

## UNCERTAINTY FOR PERFORMANCE CHECK

| Uncertainty Component                                                          | Description | Uncertainty Value(%) | Probably Distribution | Div.       | (Ci) 1g         | (Ci) 10g        | Std. Unc. 1g(%) | Std. Unc. 10g(%) | v |
|--------------------------------------------------------------------------------|-------------|----------------------|-----------------------|------------|-----------------|-----------------|-----------------|------------------|---|
| <b>Measurement system</b>                                                      |             |                      |                       |            |                 |                 |                 |                  |   |
| Probe calibration                                                              | 7.2.1       | 5.8                  | N                     | 1          | 1               | 1               | 5.8             | 5.8              | ∞ |
| Axial isotropy                                                                 | 7.2.1.1     | 3.5                  | R                     | $\sqrt{3}$ | $(1-C_p)^{1/2}$ | $(1-C_p)^{1/2}$ | 1.43            | 1.43             | ∞ |
| Hemispherical isotropy                                                         | 7.2.1.1     | 5.9                  | R                     | $\sqrt{3}$ | $\sqrt{C_p}$    | $\sqrt{C_p}$    | 2.41            | 2.41             | ∞ |
| Boundary Effects                                                               | 7.2.1.4     | 1.00                 | R                     | $\sqrt{3}$ | 1               | 1               | 0.58            | 0.58             | ∞ |
| Linearity                                                                      | 7.2.1.2     | 4.70                 | R                     | $\sqrt{3}$ | 1               | 1               | 2.71            | 2.71             | ∞ |
| System detection limits                                                        | 7.2.1.2     | 1                    | R                     | $\sqrt{3}$ | 1               | 1               | 0.58            | 0.58             | ∞ |
| Modulation Response                                                            | 7.2.1.3     | 3                    | N                     | 1          | 1               | 1               | 0.00            | 0.00             | ∞ |
| Readout Electronics                                                            | 7.2.1.5     | 0.5                  | N                     | 1          | 1               | 1               | 0.50            | 0.50             | ∞ |
| Response Time                                                                  | 7.2.1.6     | 0                    | R                     | $\sqrt{3}$ | 1               | 1               | 0.00            | 0.00             | ∞ |
| Integration Time                                                               | 7.2.1.7     | 1.4                  | R                     | $\sqrt{3}$ | 1               | 1               | 0.81            | 0.81             | ∞ |
| RF Ambient Conditions-Noise                                                    | 7.2.3.7     | 3                    | R                     | $\sqrt{3}$ | 1               | 1               | 1.73            | 1.73             | ∞ |
| RF Ambient Conditions-Reflection                                               | 7.2.3.7     | 3                    | R                     | $\sqrt{3}$ | 1               | 1               | 1.73            | 1.73             | ∞ |
| Probe positioned mechanical Tolerance                                          | 7.2.2.1     | 1.4                  | R                     | $\sqrt{3}$ | 1               | 1               | 0.81            | 0.81             | ∞ |
| Probe positioning with respect to phantom shell                                | 7.2.2.3     | 1.4                  | R                     | $\sqrt{3}$ | 1               | 1               | 0.81            | 0.81             | ∞ |
| Extrapolation interpolation and integration algorithms for Max.SAR evaluation  | 7.2.4       | 2.3                  | R                     | 1          | 1               | 1               | 1.33            | 1.33             | ∞ |
| <b>Dipole</b>                                                                  |             |                      |                       |            |                 |                 |                 |                  |   |
| Deviation of experimental source from numerical source                         |             | 4                    | N                     | 1          | 1               | 1               | 4.00            | 4.00             | ∞ |
| Input power and SAR drift measurement                                          | 7.2.3.6     | 5                    | R                     | $\sqrt{3}$ | 1               | 1               | 2.89            | 2.89             | ∞ |
| Dipole axis to liquid distance                                                 |             | 2                    | R                     | $\sqrt{3}$ | 1               | 1               |                 |                  | ∞ |
| <b>Phantom and tissue parameters</b>                                           |             |                      |                       |            |                 |                 |                 |                  |   |
| Phantom uncertainty (shape and thickness tolerances)                           | 7.2.2.2     | 4                    | R                     | $\sqrt{3}$ | 1               | 1               | 2.31            | 2.31             | ∞ |
| uncertainty in SAR correction for deviation (in permittivity and conductivity) | 7.2.6       | 2                    | N                     | 1          | 1               | 0.84            | 2.00            | 1.68             | ∞ |
| Liquid conductivity (temperature uncertainty)                                  | 7.2.3.5     | 2.5                  | N                     | 1          | 0.78            | 0.71            | 1.95            | 1.78             | ∞ |
| Liquid conductivity -measurement uncertainty                                   | 7.2.3.3     | 4                    | N                     | 1          | 0.23            | 0.26            | 0.92            | 1.04             | ∞ |
| Liquid permittivity (temperature uncertainty)                                  | 7.2.3.5     | 2.5                  | N                     | 1          | 0.78            | 0.71            | 1.95            | 1.78             | ∞ |
| Liquid permittivity measurement uncertainty                                    | 7.2.3.4     | 5                    | N                     | 1          | 0.23            | 0.26            | 1.15            | 1.30             | ∞ |
| Combined standard uncertainty                                                  |             |                      | RSS                   |            |                 |                 | 10.15           | 10.05            |   |
| Expanded uncertainty (95%CONFIDENCEINTERVAL)                                   |             |                      | k                     |            |                 |                 | 20.29           | 20.10            |   |

## 10.4. Test Equipment List

| Test Equipment                      | Manufacturer | Model           | Serial Number             | Calibration              |                         |
|-------------------------------------|--------------|-----------------|---------------------------|--------------------------|-------------------------|
|                                     |              |                 |                           | Calibration Date (D.M.Y) | Calibration Due (D.M.Y) |
| PC                                  | Lenovo       | H3050           | N/A                       | N/A                      | N/A                     |
| Signal Generator                    | Agilent      | N5182A          | MY47070282                | Jun. 08, 2022            | Jun. 07, 2023           |
| Multimeter                          | Keithley     | Multimeter 2000 | 4078275                   | Jun. 08, 2022            | Jun. 07, 2023           |
| Network Analyzer                    | Agilent      | 8753E           | US38432457                | Jun. 08, 2022            | Jun. 07, 2023           |
| Wireless Communication Test Set     | R & S        | CMU200          | 111382                    | Jun. 08, 2022            | Jun. 07, 2023           |
| Wideband Radio Communication Tester | R&S          | CMW500          | 114220                    | Jun. 08, 2022            | Jun. 07, 2023           |
| Power Meter                         | Agilent      | E4418B          | GB43312526                | Jun. 08, 2022            | Jun. 07, 2023           |
| Power Meter                         | Agilent      | E4416A          | MY45101555                | Jun. 08, 2022            | Jun. 07, 2023           |
| Power Meter                         | Agilent      | N1912A          | MY50001018                | Jun. 08, 2022            | Jun. 07, 2023           |
| Power Sensor                        | Agilent      | E9301A          | MY41497725                | Jun. 08, 2022            | Jun. 07, 2023           |
| Power Sensor                        | Agilent      | E9327A          | MY44421198                | Jun. 08, 2022            | Jun. 07, 2023           |
| Power Sensor                        | Agilent      | E9323A          | MY53070005                | Jun. 08, 2022            | Jun. 07, 2023           |
| Power Amplifier                     | PE           | PE15A4019       | 112342                    | N/A                      | N/A                     |
| Directional Coupler                 | Agilent      | 722D            | MY52180104                | N/A                      | N/A                     |
| Attenuator                          | Chensheng    | FF779           | 134251                    | N/A                      | N/A                     |
| E-Field PROBE                       | MVG          | SSE2            | SN 36/20<br>EPGO346       | Oct. 08, 2022            | Oct. 07, 2023           |
| DIPOLE 2450                         | MVG          | SID 2450        | SN 16/15 DIP<br>2G450-374 | Jun. 05, 2022            | Jun. 04, 2023           |
| DIPOLE 5200-5800                    | MVG          | SID 5000        | SN 13/14<br>WGA32         | May 15, 2022             | May 14, 2023            |
| Limesar Dielectric Probe            | MVG          | SCLMP           | SN 19/15<br>OCPG71        | Jun. 05, 2022            | Jun. 04, 2023           |
| Communication Antenna               | MVG          | ANTA59          | SN 39/14<br>ANTA59        | N/A                      | N/A                     |
| Mobile Phone Position Device        | MVG          | MSH101          | SN 19/15<br>MSH101        | N/A                      | N/A                     |
| Dummy Probe                         | MVG          | DP66            | SN 13/15 DP66             | N/A                      | N/A                     |
| SAM PHANTOM                         | MVG          | SAM120          | SN 19/15<br>SAM120        | N/A                      | N/A                     |
| PHANTOM TABLE                       | MVG          | TABP101         | SN 19/15<br>TABP101       | N/A                      | N/A                     |
| Robot TABLE                         | MVG          | TABP61          | SN 19/15<br>TABP61        | N/A                      | N/A                     |
| 6 AXIS ROBOT                        | KUKA         | KR6-R900        | 501822                    | N/A                      | N/A                     |

**Note:** 1. N/A means this equipment no need to calibrate

2. Each Time means this device need to calibrate every use time

3. The dipole was not damaged properly repaired.

4. The measured SAR deviates from the calibrated SAR value by less than 10%

5. The most recent return-loss result meets the required 20 dB minimum return-loss requirement

6. The most recent measurement of the real or imaginary parts of the impedance deviates by less than 5  $\Omega$  from the previous measurement.

