%) | 4.360000 |



Maximum location: $X=14.00$, $Y=-5.00$
SAR Peak: 1.09 W/kg

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.262804 |
| SAR 1g (W/Kg) | 0.515524 |



MEASUREMENT 2

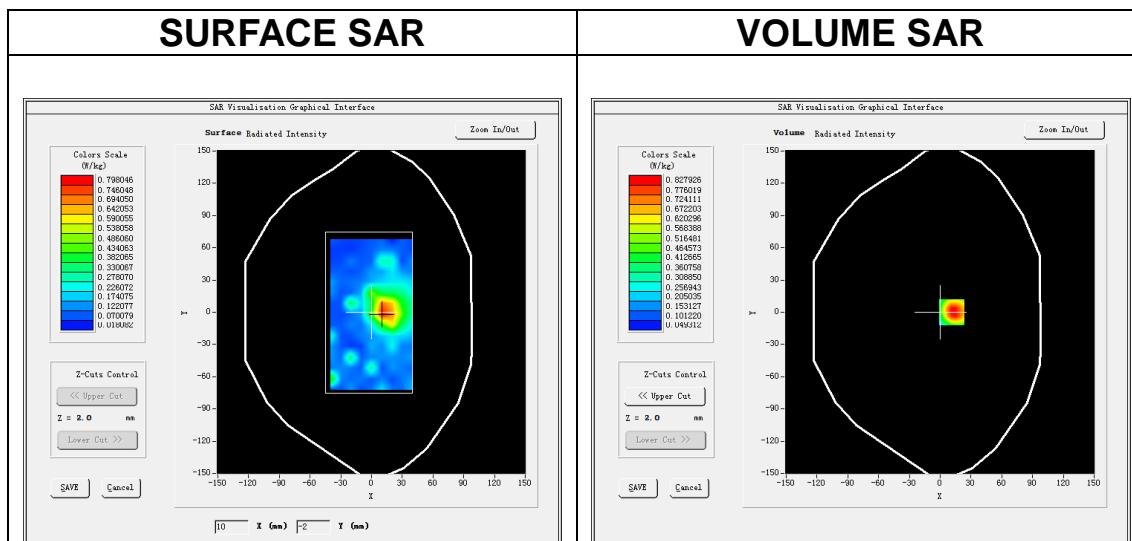
Date of measurement: 10/7/2025

A. Experimental conditions.

| | |
|------------------------|---|
| <u>Area Scan</u> | <u>$dx=10\text{mm}$ $dy=10\text{mm}$, $h= 2.00 \text{ mm}$</u> |
| <u>ZoomScan</u> | <u>$7\times 7\times 12, dx=4\text{mm}$ $dy=4\text{mm}$ $dz=2\text{mm}$</u> |
| <u>Phantom</u> | <u>Validation plane</u> |
| <u>Device Position</u> | <u>Body</u> |
| <u>Band</u> | <u>IEEE 802.11ac U-NII</u> |
| <u>Channels</u> | <u>Middle</u> |
| <u>Signal</u> | <u>IEEE802.ac (Crest factor: 1.0)</u> |
| <u>ConvF</u> | <u>2.27</u> |

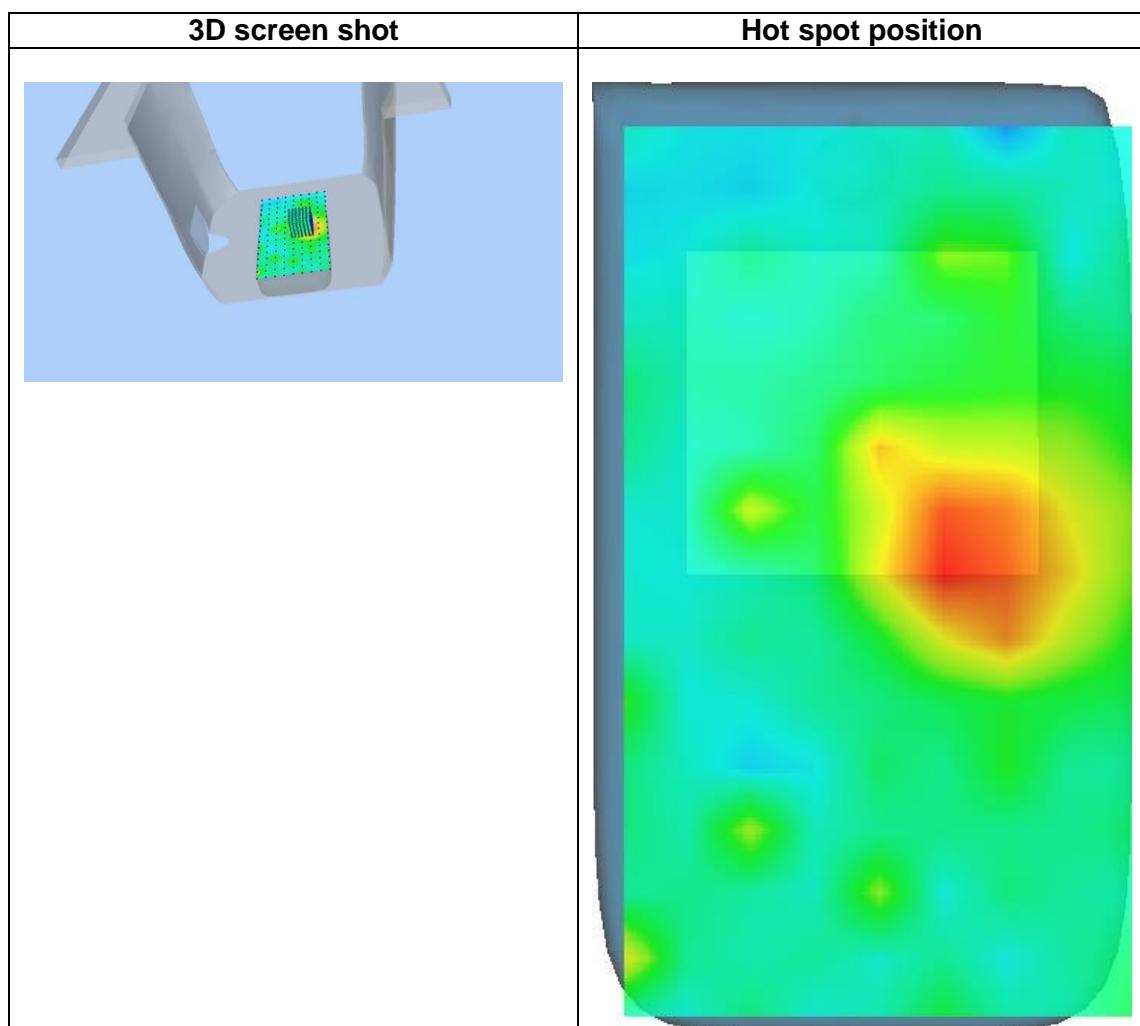
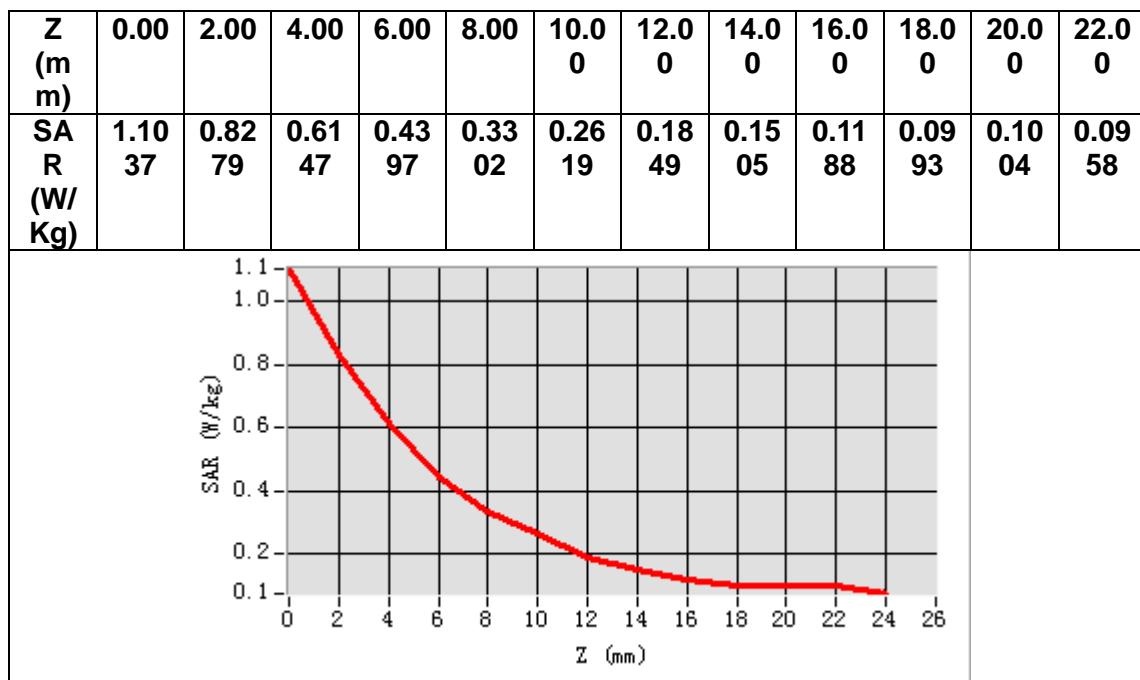
B. SAR Measurement Results

