## 15.2 SAR Test Graph Results

SAR plots for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination according to FCC KDB 865664 D02

# Plot 1

### A. Experimental conditions.

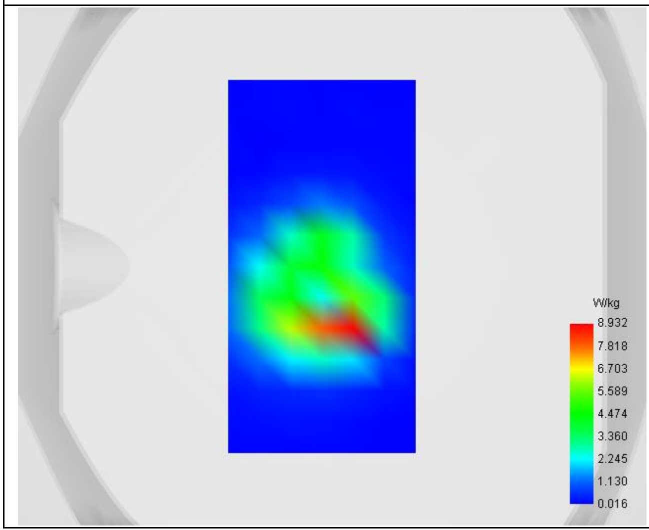
| | |
|---|---|
| Probe | SN 26/23 EPGO420 |
| ConvF | 0.81 |
| Area Scan | surf_sam_plan.txt |
| Zoom Scan | 7x7x7,dx=5mm dy=5mm dz=5mm |
| Phantom | Validation plane |
| Device Position | Body |
| Band | GSM850 |
| Channels | Middle (1) |
| Signal | Custom (Crest factor: 1.0) |

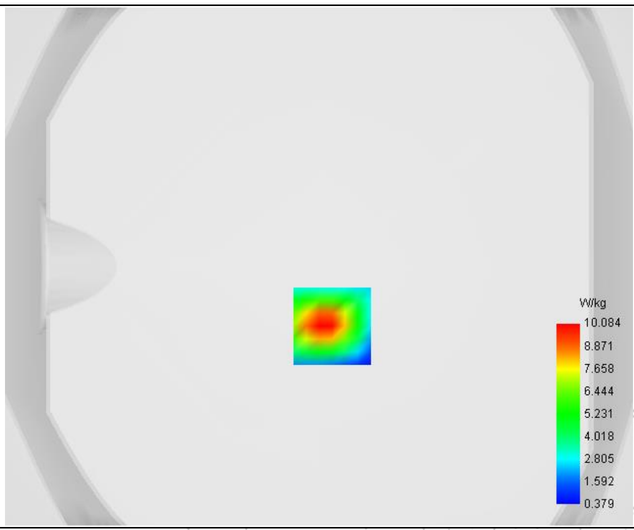
### B. Permitivity

| | |
|---|---|
| **Frequency (MHz)** | 836.600 |
| **Relative permitivity (real part)** | 39.972 |
| **Relative permitivity (imaginary part)** | 19.400 |
| **Conductivity (S/m)** | 0.911 |

### C. SAR Surface and Volume

| **SURFACE SAR** | **VOLUME SAR** |
|---|---|




Maximum location: X=5.00, Y=-23.00 ; SAR Peak: 17.69 W/kg

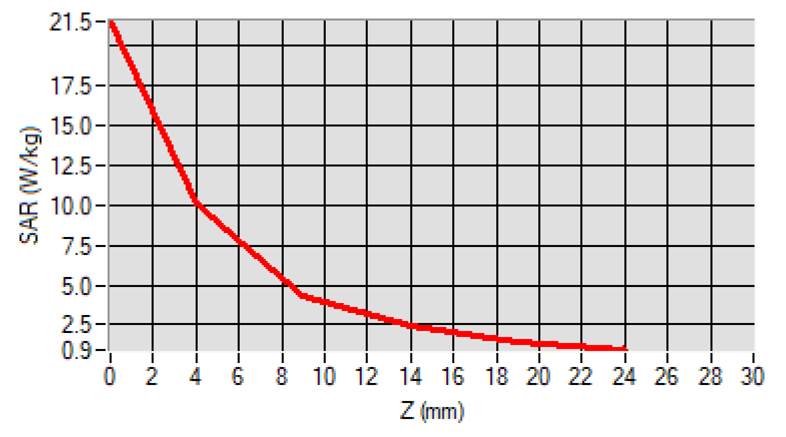
### D. SAR 1g & 10g

| | |
|---|---|
| SAR 10g (W/Kg) | 0.326 |
| SAR 1g (W/Kg) | 0.985 |
| Variation (%) | -3.970 |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%) | 0.000000 |

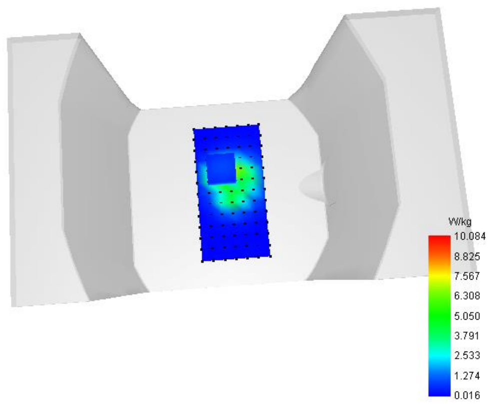
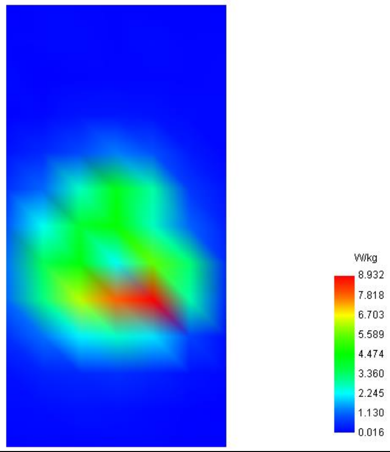
### E. Z Axis Scan

| | | | | | |
|---|---|---|---|---|---|
| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |

| | | | | | |
|---|---|---|---|---|---|
| SAR (W/Kg) | 21.483 | 10.084 | 4.284 | 2.433 | 1.408 |




**F. 3D Image**

| 3D screen shot | Hot spot position |
|---|---|
|  |  |

# Plot 2

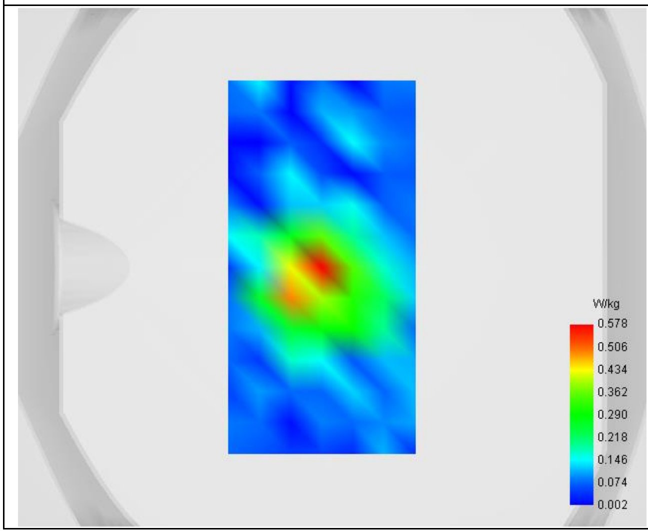
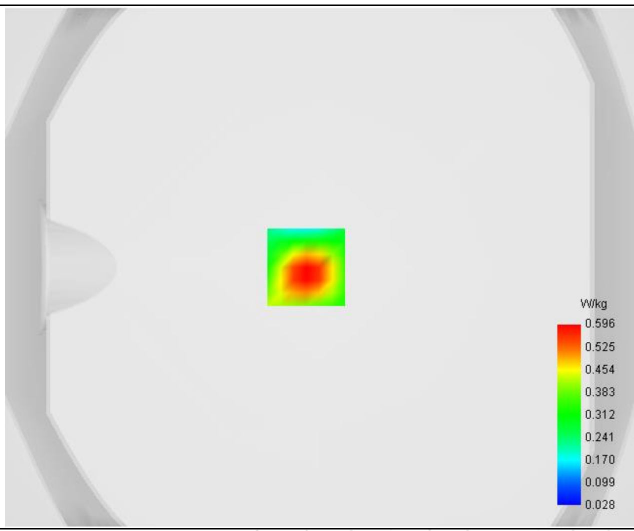
**A. Experimental conditions.**

| | |
|---|---|
| Probe | SN 26/23 EPGO420 |
| ConvF | 1.04 |
| Area Scan | surf_sam_plan.txt |
| Zoom Scan | 7x7x7,dx=5mm dy=5mm dz=5mm |
| Phantom | Validation plane |
| Device Position | Body |
| Band | GSM1900 |
| Channels | Middle (1) |
| Signal | Custom (Crest factor: 1.0) |

**B. Permitivity**

| | |
|---|---|
| **Frequency (MHz)** | 1880.000 |
| **Relative permitivity (real part)** | 38.162 |
| **Relative permitivity (imaginary part)** | 13.408 |
| **Conductivity (S/m)** | 1.462 |

**C. SAR Surface and Volume**

| SURFACE SAR | VOLUME SAR |
|---|---|
|   |   |

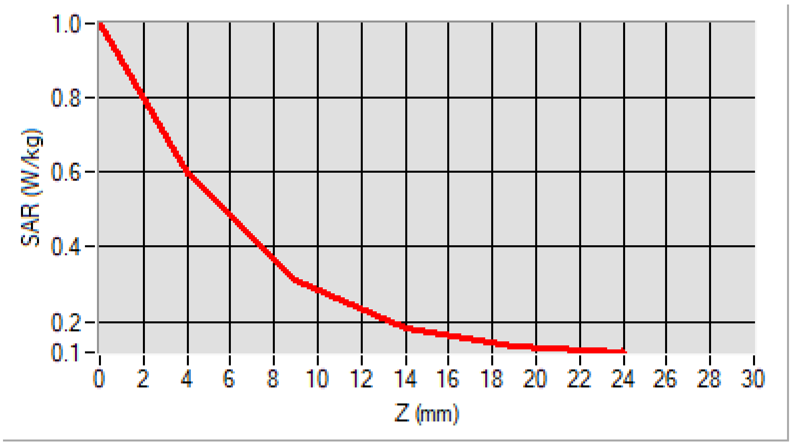
Maximum location: X=-5.00, Y=0.00 ; SAR Peak: 1.07 W/kg

**D. SAR 1g & 10g**

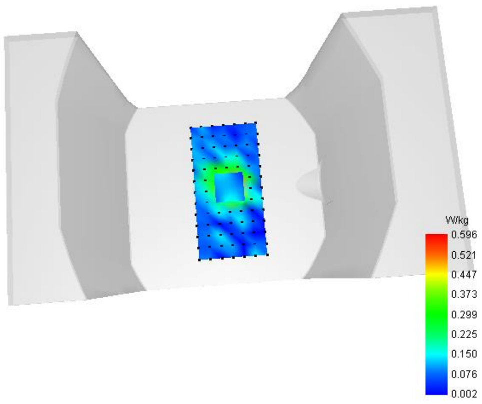
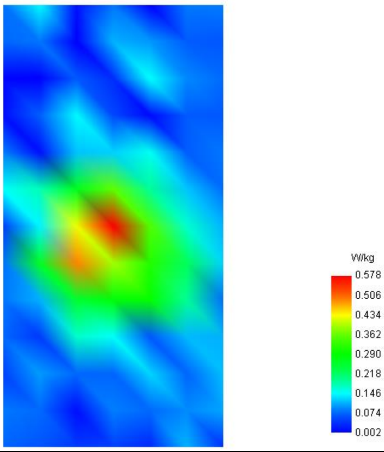
| | |
|---|---|
| SAR 10g (W/Kg) | 0.318 |
| SAR 1g (W/Kg) | 0.567 |
| Variation (%) | -0.390 |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%) | 0.000000 |

**E. Z Axis Scan**

| | | | | | |
|---|---|---|---|---|---|
| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
| SAR (W/Kg) | 0.997 | 0.596 | 0.312 | 0.183 | 0.135 |




**F. 3D Image**

| 3D screen shot | Hot spot position |
|---|---|
|  |  |

# Plot 3

## A. Experimental conditions.

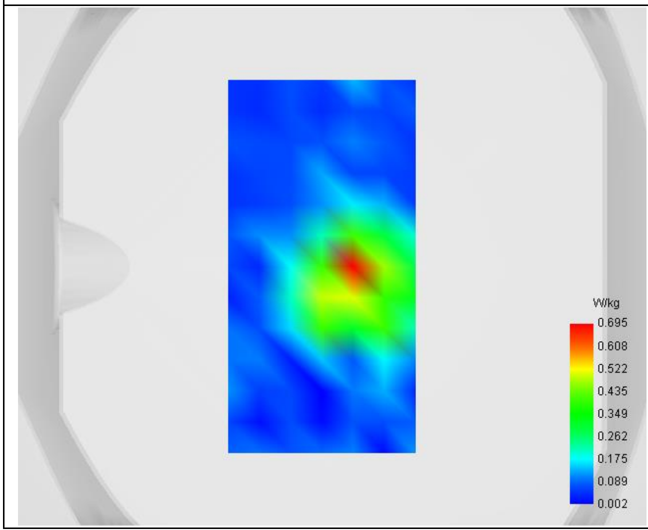
| | |
|---|---|
| Probe | SN 26/23 EPGO420 |
| ConvF | 1.04 |
| Area Scan | surf_sam_plan.txt |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Phantom | Validation plane |
| Device Position | Body |
| Band | Band2_WCDMA1900 |
| Channels | Middle (9400) |
| Signal | WCDMA (Crest factor: 1.0) |