## 11. System Check Results

Date of measurement: 01/16/2023 Test mode: 2450MHz (Body)

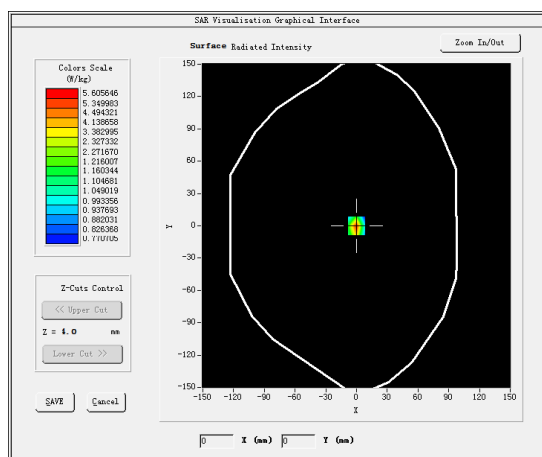
Product Description: Validation

Dipole Model: SID2450

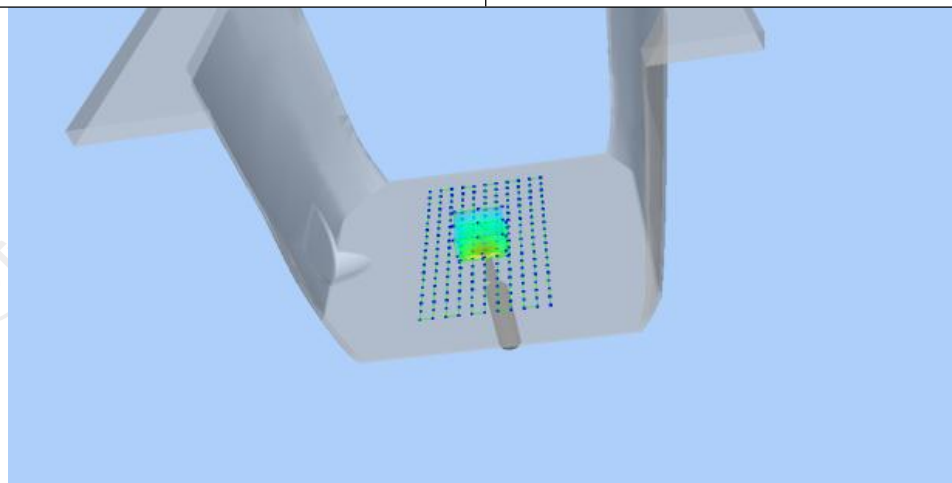
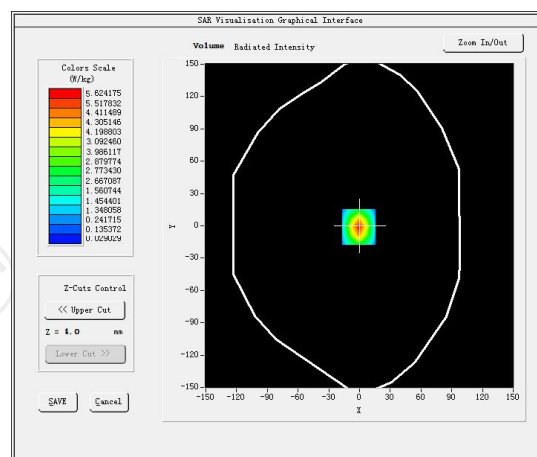
E-Field Probe: SSE2 (SN 36/20 EPGO346)

|                                        |                  |
|----------------------------------------|------------------|
| Phantom                                | Validation plane |
| Input Power                            | 100mW            |
| Crest Factor                           | 1.0              |
| Probe Conversion factor                | 2.37             |
| Frequency (MHz)                        | 2450.000000      |
| Relative permittivity (real part)      | 51.921199        |
| Relative permittivity (imaginary part) | 14.930150        |
| Conductivity (S/m)                     | 2.012159         |
| Variation (%)                          | -0.230000        |
| <b>SAR 10g (W/Kg)</b>                  | <b>2.416669</b>  |
| <b>SAR 1g (W/Kg)</b>                   | <b>5.066368</b>  |

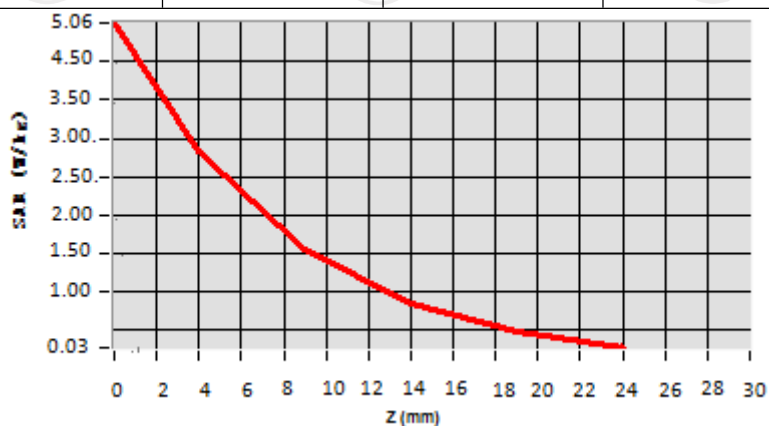
### SURFACE SAR



### VOLUME SAR



| Z (mm)     | 0.00   | 4.00   | 9.00   | 14.00  | 19.00  |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 5.0622 | 2.7984 | 1.5251 | 0.8352 | 0.4200 |



### Hot spot position



Date of measurement: 01/17/2023 Test mode: 5200 (Body)