| | |
|---|-------------|
| Frequency (MHz) | 5775.000000 |
| Relative permittivity (real part) | 35.313888 |
| Relative permittivity (imaginary part) | 16.355388 |
| Conductivity (S/m) | 5.247354 |
| Variation (%) | 4.700000 |



Maximum location: X=11.00, Y=0.00
SAR Peak: 1.19 W/kg

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.294332 |
| SAR 1g (W/Kg) | 0.575596 |



MEASUREMENT 3

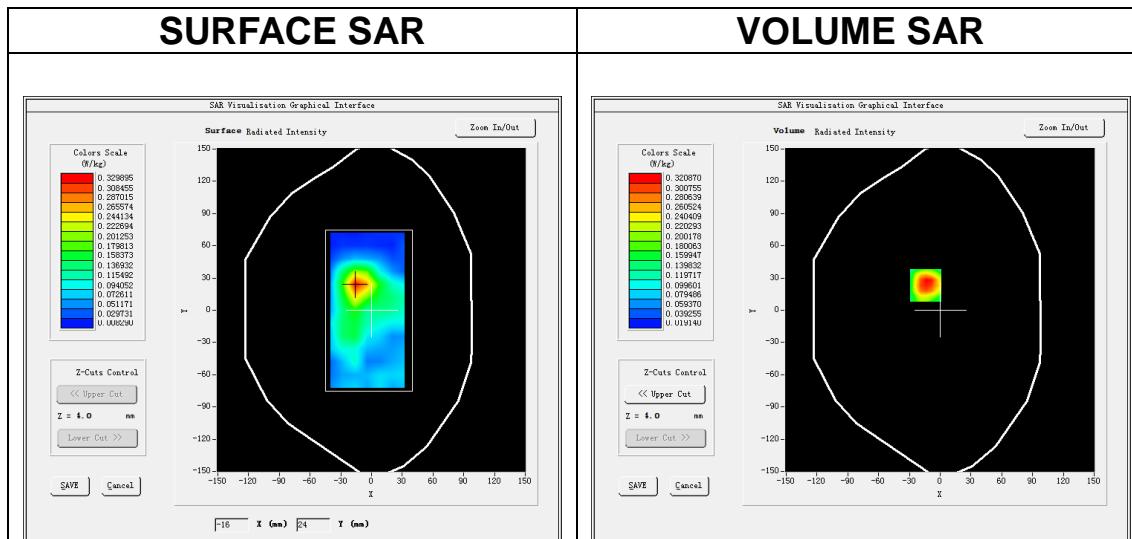
Date of measurement: 8/7/2025

A. Experimental conditions.

| | |
|------------------------|---|
| <u>Area Scan</u> | <u>$dx=12\text{mm}$ $dy=12\text{mm}$, $h= 5.00\text{ mm}$</u> |
| <u>ZoomScan</u> | <u>$7\times 7\times 7$, $dx=5\text{mm}$ $dy=5\text{mm}$ $dz=5\text{mm}$</u> |
| <u>Phantom</u> | <u>Validation plane</u> |
| <u>Device Position</u> | <u>Body</u> |
| <u>Band</u> | <u>IEEE 802.11b ISM</u> |
| <u>Channels</u> | <u>Low</u> |
| <u>Signal</u> | <u>IEEE802.b (Crest factor: 1.0)</u> |
| <u>ConvF</u> | <u>2.38</u> |