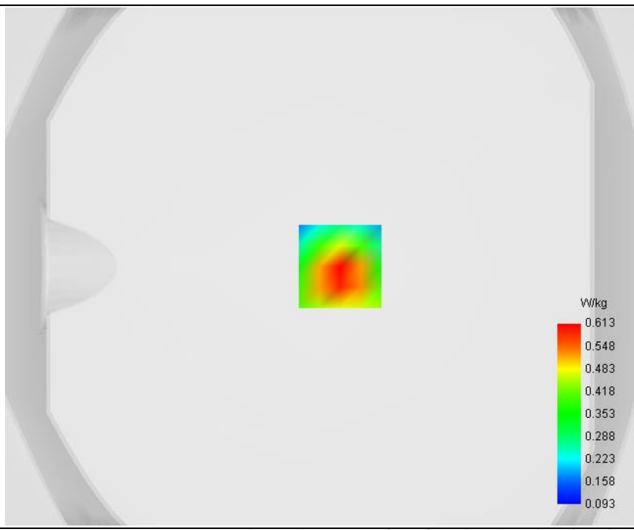
## B. Permitivity

| | |
|---|---|
| **Frequency (MHz)** | 1880.000 |
| **Relative permitivity (real part)** | 38.162 |
| **Relative permitivity (imaginary part)** | 13.408 |
| **Conductivity (S/m)** | 1.462 |

## C. SAR Surface and Volume

| SURFACE SAR | VOLUME SAR |
|---|---|



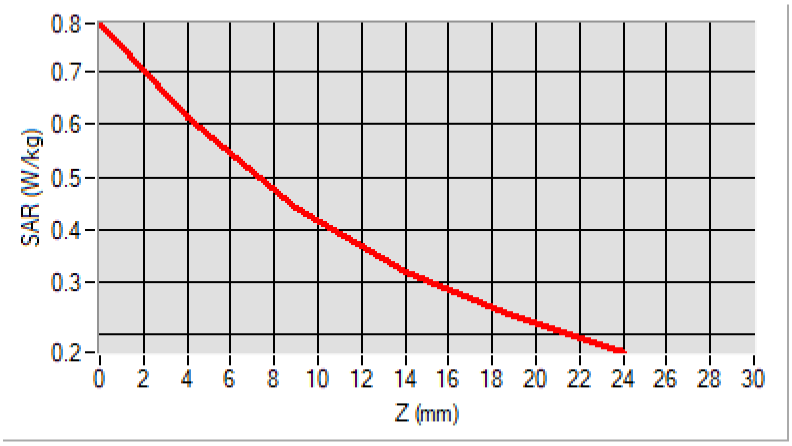

Maximum location: X=8.00, Y=0.00 ; SAR Peak: 0.82 W/kg

## D. SAR 1g & 10g

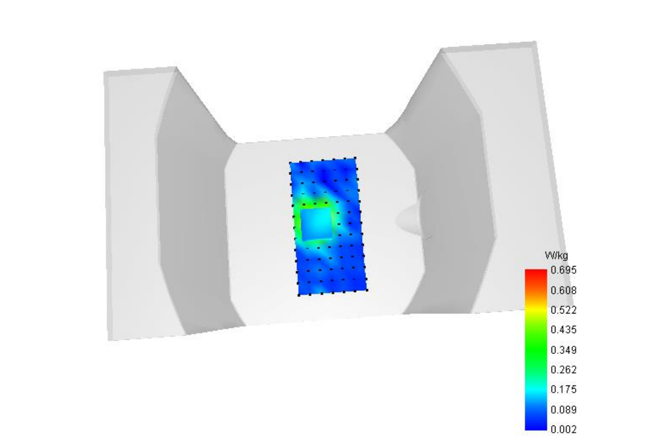
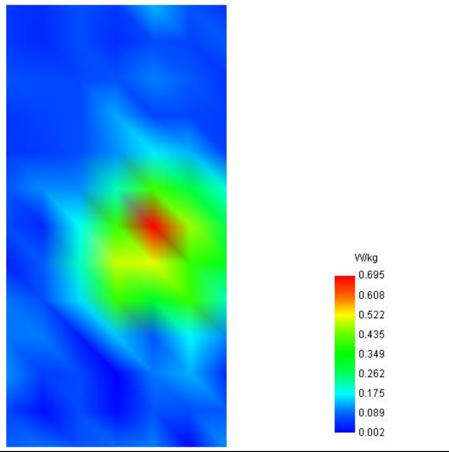
| | |
|---|---|
| SAR 10g (W/Kg) | 0.381 |
| SAR 1g (W/Kg) | 0.586 |
| Variation (%) | 2.720 |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%) | 0.000000 |

## E. Z Axis Scan

| | | | | | |
|---|---|---|---|---|---|
| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
| SAR (W/Kg) | 0.793 | 0.613 | 0.443 | 0.321 | 0.233 |




**F. 3D Image**

| 3D screen shot | Hot spot position |
|---|---|
|  |  |

# Plot 4

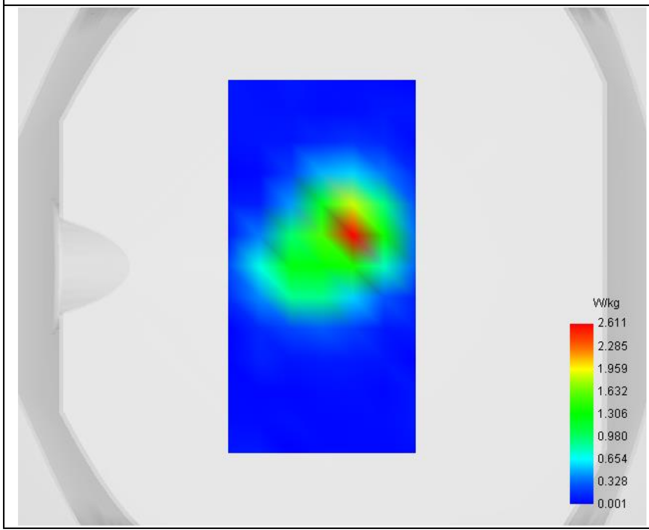
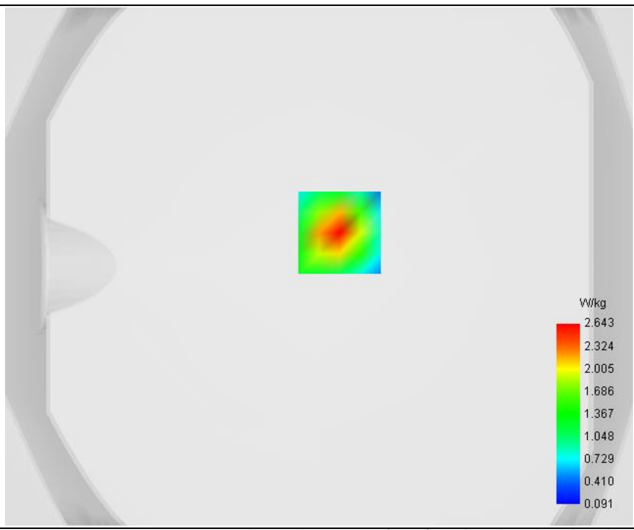
## A. Experimental conditions.