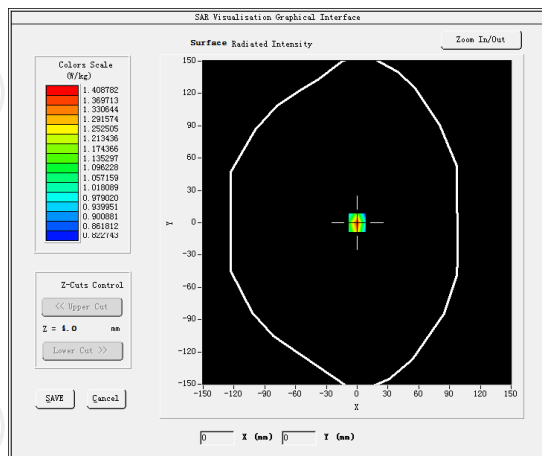
Product Description: Validation

Dipole Model: SID5000

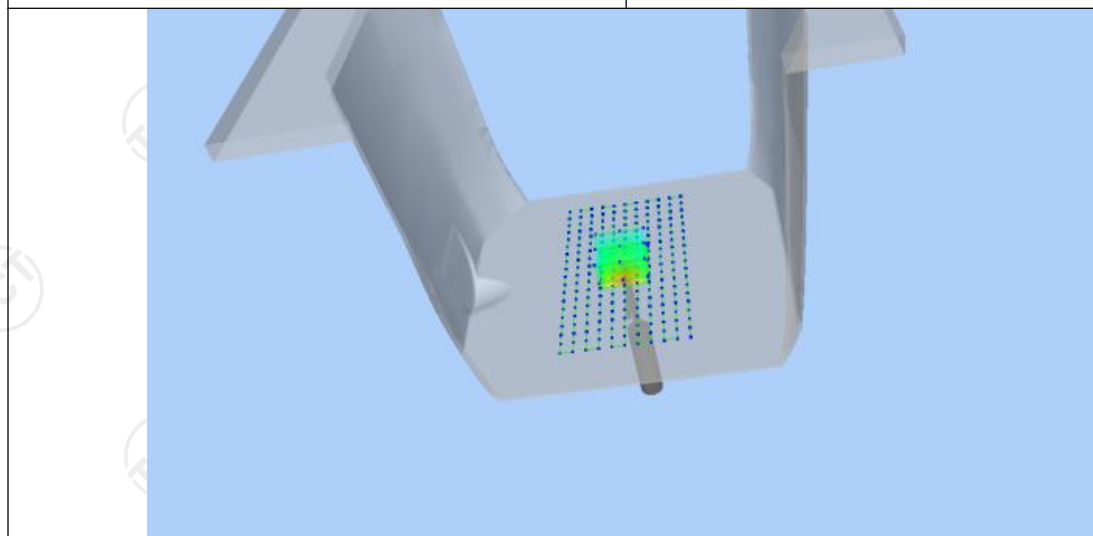
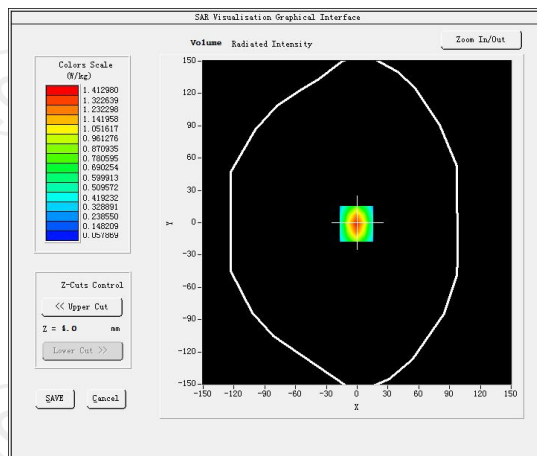
E-Field Probe: SSE2 (SN 36/20 EPGO346)

|                                        |                  |
|----------------------------------------|------------------|
| Phantom                                | Validation plane |
| Input Power                            | 100mW            |
| Crest Factor                           | 1.0              |
| Probe Conversion factor                | 2.08             |
| Frequency (MHz)                        | 5200.000000      |
| Relative permittivity (real part)      | 49.522077        |
| Relative permittivity (imaginary part) | 21.378187        |
| Conductivity (S/m)                     | 5.403883         |
| Variation (%)                          | -3.140000        |
| <b>SAR 10g (W/Kg)</b>                  | <b>5.513123</b>  |
| <b>SAR 1g (W/Kg)</b>                   | <b>15.472446</b> |

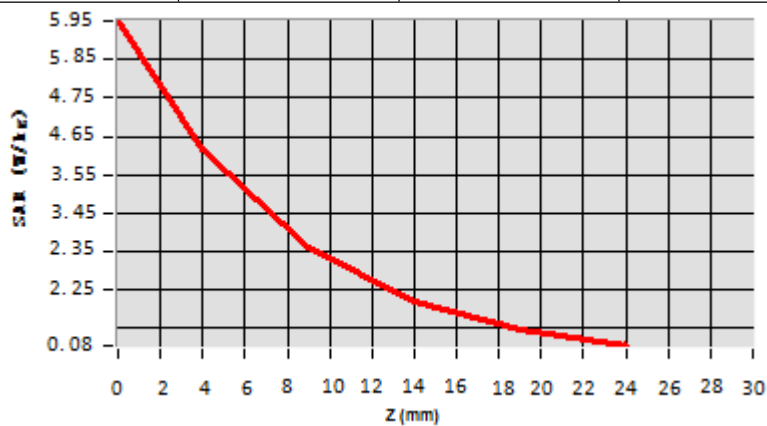
## SURFACE SAR



## VOLUME SAR



| Z (mm)     | 0.00   | 4.00   | 9.00   | 14.00  | 19.00  |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 5.9525 | 0.6022 | 0.3594 | 0.2202 | 0.0725 |



Hot spot position



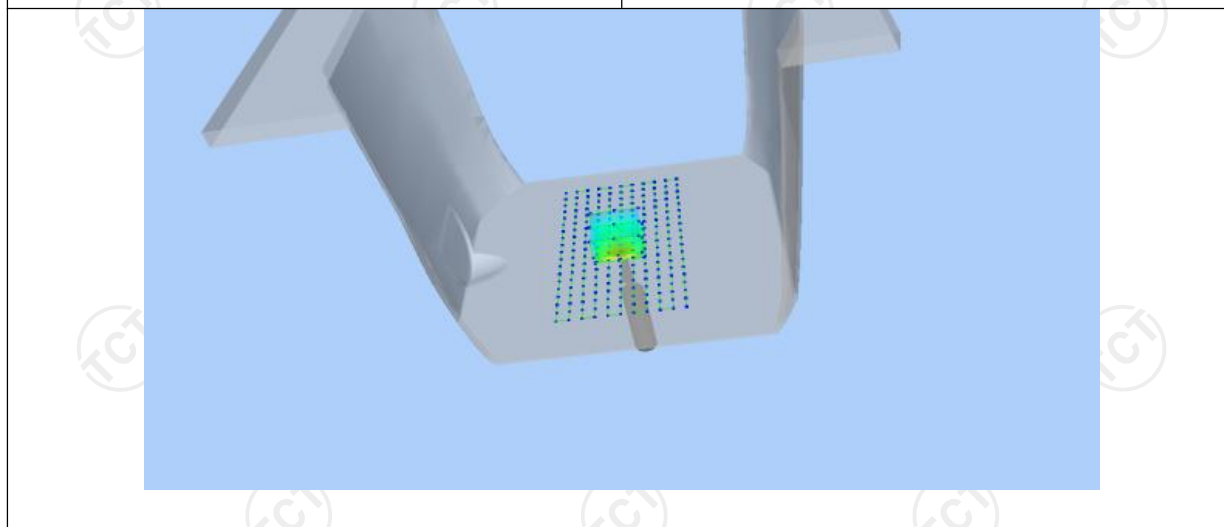
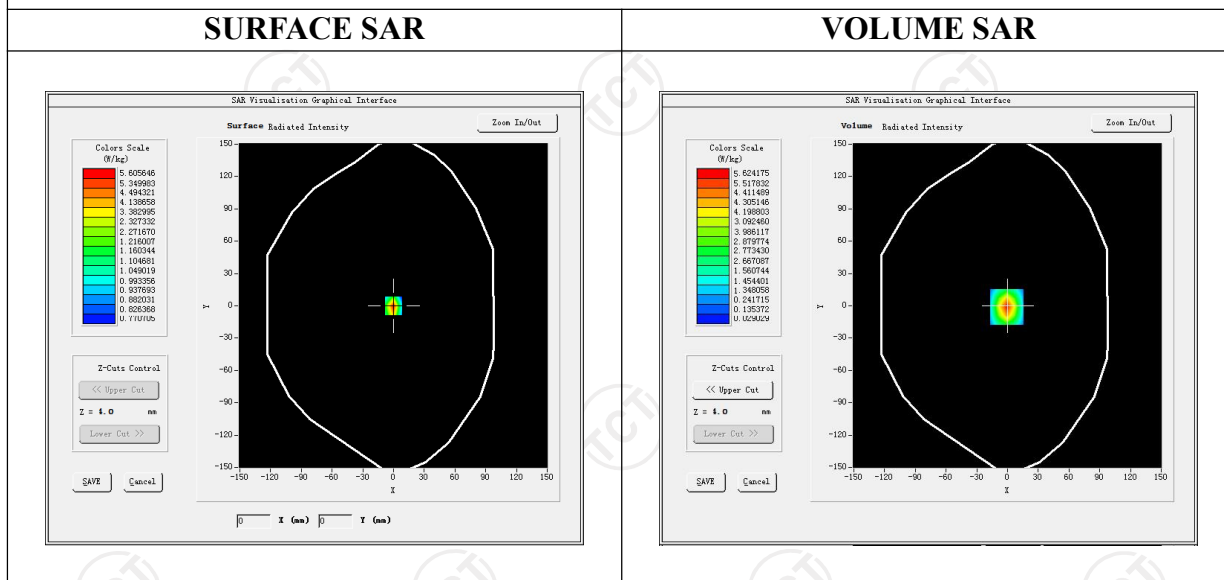
Date of measurement: 01/17/2023 Test mode: 5800MHz (Body)