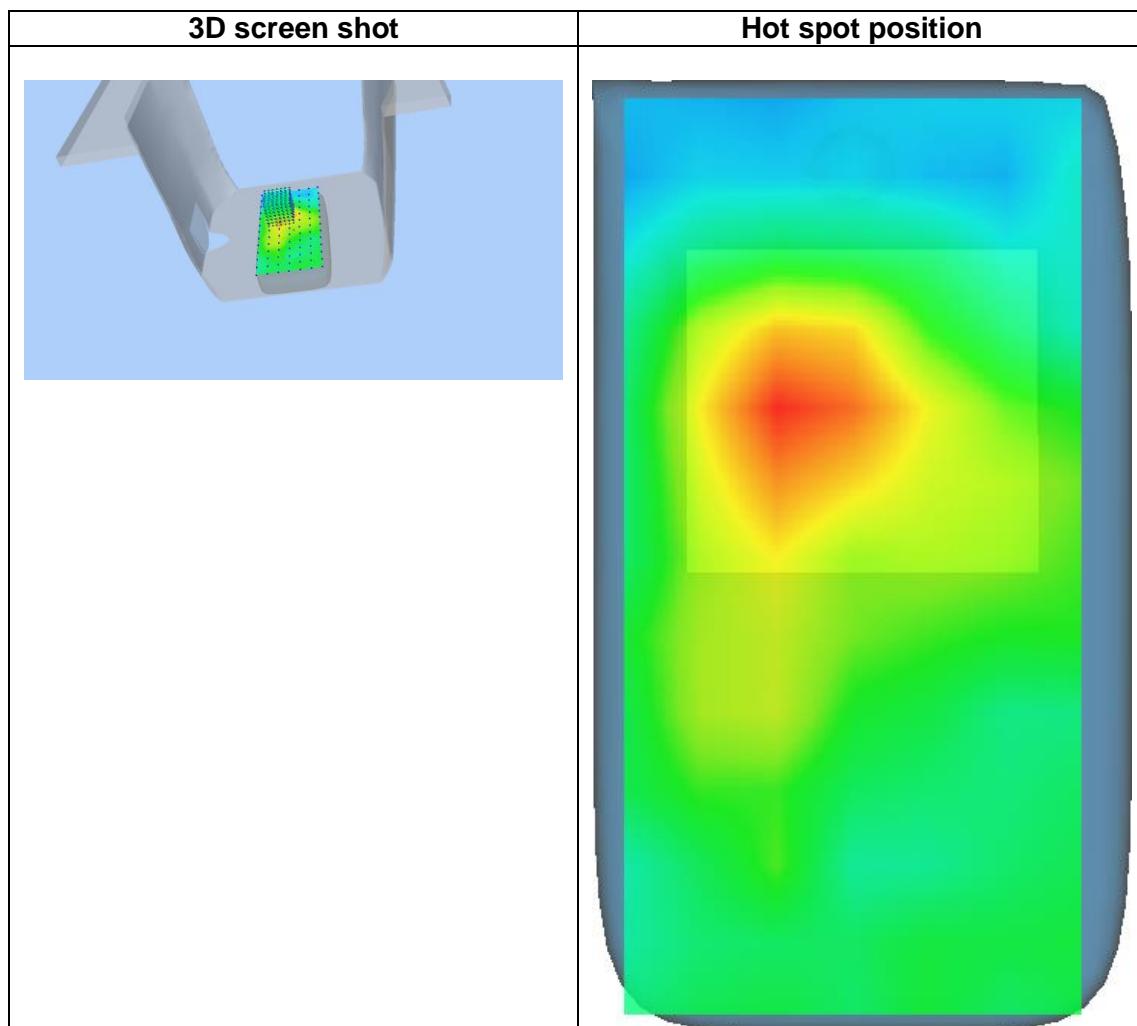
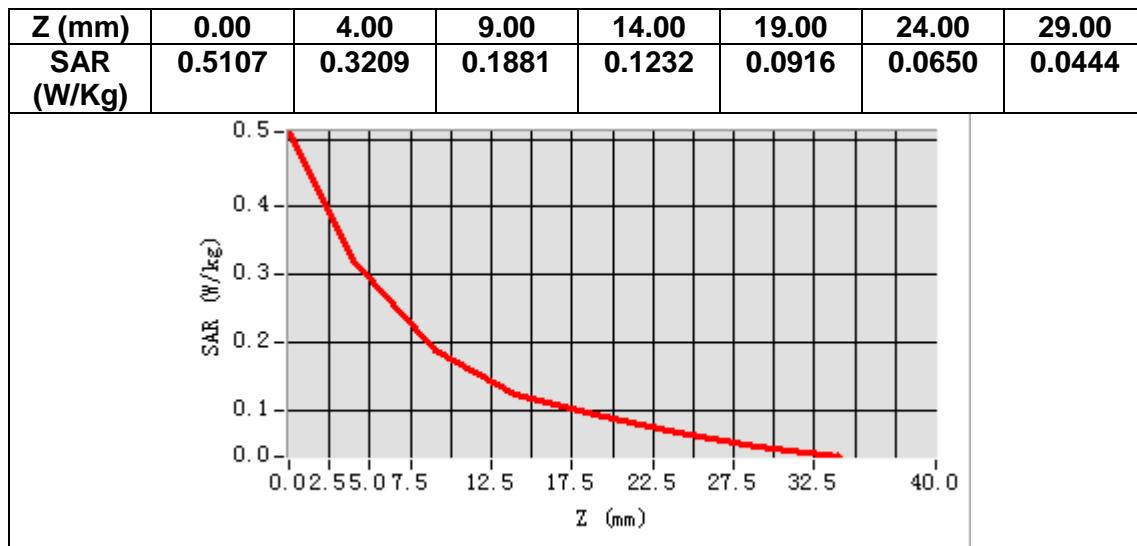
B. SAR Measurement Results

| | |
|---|-------------|
| Frequency (MHz) | 2412.000000 |
| Relative permittivity (real part) | 39.224000 |
| Relative permittivity (imaginary part) | 13.205000 |
| Conductivity (S/m) | 1.769470 |
| Variation (%) | 4.690000 |



Maximum location: X=-14.00, Y=23.00
SAR Peak: 0.49 W/kg

| | |
|-----------------------|----------|
| SAR 10g (W/Kg) | 0.180569 |
| SAR 1g (W/Kg) | 0.296715 |



Appendix D. Calibration Certificate

| Table of contents |
|--|
| E Field Probe - EPGO0523-403 |
| 2450 MHz Dipole - SN 03/15 DIP 2G450-352 |
| 5000-6000 MHz Dipole - SN 03/14 WGA33 |



COMOSAR E-Field Probe Calibration Report

Ref : ACR.307.3.24.BES.A

**GUANGDONG ASIA HONGKE TEST
TECHNOLOGY CO., LTD**
NO.1/F,BUILDING B1, JUNFENG INDUSTRIAL PARK,
CHONGQING ROAD, HEPING COMMUNITY,
FUHAIHAI STREET, BAO'AN DISTRICT,SHENZHEN,
GUANGDONG 518055, P.R.CHINA
MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 39/21 EPGO0523-403

Calibrated at MVG

Z.I. de la pointe du diable

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

Calibration date: 09/11/2024



Accreditations #2-6789
Scope available on www.cofrac.fr

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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).