| | |
|---|---|
| Probe | SN 26/23 EPGO420 |
| ConvF | 0.81 |
| Area Scan | surf_sam_plan.txt |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Phantom | Validation plane |
| Device Position | Body |
| Band | Band5_WCDMA850 |
| Channels | Middle (4182) |
| Signal | WCDMA (Crest factor: 1.0) |

## B. Permitivity

| | |
|---|---|
| **Frequency (MHz)** | 836.400 |
| **Relative permitivity (real part)** | 39.972 |
| **Relative permitivity (imaginary part)** | 20.226 |
| **Conductivity (S/m)** | 0.911 |

## C. SAR Surface and Volume

| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |

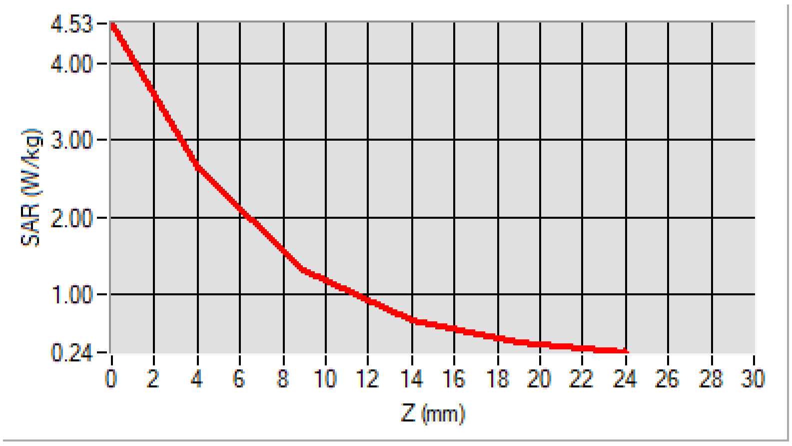
Maximum location: X=8.00, Y=13.00 ; SAR Peak: 4.54 W/kg

## D. SAR 1g & 10g

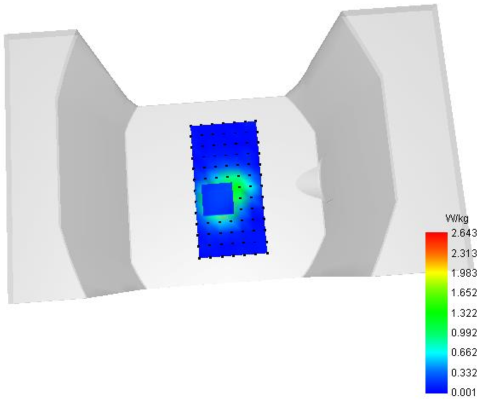
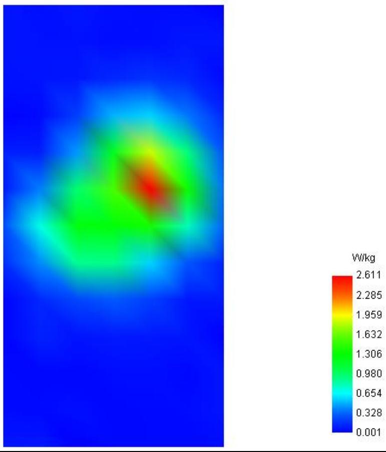
| | |
|---|---|
| SAR 10g (W/Kg) | 0.322 |
| SAR 1g (W/Kg) | 0.906 |
| Variation (%) | -1.850 |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%) | 0.000000 |

## E. Z Axis Scan

| | | | | | |
|---|---|---|---|---|---|
| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
| SAR (W/Kg) | 4.526 | 2.643 | 1.297 | 0.654 | 0.376 |




**F. 3D Image**

| 3D screen shot | Hot spot position |
|---|---|
|   |   |

# Plot 5

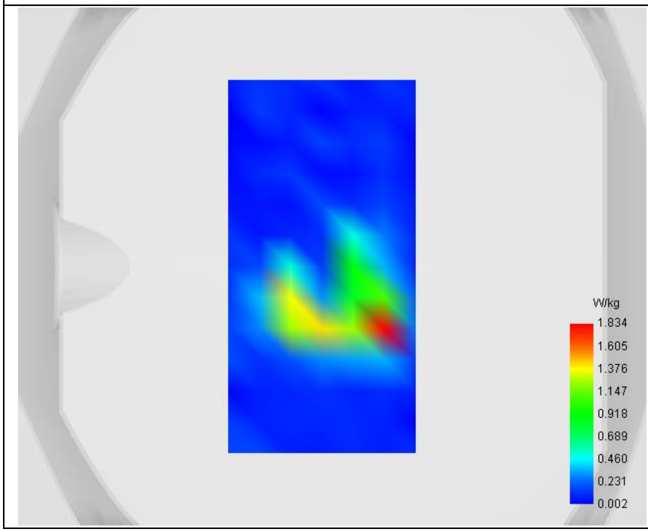
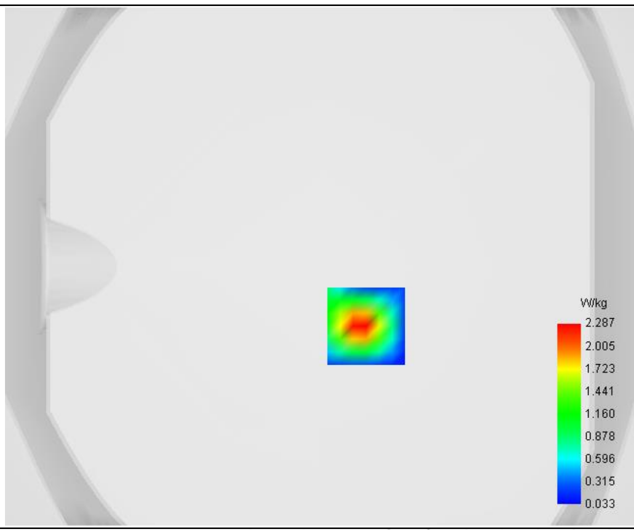
## A. Experimental conditions.

| | |
|---|---|
| Probe | SN 26/23 EPGO420 |
| ConvF | 1.11 |
| Area Scan | surf_sam_plan.txt |
| Zoom Scan | 7x7x7,dx=5mm dy=5mm dz=5mm |
| Phantom | Validation plane |
| Device Position | Body |
| Band | LTE band 7 |
| Channels | Lower (20850) |
| Signal | LTE (Crest factor: 1.0) |

## B. Permitivity

| | |
|---|---|
| **Frequency (MHz)** | 2510.000 |
| **Relative permitivity (real part)** | 37.976 |
| **Relative permitivity (imaginary part)** | 13.360 |
| **Conductivity (S/m)** | 1.895 |