Product Description: Validation

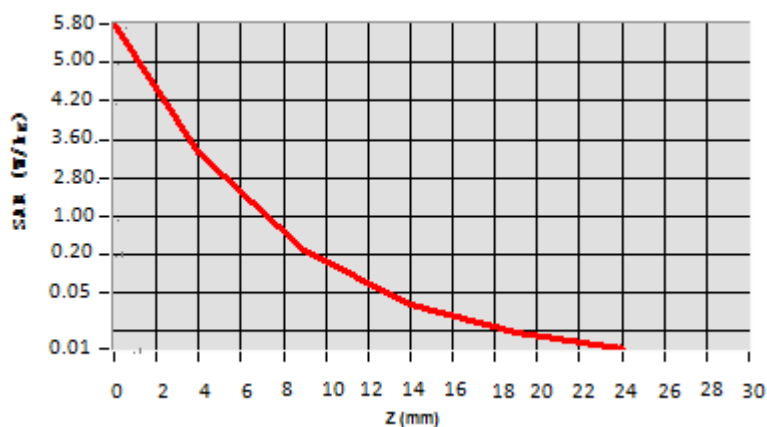
Dipole Model: SID5000

E-Field Probe: SSE2 (SN 36/20 EPGO346)

|                                        |                  |
|----------------------------------------|------------------|
| Phantom                                | Validation plane |
| Input Power                            | 100mW            |
| Crest Factor                           | 1.0              |
| Probe Conversion factor                | 2.13             |
| Frequency (MHz)                        | 5800.000000      |
| Relative permittivity (real part)      | 47.593887        |
| Relative permittivity (imaginary part) | 14.935214        |
| Conductivity (S/m)                     | 5.954821         |
| Variation (%)                          | -1.420000        |
| SAR 10g (W/Kg)                         | 6.182177         |
| SAR 1g (W/Kg)                          | 18.304098        |



| Z (mm)     | 0.00   | 4.00   | 9.00   | 14.00  | 19.00  |
|------------|--------|--------|--------|--------|--------|
| SAR (W/Kg) | 5.7721 | 3.2210 | 0.1937 | 0.0321 | 0.0203 |



Hot spot position



## 12. SAR Test Data

### SAR Measurement at IEEE 802.11b ISM (Body, Validation Plane)

Date of measurement: 16/01/2023

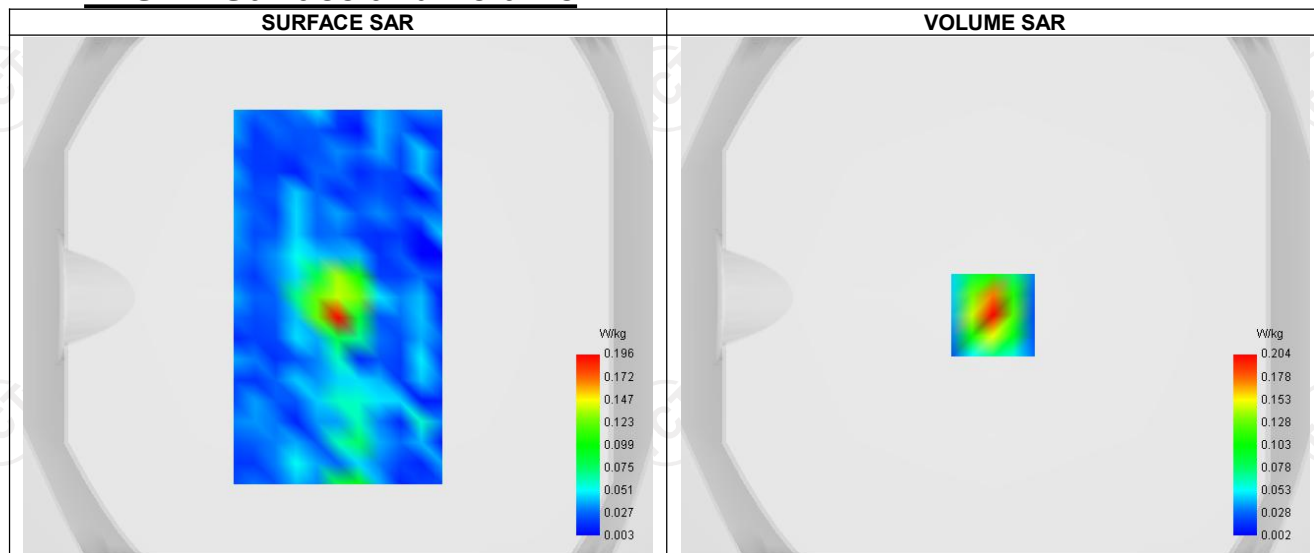
#### A. Experimental conditions.

|                 |                                     |
|-----------------|-------------------------------------|
| Probe           | SSE2 (SN 36/20 EPG0346)             |
| ConvF           | 2.37                                |
| Area Scan       | surf_sam_plan.txt                   |
| Zoom Scan       | 5x5x7,dx=8mm dy=8mm dz=5mm,Complete |
| Phantom         | Validation plane                    |
| Device Position | Body                                |
| Band            | IEEE 802.11b ISM                    |
| Channels        | Lower (1)                           |
| Signal          | IEEE 802.11                         |

#### B. Permittivity

|                                        |          |
|----------------------------------------|----------|
| Frequency (MHz)                        | 2412.000 |
| Relative permittivity (real part)      | 51.960   |
| Relative permittivity (imaginary part) | 14.930   |
| Conductivity (S/m)                     | 1.972    |

#### C. SAR Surface and Volume

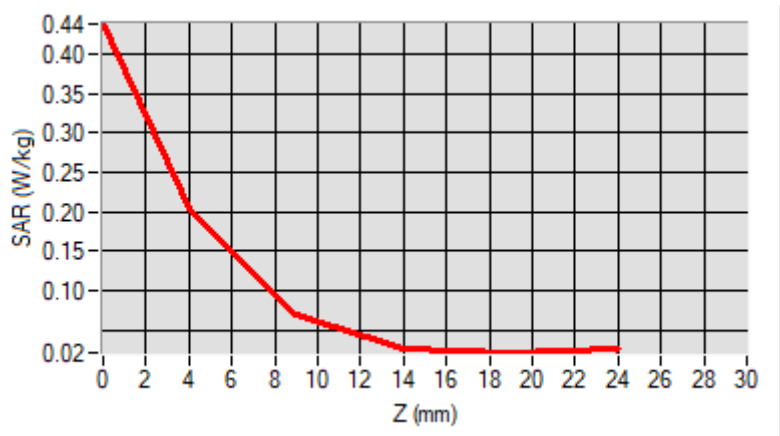


#### D. SAR 1g & 10g

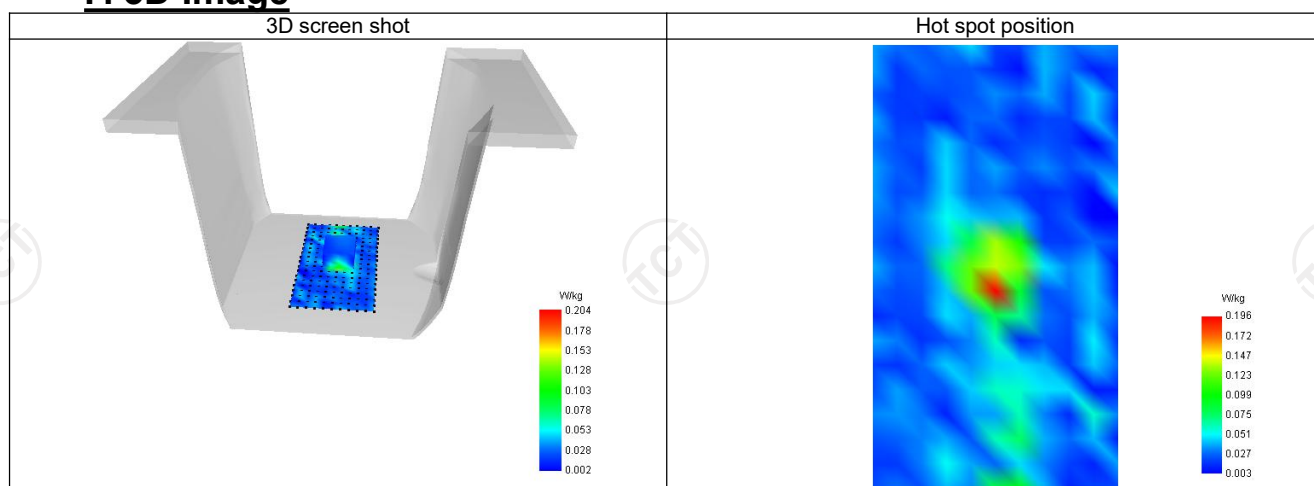
|                                                       |          |
|-------------------------------------------------------|----------|
| SAR 10g (W/Kg)                                        | 0.149    |
| SAR 1g (W/Kg)                                         | 0.218    |
| Variation (%)                                         | -0.130   |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%)     | 0.000000 |

#### E. Z Axis Scan

|            |       |       |       |       |       |
|------------|-------|-------|-------|-------|-------|
| Z (mm)     | 0.00  | 4.00  | 9.00  | 14.00 | 19.00 |
| SAR (W/Kg) | 0.438 | 0.204 | 0.069 | 0.027 | 0.021 |