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.307.3.24.BES.A

| | Name | Function | Date | Signature |
|---------------|----------------|-------------------------|------------|---|
| Prepared by : | Jérôme Le Gall | Measurement Responsible | 09/10/2024 |  |
| Checked by : | Jérôme Luc | Technical Manager | 09/10/2024 |  |
| Approved by : | Yann Toutain | Laboratory Director | 09/11/2024 |  |

| | Customer Name |
|----------------|-------------------------|
| Distribution : | Shenzhen Asia Hongke |

| Issue | Name | Date | Modifications |
|-------|------------|-----------|-----------------|
| A | Jérôme Luc | 9/11/2024 | Initial release |
| | | | |
| | | | |
| | | | |



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR 307.3.24.BES.A

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 | 4 |
| 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 |



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref. ACR.307.3.24.BES.A

1 DEVICE UNDER TEST

| Device Under Test | |
|--|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | MVG |
| Model | SSE2 |
| Serial Number | SN 39/21 EPGO0523-403 |
| Product Condition (new / used) | New |
| Frequency Range of Probe | 0.15 GHz-6GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.199 MΩ Dipole 2: R2=0.218 MΩ Dipole 3: R3=0.210 MΩ |

2 PRODUCT DESCRIPTION**2.1 GENERAL INFORMATION**

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

**Figure 1 – MVG COMOSAR Dosimetric E field Probe**

| | |
|--|--------|
| 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 IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

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.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR 307.3.24.BES.A

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:

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

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 |
| d_{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 |
| δ | 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. |

The measured worst case boundary effect $\text{SAR}_{\text{uncertainty}} [\%]$ for scanning distances larger than 4mm is 1.0% Limit ,2%).



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR 307.3.24.BES.A

4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 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 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 1 (μ V/(V/m) 2) | Normy dipole 2 (μ V/(V/m) 2) | Normz dipole 3 (μ V/(V/m) 2) |
|---------------------------------------|---------------------------------------|---------------------------------------|
| 1.26 | 0.87 | 0.77 |

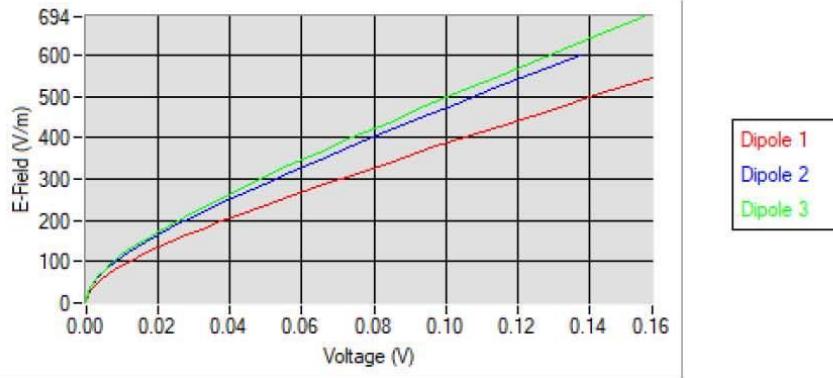
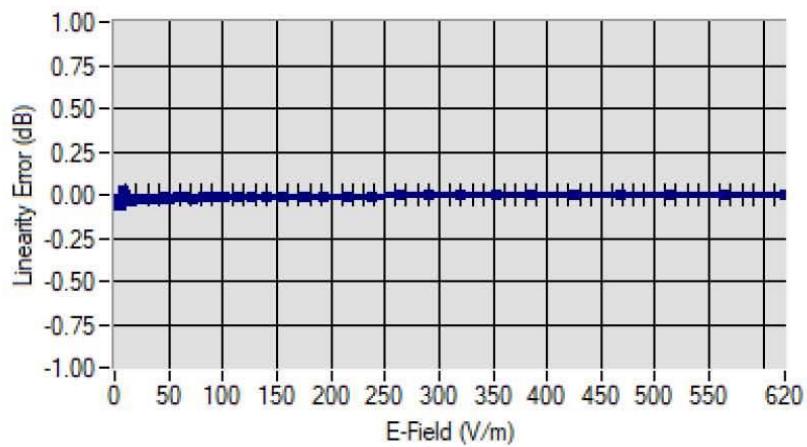
| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|-------------------|-------------------|-------------------|
| 113 | 108 | 113 |

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

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

**COMOSAR E-FIELD PROBE CALIBRATION REPORT**

Ref: ACR 307.3.24.BES.A

Calibration curves**5.2 LINEARITY****Linearity**Linearity: +/-1.42% (+/-0.06dB)