## C. SAR Surface and Volume

| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |





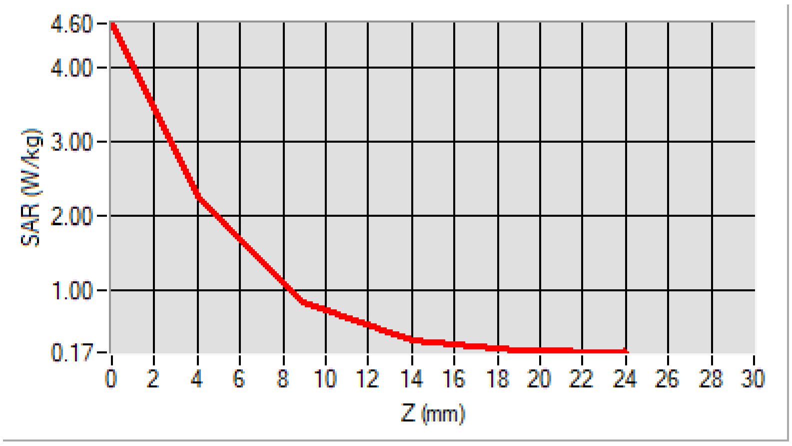
Maximum location: X=18.00, Y=-23.00 ; SAR Peak: 4.76 W/kg

## D. SAR 1g & 10g

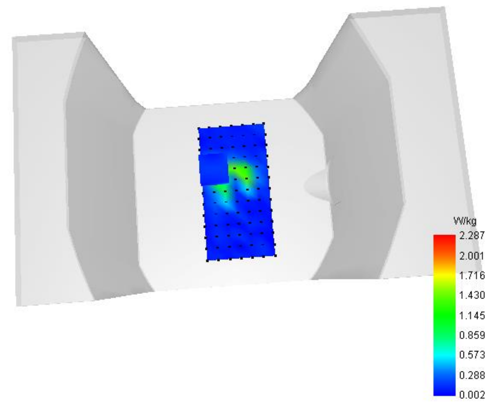
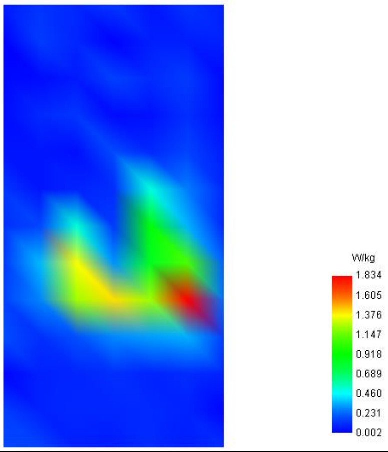
| | |
|---|---|
| SAR 10g (W/Kg) | 0.423 |
| SAR 1g (W/Kg) | 1.060 |
| Variation (%) | -1.400 |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%) | 0.000000 |

## E. Z Axis Scan

| | | | | | |
|---|---|---|---|---|---|
| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
| SAR (W/Kg) | 4.604 | 2.287 | 0.860 | 0.342 | 0.201 |




**F. 3D Image**

| 3D screen shot | Hot spot position |
|---|---|
|   |   |

# Plot 6

## A. Experimental conditions.

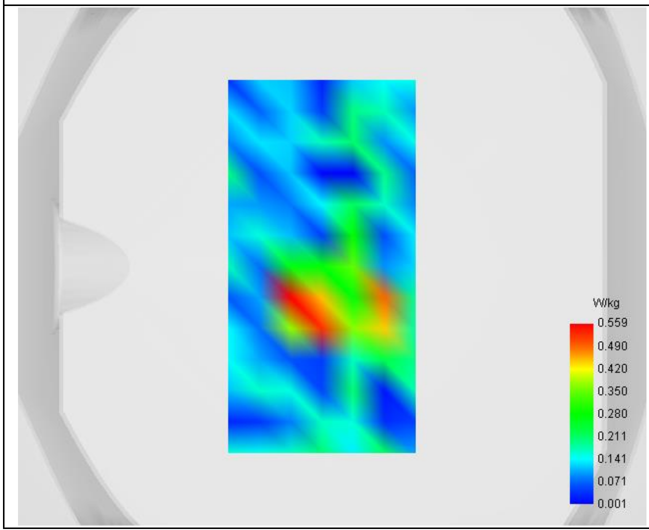
| | |
|---|---|
| Probe | SN 26/23 EPGO420 |
| ConvF | 1.03 |
| Area Scan | surf_sam_plan.txt |
| Zoom Scan | 7x7x7,dx=5mm dy=5mm dz=5mm |
| Phantom | Validation plane |
| Device Position | Body |
| Band | LTE band 38 |
| Channels | Higher (38200) |
| Signal | LTE (Crest factor: 1.0) |

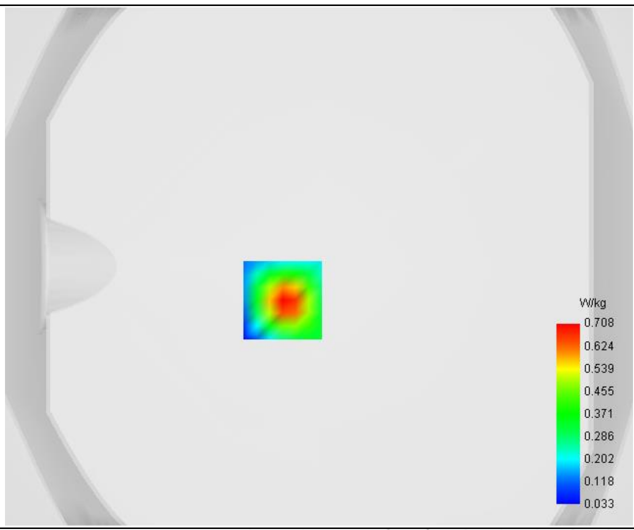
## B. Permitivity

| | |
|---|---|
| **Frequency (MHz)** | 2615.000 |
| **Relative permitivity (real part)** | 37.976 |
| **Relative permitivity (imaginary part)** | 13.601 |
| **Conductivity (S/m)** | 1.895 |