## F. 3D Image



## SAR Measurement at IEEE 802.11ax U-NII (Body, Validation Plane)

Date of measurement: 17/01/2023

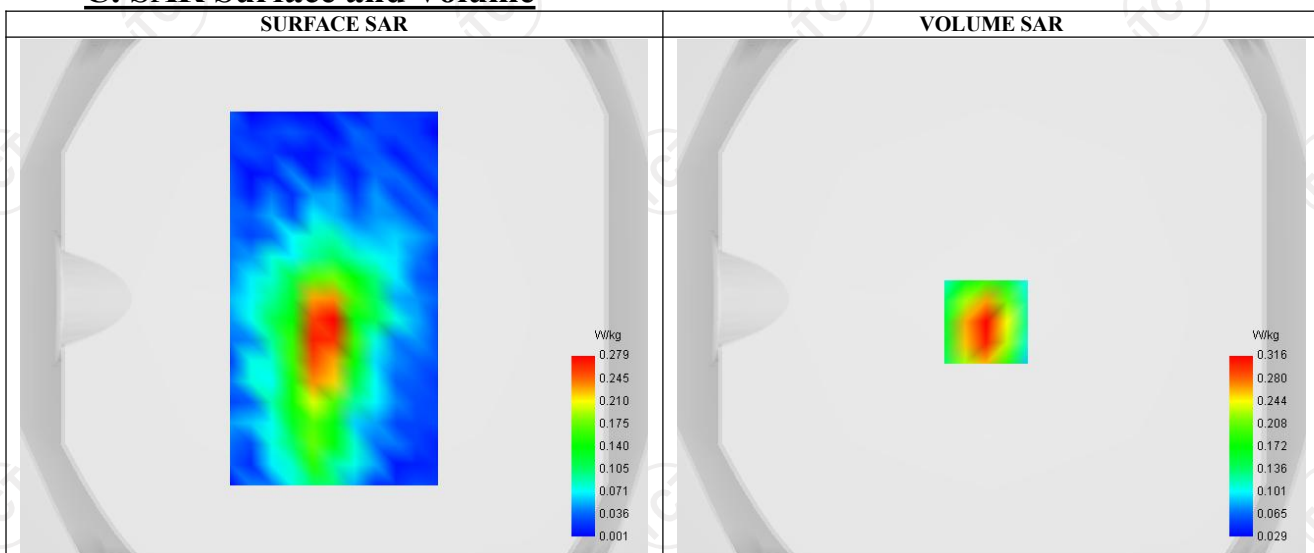
### A. Experimental conditions.

|                 |                                     |
|-----------------|-------------------------------------|
| Probe           | SSE2 (SN 36/20 EPG0346)             |
| ConvF           | 2.08                                |
| Area Scan       | surf_sam_plan.txt                   |
| Zoom Scan       | 5x5x7,dx=8mm dy=8mm dz=5mm,Complete |
| Phantom         | Validation plane                    |
| Device Position | Body                                |
| Band            | IEEE 802.11ax U-NII                 |
| Channels        | Middle (42)                         |
| Signal          | IEEE 802.11                         |

### B. Permittivity

|                                        |          |
|----------------------------------------|----------|
| Frequency (MHz)                        | 5210.000 |
| Relative permittivity (real part)      | 49.522   |
| Relative permittivity (imaginary part) | 21.378   |
| Conductivity (S/m)                     | 5.404    |

### C. SAR Surface and Volume



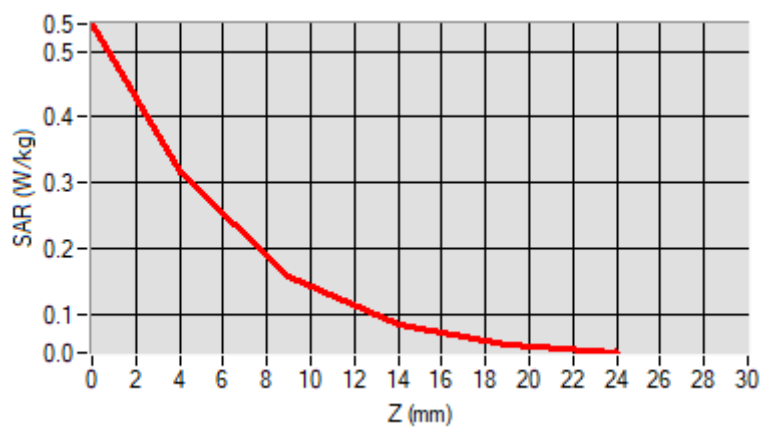
Maximum location: X=-2.00, Y=-9.00 ; SAR Peak: 0.55 W/kg

### D. SAR 1g & 10g

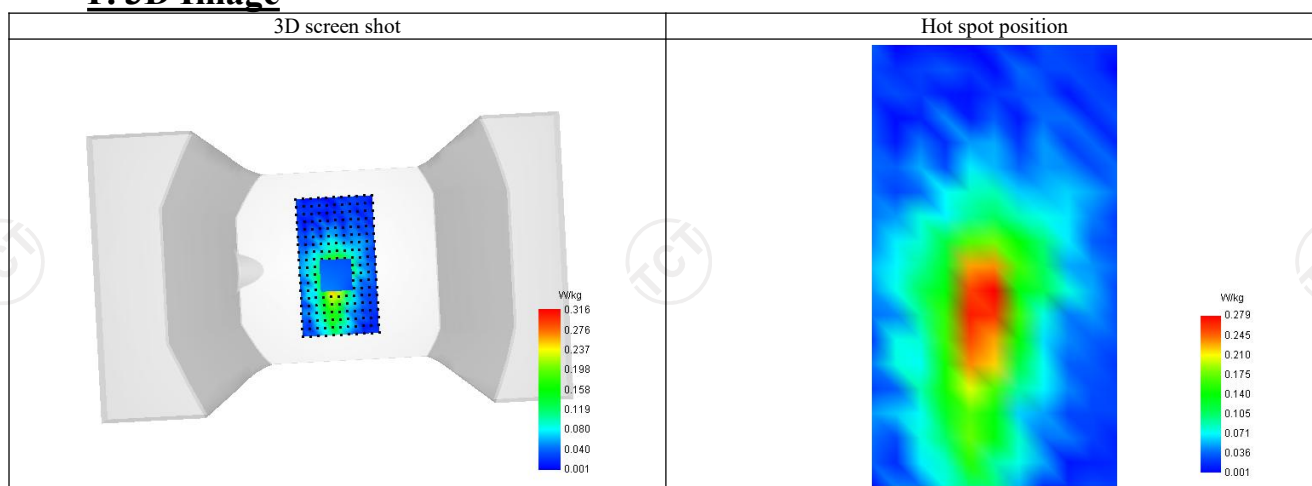
|                                                       |          |
|-------------------------------------------------------|----------|
| SAR 10g (W/Kg)                                        | 0.156    |
| SAR 1g (W/Kg)                                         | 0.349    |
| Variation (%)                                         | 0.700    |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%)     | 0.000000 |

### E. Z Axis Scan

|            |       |       |       |       |       |
|------------|-------|-------|-------|-------|-------|
| Z (mm)     | 0.00  | 4.00  | 9.00  | 14.00 | 19.00 |
| SAR (W/Kg) | 0.542 | 0.316 | 0.157 | 0.083 | 0.054 |