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR 307.3.24.BES.A

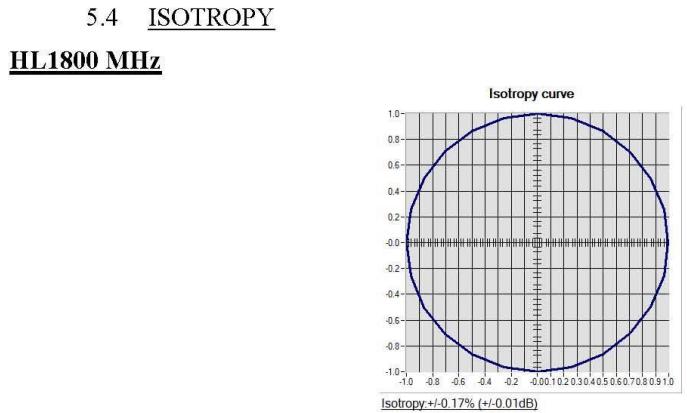
5.3 SENSITIVITY IN LIQUID

| <u>Liquid</u> | <u>Frequency</u> (MHz +/- 100MHz) | <u>ConvF</u> |
|---------------|---|--------------|
| HL600 | 600 | 1.62 |
| HL750 | 750 | 1.65 |
| HL850 | 835 | 1.66 |
| HL900 | 900 | 1.77 |
| HL1500 | 1500 | 2.09 |
| HL1750 | 1750 | 2.09 |
| HL1800 | 1800 | 2.05 |
| HL1900 | 1900 | 2.05 |
| HL2000 | 2000 | 2.41 |
| HL2100 | 2100 | 2.36 |
| HL2300 | 2300 | 2.55 |
| HL2450 | 2450 | 2.38 |
| HL2600 | 2600 | 2.35 |
| HL3300 | 3300 | 2.04 |
| HL3500 | 3500 | 1.98 |
| HL3700 | 3700 | 2.11 |
| HL3900 | 3900 | 2.54 |
| HL4200 | 4200 | 2.22 |
| HL4600 | 4600 | 2.40 |
| HL4900 | 4900 | 2.33 |
| HL5200 | 5200 | 2.30 |
| HL5400 | 5400 | 2.30 |
| HL5600 | 5600 | 2.29 |
| HL5800 | 5800 | 2.27 |

LOWER DETECTION LIMIT: 8mW/kg

**COMOSAR E-FIELD PROBE CALIBRATION REPORT**

Ref. ACR.307.3.24.BES.A





COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR 307.3.24.BES.A

6 LIST OF EQUIPMENT

| Equipment Summary Sheet | | | | |
|------------------------------------|-------------------------|-------------------------|---|---|
| Equipment Description | Manufacturer / Model | Identification No. | Current Calibration Date | Next Calibration Date |
| CALIPROBE Test Bench | Version 2 | NA | Validated. No cal required. | Validated. No cal required. |
| Network Analyzer | Rohde & Schwarz ZVM | 100203 | 08/2024 | 08/2027 |
| Network Analyzer | Agilent 8753ES | MY40003210 | 10/2021 | 10/2024 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 05/2024 | 05/2027 |
| Network Analyzer – Calibration kit | HP 85033D | 3423A08186 | 06/2021 | 06/2027 |
| Multimeter | Keithley 2000 | 1160271 | 02/2024 | 02/2027 |
| Signal Generator | Rohde & Schwarz SMB | 106589 | 04/2024 | 04/2027 |
| Amplifier | MVG | MODU-023-C-0002 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | NI-USB 5680 | 170100013 | 06/2024 | 06/2027 |
| Power Meter | Rohde & Schwarz NRVD | 832839-056 | 11/2021 | 11/2024 |
| Directional Coupler | Krytar 158020 | 131467 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Waveguide | MVG | SN 32/16 WG4_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_0G900_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG6_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_1G500_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG8_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_1G800B_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_1G800H_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG10_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_3G500_1 | Validated. No cal required. | Validated. No cal required. |

Page: 10/11

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR 307.3.24.BES.A

| | | | | |
|-------------------------------|--------------|------------------------|-----------------------------|-----------------------------|
| Waveguide | MVG | SN 32/16 WG12_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_5G000_1 | Validated. No cal required. | Validated. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44225320 | 06/2024 | 06/2027 |



SAR Reference Dipole Calibration Report

Ref : ACR.53.29.24.BES.A

**GUANGDONG ASIA HONGKE TEST
TECHNOLOGY CO., LTD**
NO.1/F,BUILDING B1, JUNFENG INDUSTRIAL PARK,
CHONGQING ROAD, HEPING COMMUNITY ,
FUHAIHAI STREET, BAO'AN DISTRICT,SHENZHEN,
GUANGDONG 518055, P.R.CHINA
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 2450MHZ
SERIAL NO.: SN 03/15 DIP2G450-352

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

Calibration date: 02/21/2024



Accreditations #2-6789 and #2-6814
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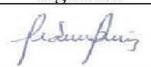
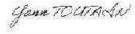
Summary:

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



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.53.29/24-BES A

| | Name | Function | Date | Signature |
|------------------------|--------------|-------------------------|-----------|---|
| Prepared by: | Pedro Ruiz | Measurement Responsible | 2/22/2024 |  |
| Checked & approved by: | Jérôme Luc | Technical Manager | 2/22/2024 |  |
| Authorized by: | Yann Toutain | Laboratory Director | 2/27/2024 |  |

Yann
Toutain ID 
Signature
numérique de
Yann Toutain ID
Date : 2024.02.27
08:57:39 +01'00'

| | Customer Name |
|----------------|-------------------------|
| Distribution : | Shenzhen Asia Hongke |

| Issue | Name | Date | Modifications |
|-------|------------|-----------|-----------------|
| A | Pedro Ruiz | 2/22/2024 | Initial release |
| | | | |
| | | | |
| | | | |

Page: 2/8

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref : ACR.53.29.24.BES A

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 | Mechanical Requirements | 5 |
| 4.2 | S11 parameter Requirements | 5 |
| 4.3 | SAR Requirements | 5 |
| 5 | Measurement Uncertainty..... | 5 |
| 5.1 | Mechanical dimensions | 5 |
| 5.2 | S11 Parameter | 5 |
| 5.3 | SAR | 5 |
| 6 | Calibration Results..... | 6 |
| 6.1 | Mechanical Dimensions | 6 |
| 6.2 | S11 parameter | 6 |
| 6.3 | SAR | 6 |
| 7 | List of Equipment | 8 |



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref : ACR.53.29.24.BES A

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 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 03/15DIP2G450-352 |
| Product Condition (new / used) | Used |

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Dipoles are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards. The product is designed for use with the COMOSAR test bench only.



Figure 1 – MVG COMOSAR Validation Dipole



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref : ACR.53.29.24.BES A

4 MEASUREMENT METHOD

4.1 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

4.2 S11 PARAMETER REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a S11 of -20 dB or better. The S11 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.

4.3 SAR REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

5 MEASUREMENT UNCERTAINTY

5.1 MECHANICAL DIMENSIONS

For the measurement in the range 0-300mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.20 mm with respect to measurement conditions.

For the measurement in the range 300-450mm, the estimated expanded uncertainty (k=2) in calibration for the dimension measurement in mm is +/-0.44 mm with respect to measurement conditions.