## C. SAR Surface and Volume

| SURFACE SAR | VOLUME SAR |
|---|---|



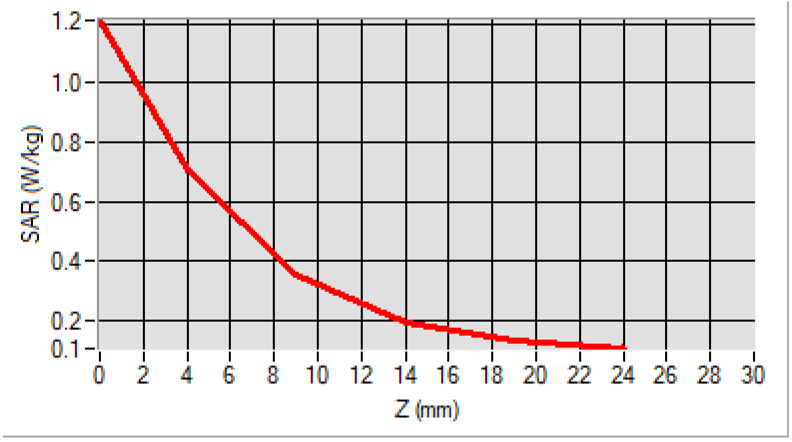

Maximum location: X=-14.00, Y=-13.00 ; SAR Peak: 1.22 W/kg

## D. SAR 1g & 10g

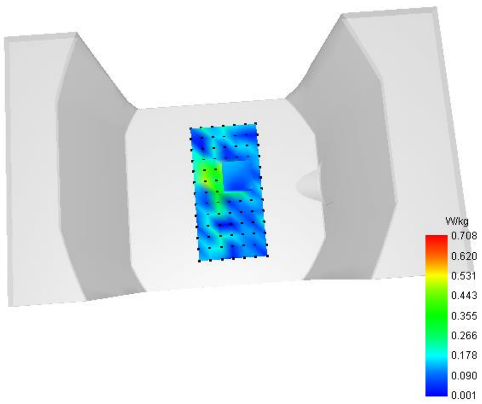
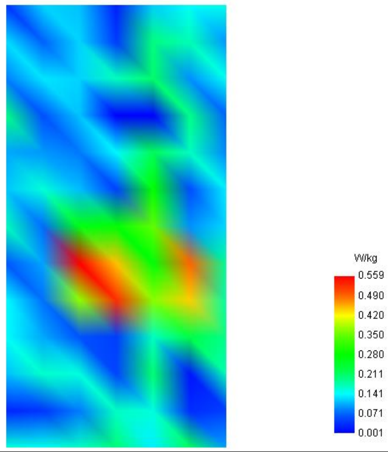
| | |
|---|---|
| SAR 10g (W/Kg) | 0.326 |
| SAR 1g (W/Kg) | 0.636 |
| Variation (%) | -0.580 |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%) | 0.000000 |

## E. Z Axis Scan

| | | | | | |
|---|---|---|---|---|---|
| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
| SAR (W/Kg) | 1.213 | 0.708 | 0.354 | 0.193 | 0.130 |




## F. 3D Image

| 3D screen shot | Hot spot position |
|---|---|
|   |   |

# Plot 7

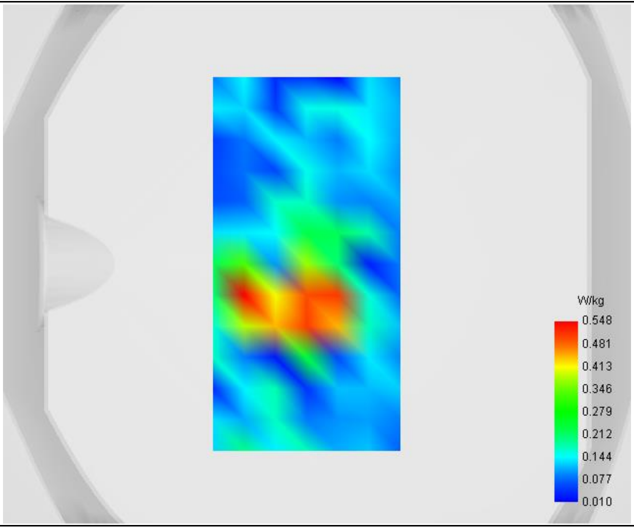
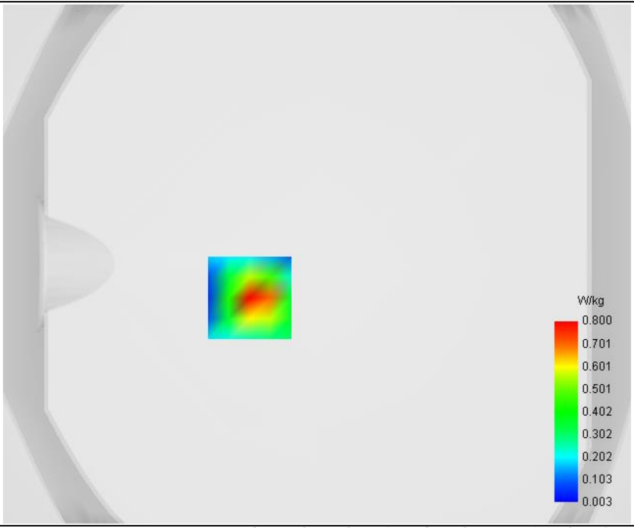
## A. Experimental conditions.

| | |
|---|---|
| Probe | SN 26/23 EPGO420 |
| ConvF | 1.03 |
| Area Scan | surf_sam_plan.txt |
| Zoom Scan | 5x5x7,dx=8mm dy=8mm dz=5mm |
| Phantom | Validation plane |
| Device Position | Body |
| Band | LTE band 41 |
| Channels | Higher (41540) |
| Signal | LTE (Crest factor: 1.0) |

## B. Permitivity

| | |
|---|---|
| **Frequency (MHz)** | 2685.000 |
| **Relative permitivity (real part)** | 37.976 |
| **Relative permitivity (imaginary part)** | 13.746 |
| **Conductivity (S/m)** | 1.895 |

## C. SAR Surface and Volume

| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |

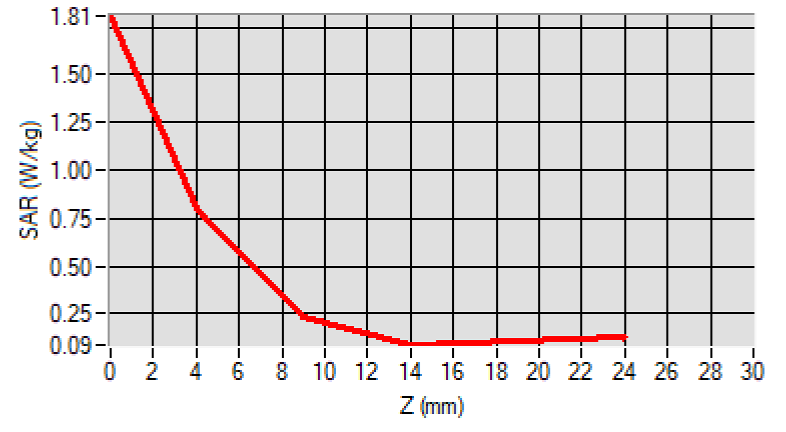
Maximum location: X=-26.00, Y=-13.00 ; SAR Peak: 1.94 W/kg