## F. 3D Image



## SAR Measurement at IEEE 802.11n U-NII (Body, Validation Plane)

Date of measurement: 17/01/2023

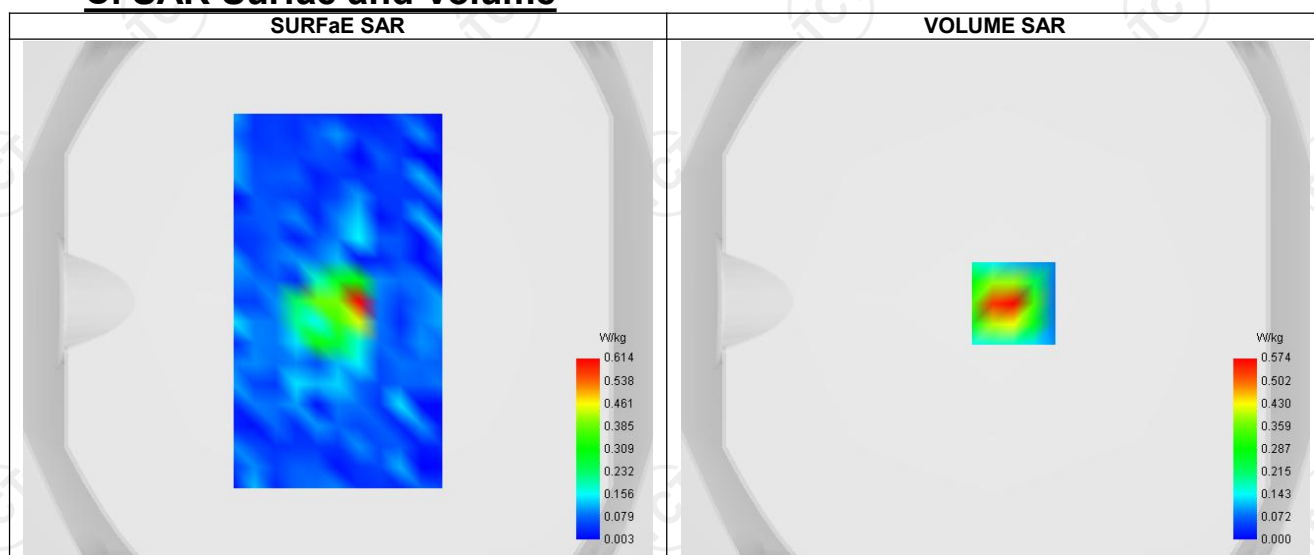
### A. Experimental conditions.

|                 |                                     |
|-----------------|-------------------------------------|
| Probe           | SSE2 (SN 36/20 EPG0346)             |
| ConvF           | 2.13                                |
| Area Scan       | surf_sam_plan.txt                   |
| Zoom Scan       | 5x5x7,dx=8mm dy=8mm dz=5mm,Complete |
| Phantom         | Validation plane                    |
| Device Position | Body                                |
| Band            | IEEE 802.11n U-NII                  |
| Channels        | Higher (159)                        |
| Signal          | IEEE 802.11                         |

### B. Permittivity

|                                        |          |
|----------------------------------------|----------|
| Frequency (MHz)                        | 5795.000 |
| Relative permittivity (real part)      | 47.594   |
| Relative permittivity (imaginary part) | 14.935   |
| Conductivity (S/m)                     | 5.954    |

### C. SAR Surface and Volume



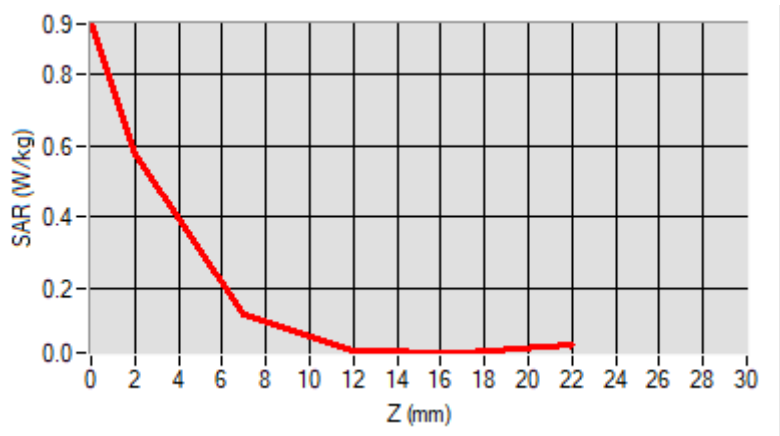
Maximum location: X=7.00, Y=-1.00 ; SAR Peak: 0.92 W/kg

### D. SAR 1g & 10g

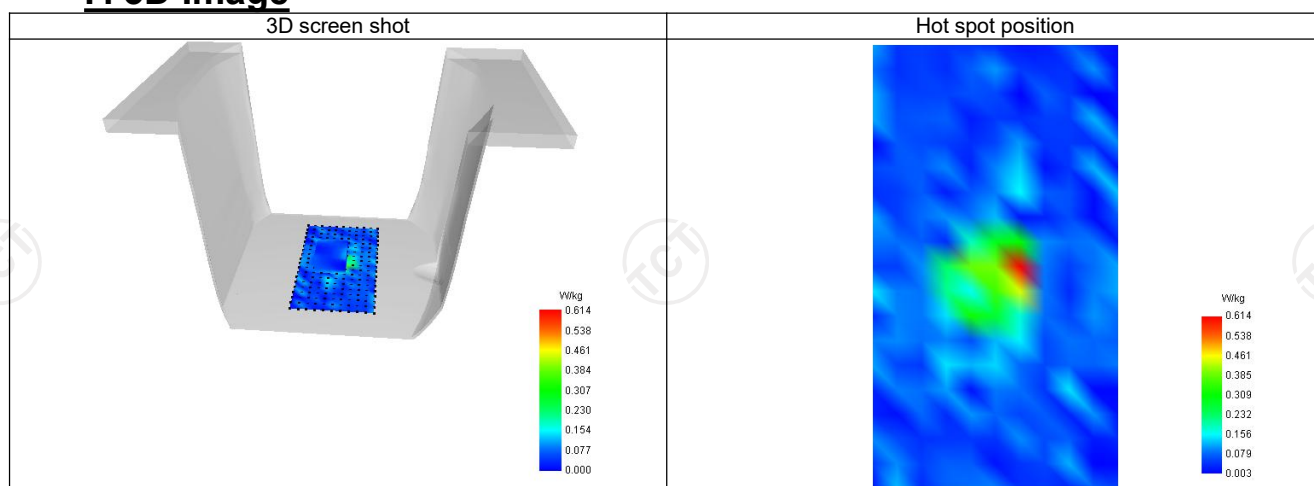
|                                                       |          |
|-------------------------------------------------------|----------|
| SAR 10g (W/Kg)                                        | 0.074    |
| SAR 1g (W/Kg)                                         | 0.123    |
| Variation (%)                                         | -1.334   |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%)     | 0.000000 |

### E. Z Axis Scan

|            |       |       |       |       |       |
|------------|-------|-------|-------|-------|-------|
| Z (mm)     | 0.00  | 2.00  | 7.00  | 12.00 | 17.00 |
| SAR (W/Kg) | 0.943 | 0.574 | 0.125 | 0.024 | 0.017 |



## F. 3D Image



## SAR Measurement at Bluetooth (Body, Validation Plane)

Date of measurement: 16/01/2023

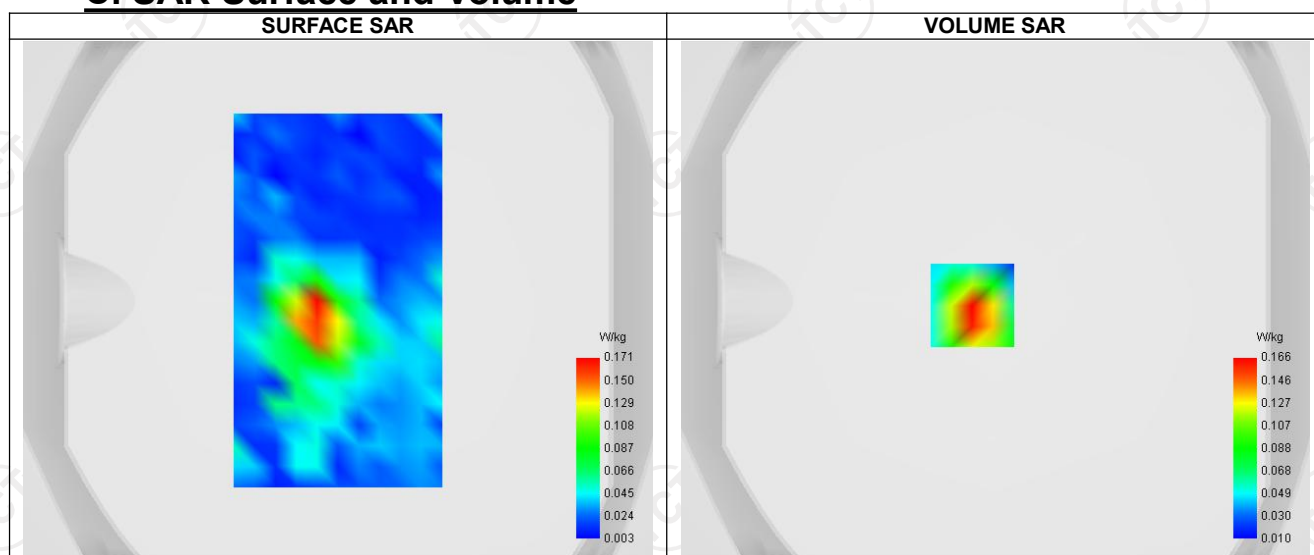
### A. Experimental conditions.