5.2 S11 PARAMETER

The estimated expanded uncertainty (k=2) in calibration for the S11 parameter in linear is +/-0.08 with respect to measurement conditions.

5.3 SAR

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty for validation measurements.

The estimated expanded uncertainty (k=2) in calibration for the 1g and 10g SAR measurement in W/kg is +/-19% with respect to measurement conditions.

Page: 5/8

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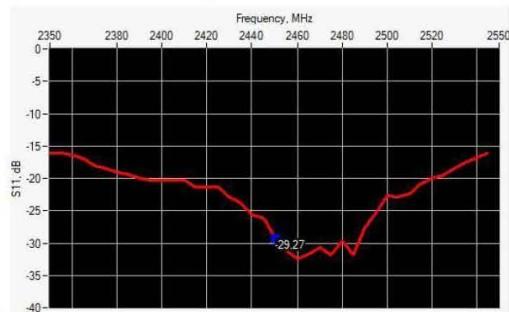


SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref : ACR.53.29.24.BES A

6 CALIBRATION RESULTS**6.1 MECHANICAL DIMENSIONS**

| L mm | | h mm | | d mm | |
|----------|--------------|----------|--------------|----------|-------------|
| Measured | Required | Measured | Required | Measured | Required |
| - | 51.50 +/- 2% | - | 30.40 +/- 2% | - | 3.60 +/- 2% |

6.2 S11 PARAMETER**6.2.1 S11 parameter in Head Liquid**

| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|-----------------|--------------------|------------------|---------------------------|
| 2450 | -29.27 | -20 | $53.6\Omega + 0.1j\Omega$ |

6.3 SAR

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

6.3.1 SAR with Head Liquid

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

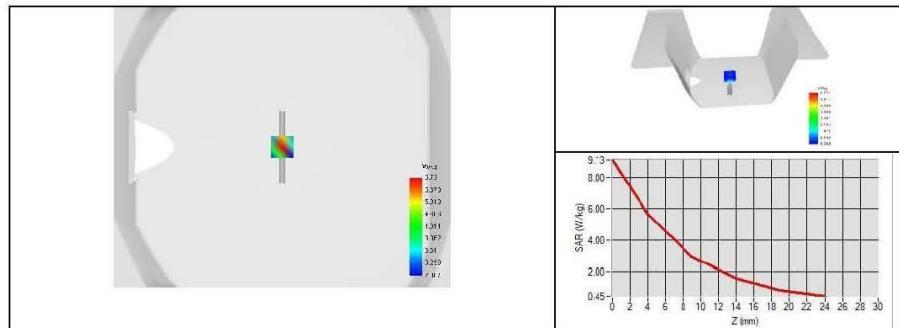


SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref : ACR.53.29.24.BES A

| | |
|---|--|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | 3523-EPGO-429 |
| Liquid | Head Liquid Values: $\epsilon\mu'$: 42.1 sigma : 1.83 |
| 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 | 1g SAR (W/kg) | | | 10g SAR (W/kg) | | |
|-----------|---------------|---------------------------|-------------------------|----------------|---------------------------|-------------------------|
| | Measured | Measured normalized to 1W | Target normalized to 1W | Measured | Measured normalized to 1W | Target normalized to 1W |
| 2450 MHz | 5.00 | 50.05 | 52.40 | 2.38 | 23.80 | 24.00 |





SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref : ACR.53.29.24.BES A

7 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 | 08/2021 | 08/2024 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2025 |
| Calipers | Mitutoyo | SN 0009732 | 11/2022 | 11/2025 |
| Reference Probe | MVG | 3523-EPGO-429 | 11/2023 | 11/2024 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 106589 | 03/2022 | 03/2025 |
| Amplifier | MVG | MODU-023-C-0002 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | NI-USB 5680 | 170100013 | 06/2021 | 06/2024 |
| Power Meter | Keysight U2000A | SN: MY62340002 | 10/2022 | 10/2025 |
| Directional Coupler | Krytar 158020 | 131467 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44225320 | 06/2021 | 06/2024 |

Page: 8/8

Template_ACR.DDD.N.YY.MVGB.ISSUE_SAR Reference Dipole v1

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SAR Reference Waveguide Calibration Report

Ref: ACR.53.31.24.BES.A

**GUANGDONG ASIA HONGKE TEST
TECHNOLOGY CO., LTD**
NO.1/F,BUILDING B1, JUNFENG INDUSTRIAL PARK,
CHONGQING ROAD, HEPING COMMUNITY ,
FUHAIHAI STREET, BAO'AN DISTRICT,SHENZHEN,
GUANGDONG 518055, P.R.CHINA
MVG COMOSAR REFERENCE WAVEGUIDE
FREQUENCY: 5000-6000 MHZ
SERIAL NO.: SN 13/14 WGA33

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

Calibration date: 02/21/2024



Accreditations #2-6789 and #2-6814
Scope available on www.cofrac.fr

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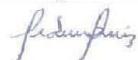
Summary:

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



SAR REFERENCE WAVEGUIDE CALIBRATION REPORT

Ref: ACR.53.31.24.BES A

| | Name | Function | Date | Signature |
|------------------------|--------------|-------------------------|-----------|---|
| Prepared by: | Pedro Ruiz | Measurement Responsible | 2/22/2024 |  |
| Checked & approved by: | Jérôme Luc | Technical Manager | 2/22/2024 |  |
| Authorized by: | Yann Toutain | Laboratory Director | 2/27/2024 |  |

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Date : 2024.02.27
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| | Customer Name |
|----------------|-------------------------|
| Distribution : | Shenzhen Asia Hongke |

| Issue | Name | Date | Modifications |
|-------|------------|-----------|-----------------|
| A | Pedro Ruiz | 2/22/2024 | Initial release |
| | | | |
| | | | |
| | | | |

Page: 2/9

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**TABLE OF CONTENTS**

| | | |
|-----|----------------------------------|---|
| 1 | Introduction..... | 4 |
| 2 | Device Under Test | 4 |
| 3 | Product Description | 4 |
| 3.1 | General Information | 4 |
| 4 | Measurement Method | 4 |
| 4.1 | Mechanical Requirements | 4 |
| 4.2 | S11 parameter Requirements | 4 |
| 4.3 | SAR Requirements | 5 |
| 5 | Measurement Uncertainty..... | 5 |
| 5.1 | Mechanical dimensions | 5 |
| 5.2 | S11 Parameter | 5 |
| 5.3 | SAR | 5 |
| 6 | Calibration Results..... | 5 |
| 6.1 | Mechanical Dimensions | 5 |
| 6.2 | S11 parameter | 6 |
| 6.3 | SAR | 6 |
| 7 | List of Equipment | 9 |



1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards for reference waveguides 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 5000-6000 MHz REFERENCE WAVEGUIDE |
| Manufacturer | MVG |
| Model | SWG5500 |
| Serial Number | SN 13/14 WGA 33 |
| Product Condition (new / used) | Used |

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's COMOSAR Validation Waveguides are built in accordance to the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards.