## D. SAR 1g & 10g

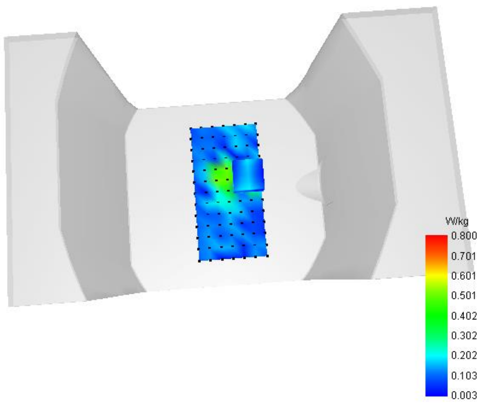
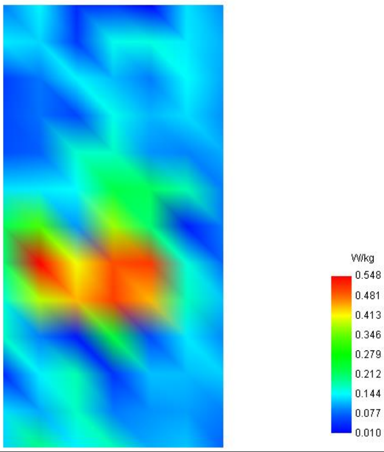
| | |
|---|---|
| SAR 10g (W/Kg) | 0.347 |
| SAR 1g (W/Kg) | 0.684 |
| Variation (%) | -1.700 |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%) | 0.000000 |

## E. Z Axis Scan

| | | | | | |
|---|---|---|---|---|---|
| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
| SAR (W/Kg) | 1.810 | 0.800 | 0.230 | 0.085 | 0.102 |




**F. 3D Image**

| 3D screen shot | Hot spot position |
| --- | --- |
|  |  |

# Plot 8

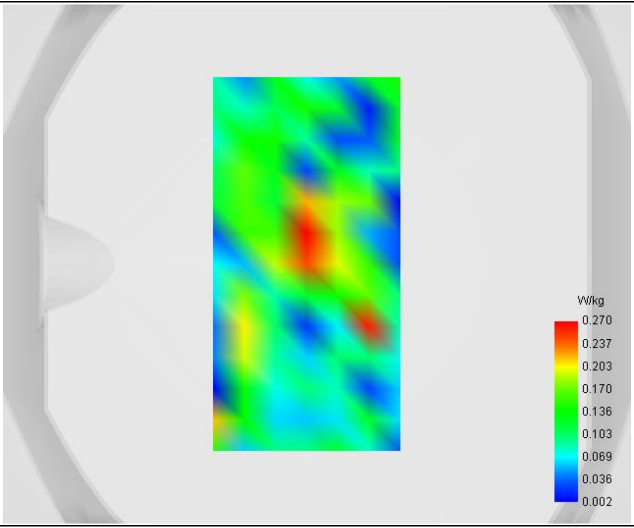
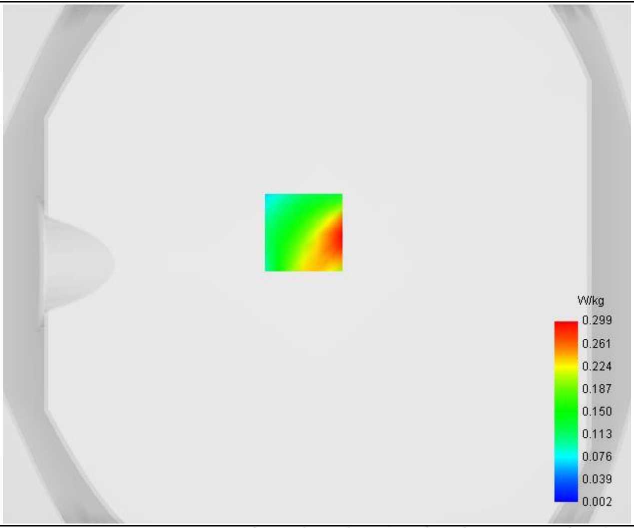
## A. Experimental conditions.

| | |
|---|---|
| Probe | SN 26/23 EPGO420 |
| ConvF | 1.11 |
| Area Scan | surf_sam_plan.txt |
| Zoom Scan | 7x7x7,dx=5mm dy=5mm dz=5mm |
| Phantom | Validation plane |
| Device Position | Body |
| Band | IEEE 802.11b ISM |
| Channels | Higher (13) |
| Signal | IEEE802.b (Crest factor: 1.0) |

## B. Permitivity

| | |
|---|---|
| **Frequency (MHz)** | 2472.000 |
| **Relative permitivity (real part)** | 38.946 |
| **Relative permitivity (imaginary part)** | 13.271 |
| **Conductivity (S/m)** | 1.800 |

## C. SAR Surface and Volume

| SURFACE SAR | VOLUME SAR |
|---|---|
|  |  |

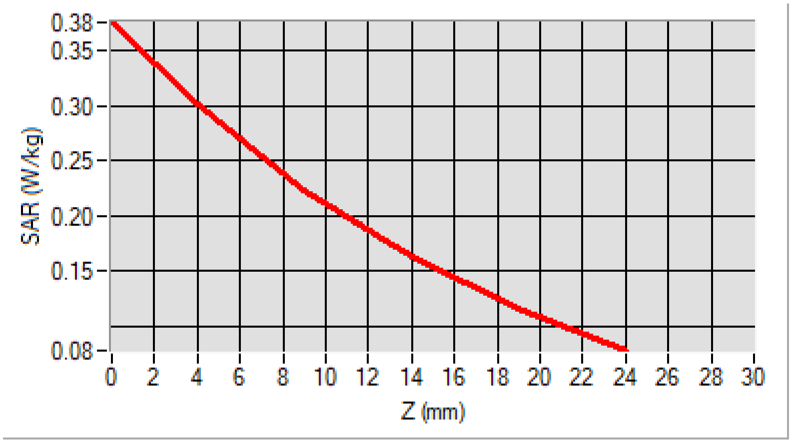
Maximum location: X=-5.00, Y=12.00 ; SAR Peak: 0.88 W/kg

## D. SAR 1g & 10g

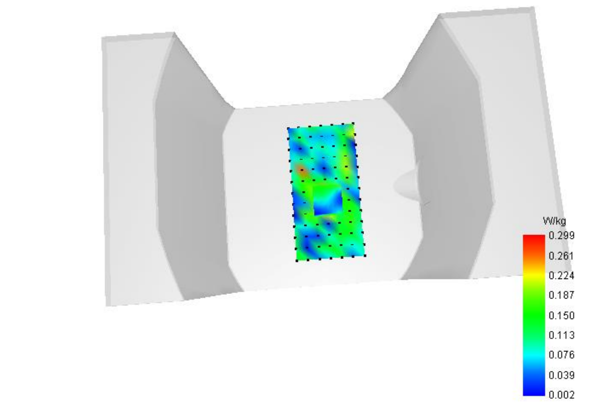
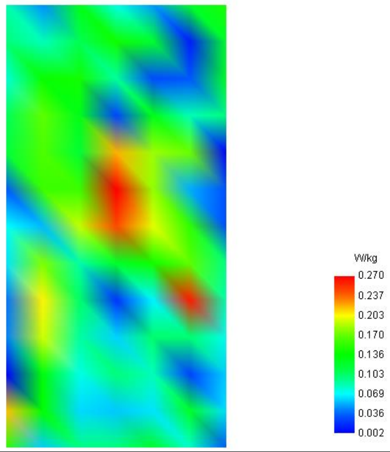
| | |
|---|---|
| SAR 10g (W/Kg) | 0.177 |
| SAR 1g (W/Kg) | 0.295 |
| Variation (%) | 1.940 |
| Horizontal validation criteria: minimum distance (mm) | 0.000000 |
| Vertical validation criteria: SAR ratio M2/M1 (%) | 0.000000 |