|                 |                                     |
|-----------------|-------------------------------------|
| Probe           | SN 04/22 EPG0365                    |
| ConvF           | 2.37                                |
| Area Scan       | surf_sam_plan.txt                   |
| Zoom Scan       | 5x5x7,dx=8mm dy=8mm dz=5mm,Complete |
| Phantom         | Validation plane                    |
| Device Position | Body                                |
| Band            | Bluetooth                           |
| Channels        | Lower (1)                           |
| Signal          | Bluetooth                           |

### B. Permittivity

|                                        |          |
|----------------------------------------|----------|
| Frequency (MHz)                        | 2402.000 |
| Relative permittivity (real part)      | 51.961   |
| Relative permittivity (imaginary part) | 14.930   |
| Conductivity (S/m)                     | 1.972    |

### C. SAR Surface and Volume



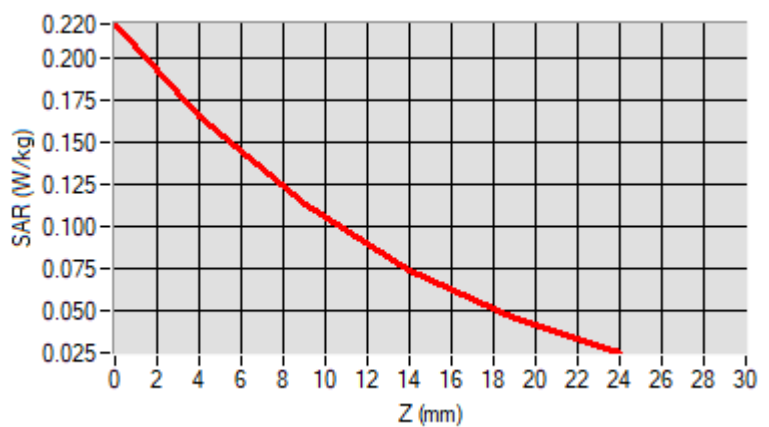
Maximum location: X=-9.00, Y=-2.00 ; SAR Peak: 0.24 W/kg

### D. SAR 1g & 10g

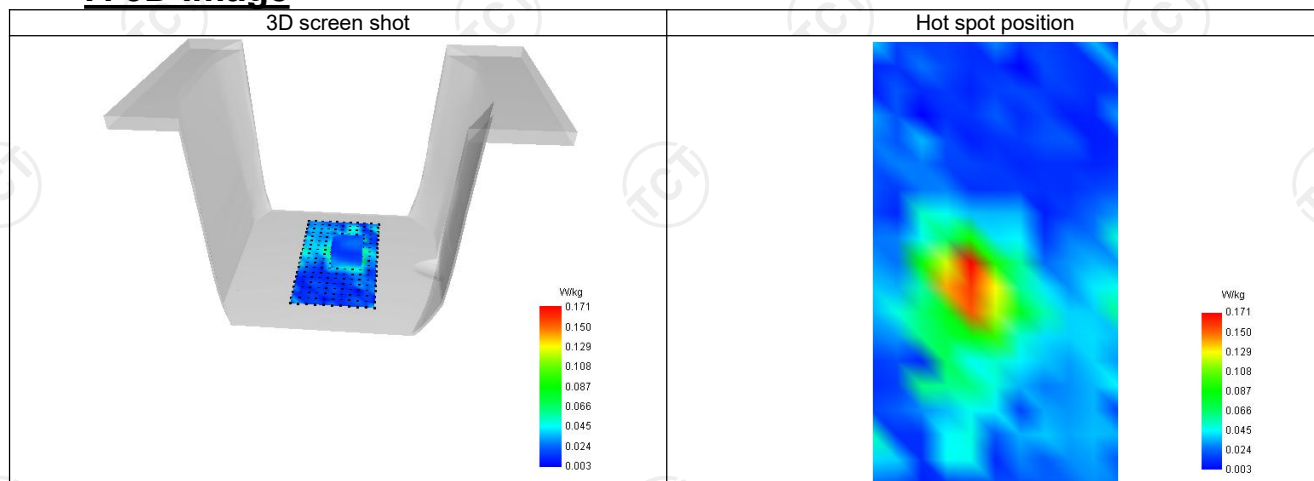
|                                                       |          |
|-------------------------------------------------------|----------|
| SAR 10g (W/Kg)                                        | 0.077    |
| SAR 1g (W/Kg)                                         | 0.101    |
| Variation (%)                                         | -3.030   |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%)     | 0.000000 |

### E. Z Axis Scan

|            |       |       |       |       |       |
|------------|-------|-------|-------|-------|-------|
| Z (mm)     | 0.00  | 4.00  | 9.00  | 14.00 | 19.00 |
| SAR (W/Kg) | 0.220 | 0.166 | 0.113 | 0.074 | 0.046 |



## F. 3D Image



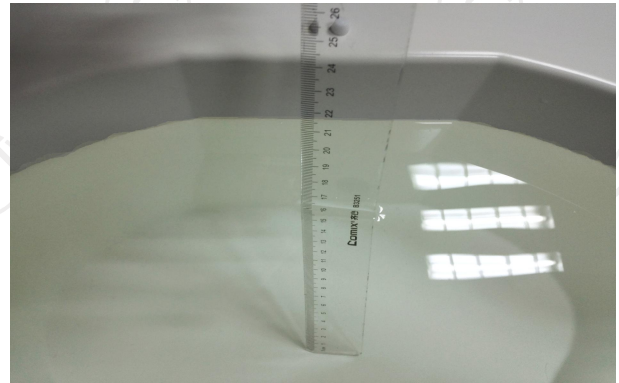
## Appendix A: EUT Photos

Please refer to RF report.

### Liquid depth

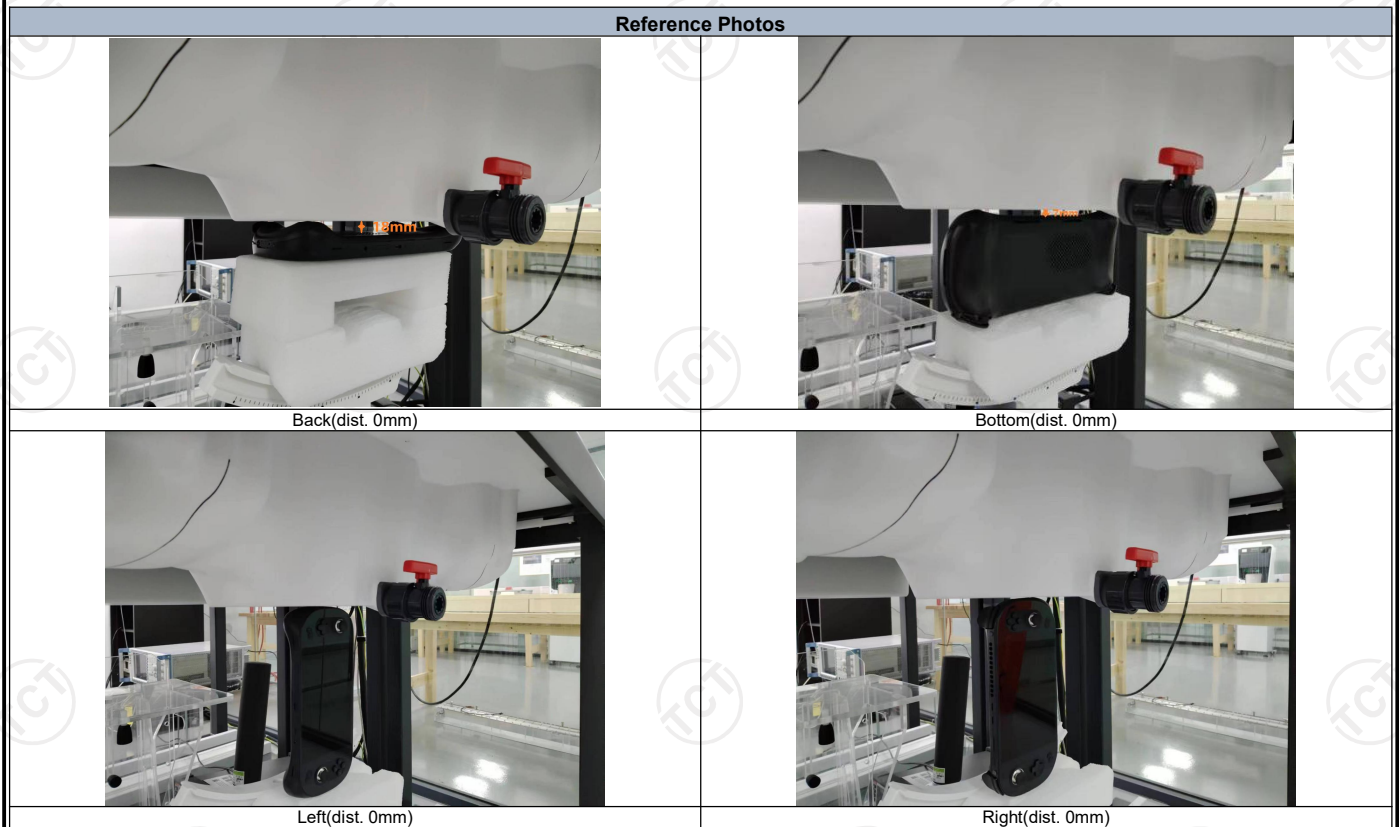


The Body Liquid of 2450MHz (15.3cm)