4 MEASUREMENT METHOD

4.1 MECHANICAL REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

4.2 S11 PARAMETER REQUIREMENTS

The dipole used for SAR system validation measurements and checks must have a S11 of -8 dB or better. The S11 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.



SAR REFERENCE WAVEGUIDE CALIBRATION REPORT

Ref: ACR.53.31.24.BES.A

4.3 SAR REQUIREMENTS

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 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.

5 MEASUREMENT UNCERTAINTY

5.1 MECHANICAL DIMENSIONS

The estimated expanded uncertainty ($k=2$) in calibration for the dimension measurement in mm is $+/-0.20$ mm with respect to measurement conditions.

5.2 S11 PARAMETER

The estimated expanded uncertainty ($k=2$) in calibration for the S11 parameter in linear is $+/-0.08$ with respect to measurement conditions.

5.3 SAR

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty for validation measurements.

The estimated expanded uncertainty ($k=2$) in calibration for the 1g and 10g SAR measurement in W/kg is $+/-19\%$ with respect to measurement conditions.

6 CALIBRATION RESULTS

6.1 MECHANICAL DIMENSIONS

| Frequency (MHz) | L (mm) | | W (mm) | | L _r (mm) | | W _r (mm) | |
|--------------------|---------------------|----------|---------------------|----------|---------------------|----------|---------------------|----------|
| | Required | Measured | Required | Measured | Required | Measured | Required | Measured |
| 5800 | 40.39 \pm 0.13 | - | 20.19 \pm 0.13 | - | 81.03 \pm 0.13 | - | 61.98 \pm 0.13 | - |

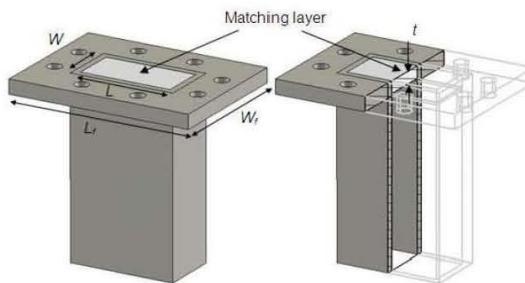
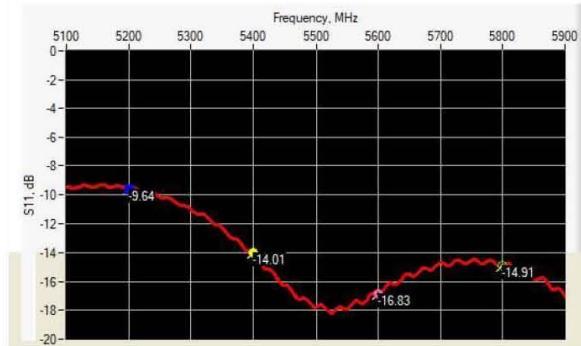


Figure 1: Validation Waveguide Dimensions



SAR REFERENCE WAVEGUIDE CALIBRATION REPORT

Ref: ACR.53.31.24.BES.A

6.2 S11 PARAMETER6.2.1 S11 parameter In Head Liquid

| Frequency (MHz) | S11 parameter (dB) | Requirement (dB) | Impedance |
|-----------------|--------------------|------------------|--------------------------------|
| 5200 | -9.64 | -8 | $25.80 \Omega - 6.58 j\Omega$ |
| 5400 | -14.01 | -8 | $51.53 \Omega + 20.60 j\Omega$ |
| 5600 | -16.83 | -8 | $44.12 \Omega - 12.35 j\Omega$ |
| 5800 | -14.91 | -8 | $38.53 \Omega + 11.21 j\Omega$ |

6.3 SAR

The IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards state that the system validation measurements must be performed using a reference waveguide meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed with the matching layer placed in the open end of the waveguide, with the waveguide and matching layer in direct contact with the phantom shell.

6.3.1 SAR With Head Liquid

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



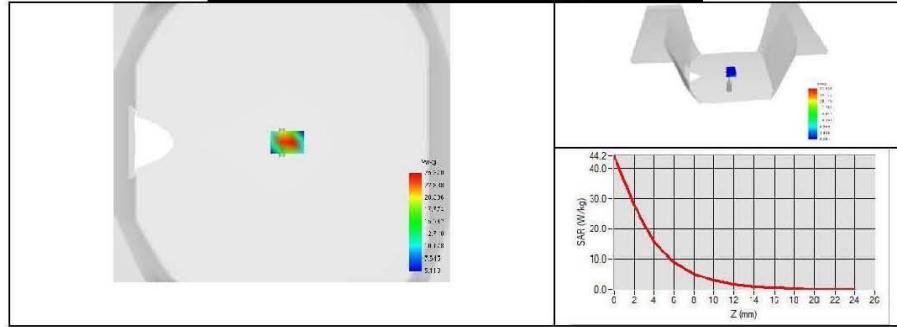
SAR REFERENCE WAVEGUIDE CALIBRATION REPORT

Ref: ACR.53.31.24.BES A

| | |
|--|--|
| Software | OPENSAR V5 |
| Phantom | SN 13/09 SAM68 |
| Probe | 3523-EPGO-429 |
| Liquid | Head Liquid Values 5200 MHz: $\epsilon' = 34.16$ sigma : 4.42 Head Liquid Values 5400 MHz: $\epsilon' = 33.63$ sigma : 4.64 Head Liquid Values 5600 MHz: $\epsilon' = 33.12$ sigma : 4.87 Head Liquid Values 5800 MHz: $\epsilon' = 32.57$ sigma : 5.12 |
| Distance between dipole waveguide and liquid | 0 mm |
| Area scan resolution | $dx = 8\text{mm}/dy = 8\text{mm}$ |
| Zoon Scan Resolution | $dx = 4\text{mm}/dy = 4\text{m}/dz = 2\text{mm}$ |
| Frequency | 5200 MHz 5400 MHz 5600 MHz 5800 MHz |
| Input power | 20 dBm |
| Liquid Temperature | 20 ± 1 °C |
| Lab Temperature | 20 ± 1 °C |
| Lab Humidity | 30-70 % |