The Body Liquid of 5000-6000MHz (16.5cm)

**Appendix B: Test Setup Photos**



## Appendix C: Probe Calibration Certificate

COMOSAR E-FIELD Probe



### COMOSAR E-Field Probe Calibration Report

Ref: ACR.297.1.20.MVGB.A

**SHENZHEN TONGCE TESTING LAB.**  
**TCT TESTING INDUSTRIAL PARK, FUQIAO 5TH**  
**INDUSTRIAL ZONE, FUHAI STREET,**  
**BAOAN DISTRICT, SHENZHEN, GUANGDONG ,**  
**518103, PEOPLES REPUBLIC OF CHINA**  
**MVG COMOSAR DOSIMETRIC E-FIELD PROBE**  
**SERIAL NO.: SN 36/20 EPG0346**

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

**Calibration date: 10/08/2022**



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).



## COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

|               | Name         | Function            | Date       | Signature           |
|---------------|--------------|---------------------|------------|---------------------|
| Prepared by : | Jérôme LUC   | Technical Manager   | 10/08/2022 | <i>JS</i>           |
| Checked by :  | Jérôme LUC   | Technical Manager   | 10/08/2022 | <i>JS</i>           |
| Approved by : | Yann Toutain | Laboratory Director | 10/11/2022 | <i>Yann Toutain</i> |

|                | Customer Name               |
|----------------|-----------------------------|
| Distribution : | SHENHEN TONGCE TESTING LAB. |

| Issue | Name       | Date       | Modifications   |
|-------|------------|------------|-----------------|
| A     | Jérôme LUC | 10/08/2022 | Initial release |
|       |            |            |                 |
|       |            |            |                 |
|       |            |            |                 |

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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 36/20 EPGO346                                                        |
| Product Condition (new / used)           | New                                                                     |
| Frequency Range of Probe                 | 0.15 GHz-6GHz                                                           |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.217 MΩ<br>Dipole 2: R2=0.245 MΩ<br>Dipole 3: R3=0.219 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:

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

where

$SAR_{uncertainty}$  is the uncertainty in percent of the probe boundary effect

$d_{be}$  is the distance between the surface and the closest *zoom-scan* 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.,  $\delta = 14$  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 SAR uncertainty [%] 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           | 30-80 %     |

##### 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> ) |
| 0.81                                       | 0.71                                       | 0.80                                       |

|                      |                      |                      |
|----------------------|----------------------|----------------------|
| DCP dipole 1<br>(mV) | DCP dipole 2<br>(mV) | DCP dipole 3<br>(mV) |
| 115                  | 112                  | 112                  |

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

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

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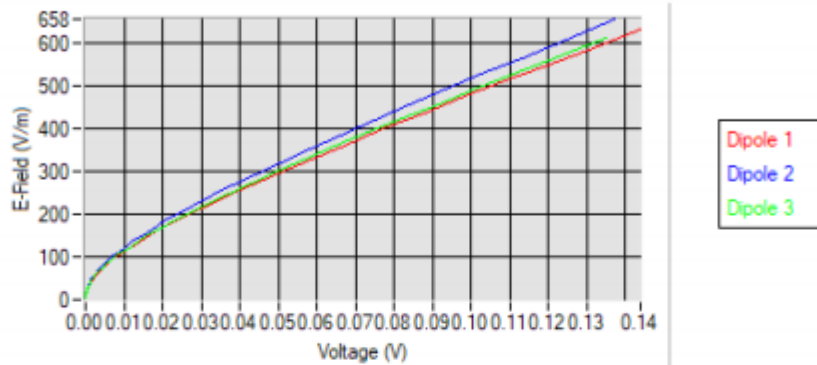
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## COMOSAR E-FIELD PROBE CALIBRATION REPORT

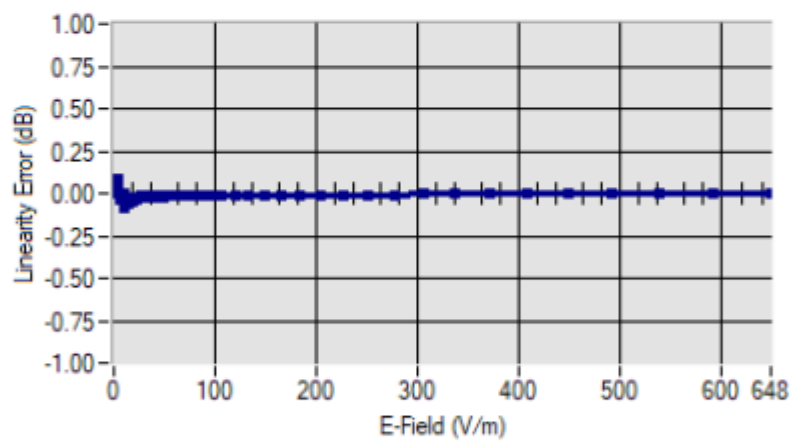
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### Calibration curves



### 5.2 LINEARITY

#### Linearity



Linearity: +/-1.97% (+/-0.09dB)

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## COMOSAR E-FIELD PROBE CALIBRATION REPORT

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### 5.3 SENSITIVITY IN LIQUID

| Liquid | Frequency<br>(MHz +/-<br>100MHz) | Permittivity | Epsilon (S/m) | ConvF |
|--------|----------------------------------|--------------|---------------|-------|
| HL450  | 450                              | 45.43        | 0.86          | 1.85  |
| BL450  | 450                              | 58.80        | 0.90          | 1.92  |
| HL750  | 750                              | 40.76        | 0.93          | 1.71  |
| BL750  | 750                              | 56.70        | 0.98          | 1.78  |
| HL850  | 835                              | 40.86        | 0.92          | 1.80  |
| BL850  | 835                              | 56.35        | 0.99          | 1.86  |
| HL900  | 900                              | 41.94        | 0.93          | 1.91  |
| BL900  | 900                              | 54.62        | 0.98          | 1.96  |
| HL1800 | 1800                             | 40.86        | 1.29          | 2.08  |
| BL1800 | 1800                             | 52.27        | 1.47          | 2.16  |
| HL1900 | 1900                             | 39.67        | 1.38          | 2.23  |
| BL1900 | 1900                             | 52.84        | 1.59          | 2.32  |
| HL2000 | 2000                             | 38.71        | 1.42          | 2.03  |
| BL2000 | 2000                             | 52.03        | 1.52          | 2.10  |
| HL2450 | 2450                             | 38.72        | 1.80          | 2.31  |
| BL2450 | 2450                             | 54.91        | 1.97          | 2.37  |
| HL2600 | 2600                             | 39.98        | 1.89          | 2.16  |
| BL2600 | 2600                             | 54.42        | 2.18          | 2.23  |
| HL3500 | 3500                             | 37.96        | 2.87          | 2.21  |
| BL3500 | 3500                             | 53.40        | 3.28          | 2.28  |
| HL5200 | 5200                             | 36.68        | 4.45          | 2.01  |
| BL5200 | 5200                             | 49.02        | 5.46          | 2.08  |
| HL5400 | 5400                             | 36.08        | 4.69          | 1.94  |
| BL5400 | 5400                             | 49.55        | 5.53          | 1.99  |
| HL5600 | 5600                             | 35.34        | 4.95          | 2.07  |
| BL5600 | 5600                             | 47.60        | 5.77          | 2.12  |
| HL5800 | 5800                             | 34.81        | 5.08          | 2.06  |
| BL5800 | 5800                             | 47.81        | 6.12          | 2.13  |

LOWER DETECTION LIMIT: 9mW/kg

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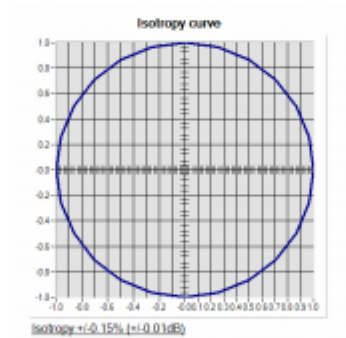
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#### 5.4 ISOTROPY

##### HL1800 MHz



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