| Frequency (MHz) | 1 g SAR (W/kg) | | | 10 g SAR (W/kg) | | |
|--------------------|----------------|---------------------------------|-------------------------------|-----------------|---------------------------------|-------------------------------|
| | Measured | Measured normalized to 1W | Target normalized to 1W | Measured | Measured normalized to 1W | Target normalized to 1W |
| 5200 | 16.26 | 162.59 | 159.00 | 5.62 | 56.21 | 56.90 |
| 5400 | 15.98 | 159.81 | 166.40 | 5.50 | 55.00 | 58.43 |
| 5600 | 17.91 | 179.15 | 173.80 | 6.10 | 61.01 | 59.97 |
| 5800 | 18.22 | 182.20 | 181.20 | 6.13 | 61.32 | 61.50 |

SAR MEASUREMENT PLOTS @ 5200 MHz



Page: 7/9

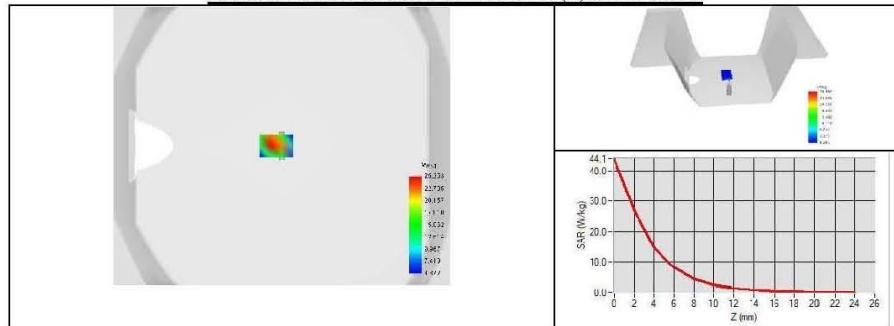
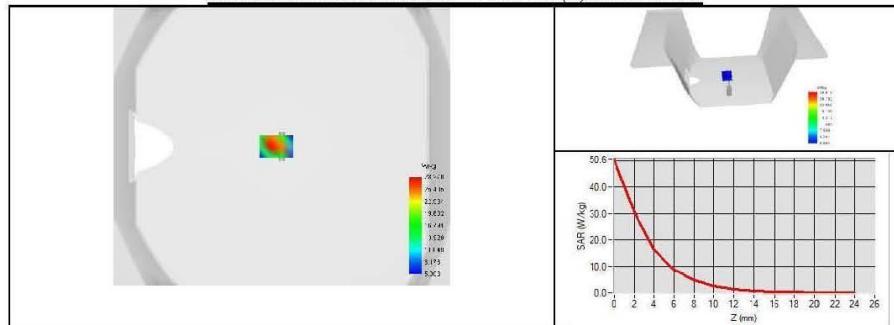
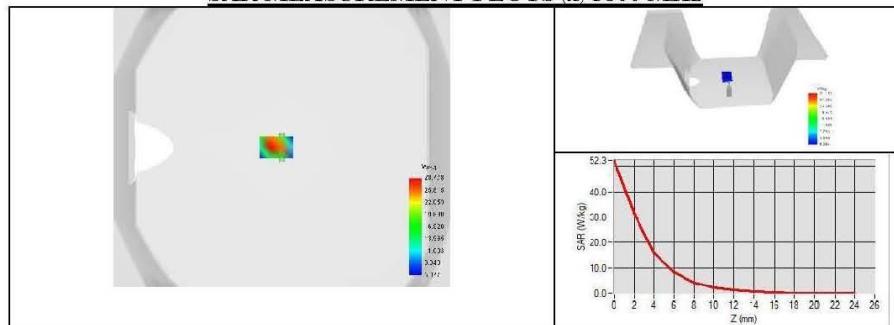
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Ref: ACR.53.31.24.BES.A

SAR MEASUREMENT PLOTS @ 5400 MHz**SAR MEASUREMENT PLOTS @ 5600 MHz****SAR MEASUREMENT PLOTS @ 5800 MHz**



SAR REFERENCE WAVEGUIDE CALIBRATION REPORT

Ref : ACR.53.31.24.BES.A

7 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 | 08/2021 | 08/2024 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2025 |
| Calipers | Mitutoyo | SN 0009732 | 11/2022 | 11/2025 |
| Reference Probe | MVG | 3623-EGPO-431 | 11/2023 | 11/2024 |
| Multimeter | Keithley 2000 | 4013982 | 02/2023 | 02/2026 |
| Signal Generator | Rohde & Schwarz SMB | 106589 | 03/2022 | 03/2025 |
| Amplifier | MVG | MODU-023-C-0002 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Power Meter | NI-USB 5680 | 170100013 | 06/2021 | 06/2024 |
| Power Meter | Keysight U2000A | SN: MY62340002 | 10/2022 | 10/2025 |
| Directional Coupler | Krytar 158020 | 131467 | Characterized prior to test. No cal required. | Characterized prior to test. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44225320 | 06/2021 | 06/2024 |

Page: 9/9

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Appendix E. Justification of the extended calibration

If dipoles are verified in return loss (<-20dB, within 20% of prior calibration for below 3GHz, and <-8dB, within 20% of prior calibration for 5GHz to 6GHz), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended.

<Head 2450MHz>

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|------------------|-----------|-----------|------------|---------------------|
| -29.27 | - | 53.6 | - | Feb. 21, 2024 |
| -29.39 | 0.41 | 53.742 | 0.142 | Feb. 20, 2025 |

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.

<Head 5200MHz>

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|------------------|-----------|-----------|------------|---------------------|
| -9.64 | - | 25.80 | - | Feb. 21, 2024 |
| -9.1819 | 4.75 | 25.891 | 0.091 | Feb. 20, 2025 |

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.

<Head 5800MHz>

| Return Loss (dB) | Delta (%) | Impedance | Delta(ohm) | Date of Measurement |
|------------------|-----------|-----------|------------|---------------------|
| -14.91 | - | 38.53 | - | Feb. 21, 2024 |
| -14.349 | 3.76 | 38.715 | 0.185 | Feb. 20, 2025 |

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.

END OF THE REPORT***