## E. Z Axis Scan

| | | | | | |
|---|---|---|---|---|---|
| Z (mm) | 0.00 | 4.00 | 9.00 | 14.00 | 19.00 |
| SAR (W/Kg) | -0.155 | 0.299 | 0.168 | 0.006 | 0.079 |




**F. 3D Image**

| 3D screen shot | Hot spot position |
| --- | --- |
|   |   |

## 16. CALIBRATION CERTIFICATES

**Probe-EPGO420 Calibration Certificate**
**SID835Dipole Calibration Ceriticate**
**SID1900Dipole Calibration Ceriticate**
**SID2450Dipole Calibration Ceriticate**
**SID2600Dipole Calibration Ceriticate**

# COMOSAR E-Field Probe Calibration Report

Ref : ACR.199.1.23.BES.A

**SHENZHEN BCTC TECHNOLOGY CO., LTD.**
**1 ~2/ F, NO. B FACTORY BUILDING, PENGZHOU INDUSTRIAL PARK, FUYUAN 1ST ROAD, TANGWEI COMMUNITY, FUHAI STREET, BAO'AN DISTRICT, SHENZHEN, GUANGDONG,CHINA**
**MVG COMOSAR DOSIMETRIC E-FIELD PROBE**
**SERIAL NO.: 2623-EPGO-420**

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

**Calibration date: 7/18/2023**

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



*Summary:*

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

*Page: 1/11*

| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Cyrille ONNEE | Measurement Responsible | 7/18/2023 | |
| *Checked & approved by:* | Jérôme Luc | Technical Manager | 7/18/2023 | |
| *Authorized by:* | Yann Toutain | Laboratory Director | 7/18/2023 | Yann TOUTAIN |

Yann Toutain ID
Signature numérique de Yann Toutain ID
Date : 2023.07.18 10:38:49 +02'00'

| | *Customer Name* |
|---|---|
| *Distribution :* | Shenzhen BCTC Technology Co., Ltd. |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Cyrille ONNEE | 7/18/2023 | Initial release |
| | | | |
| | | | |
| | | | |

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## 1 DEVICE UNDER TEST

| Device Under Test | |
|---|---|
| Device Type | COMOSAR DOSIMETRIC E FIELD PROBE |
| Manufacturer | MVG |
| Model | SSE2 |
| Serial Number | 2623-EPGO-420 |
| Product Condition (new / used) | New |
| Frequency Range of Probe | 0.15 GHz-7.5GHz |
| Resistance of Three Dipoles at Connector | Dipole 1: R1=0.228 MΩ<br>Dipole 2: R2=0.238 MΩ<br>Dipole 3: R3=0.230 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 | 24.5 mm |
| Maximum external diameter | 8 mm |
| Probe Tip External Diameter | 2.55 mm |
| Distance between dipoles / probe extremity | 12.7 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 effect. All calibrations / measurements performed meet the fore-mentioned standards.

### 3.1 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 for frequency range 600-7500MHz and using the calorimeter cell method (transfer method) as outlined in the standards for frequency 150-450 MHz.

### 3.2 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.

### 3.3 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°).

### 3.4 BOUNDARY EFFECT

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

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

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

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., $\delta \approx$ 14 mm at 3 GHz; |
| $\Delta SAR_{be}$ | in percent of SAR is the deviation between the measured SAR value, at the distance $d_{be}$ from the boundary, and the analytical SAR value. |

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

## 4 MEASUREMENT UNCERTAINTY

The guidelines outlined in the IEC/IEEE 62209-1528 and FCC KDB865664 D01 standards were followed to generate the measurement uncertainty associated with a SAR probe calibration using the waveguide or calorimetric cell technique depending on the frequency.

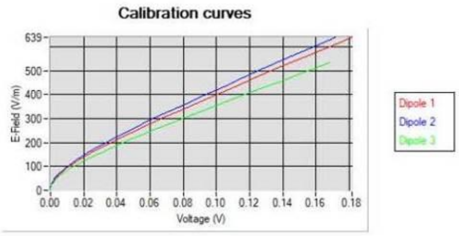
The estimated expanded uncertainty (k=2) in calibration for SAR (W/kg) is +/-11% for the frequency range 150-450MHz.
The estimated expanded uncertainty (k=2) in calibration for SAR (W/kg) is +/-14% for the frequency range 600-7500MHz.

## 5 CALIBRATION RESULTS

| Ambient condition | |
|---|---|
| Liquid Temperature | 20 +/- 1 °C |
| Lab Temperature | 20 +/- 1 °C |
| Lab Humidity | 30-70 % |

### 5.1 CALIBRATION IN AIR

The following curve represents the measurement in waveguide of the voltage picked up by the probe toward the E-field generated inside the waveguide.




From this curve, the sensitivity in air is calculated using the below formula.

$$E^2 = \sum_{i=1}^{3} \frac{V_i\,(1 + V_i/DCP_i)}{Norm_i}$$

where
Vi=voltage readings on the 3 channels of the probe
DCPi=diode compression point given below for the 3 channels of the probe
Normi=dipole sensitivity given below for the 3 channels of the probe

| Normx dipole 1 ($\mu V/(V/m)^2$) | Normy dipole 2 ($\mu V/(V/m)^2$) | Normz dipole 3 ($\mu V/(V/m)^2$) |
|---|---|---|
| 1.21 | 1.09 | 1.56 |

| DCP dipole 1 (mV) | DCP dipole 2 (mV) | DCP dipole 3 (mV) |
|---|---|---|
| 106 | 109 | 103 |

### 5.2 CALIBRATION IN LIQUID

The calorimeter cell or the waveguide is used to determine the calibration in liquid using the formula below.

$$ConvF = \frac{E_{liquid}^2}{E_{air}^2}$$

The E-field in the liquid is determined from the SAR measurement according to the below formula.

$$E_{liquid}^2 = \frac{\rho\, SAR}{\sigma}$$

where
σ=the conductivity of the liquid
ρ=the volumetric density of the liquid
SAR=the SAR measured from the formula that depends on the setup used. The SAR formulas are given below

For the calorimeter cell (150-450 MHz), the formula is:

$$SAR = c\frac{dT}{dt}$$

where
c=the specific heat for the liquid
dT/dt=the temperature rises over the time

For the waveguide setup (600-75000 MHz), the formula is:

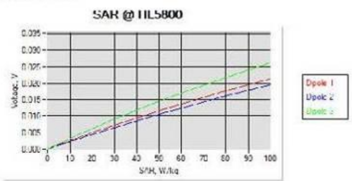
$$SAR = \frac{4P_W}{ab\delta}e^{\frac{-2z}{\delta}}$$

where
a=the larger cross-sectional of the waveguide
b=the smaller cross-sectional of the waveguide
δ=the skin depth for the liquid in the waveguide
Pw=the power delivered to the liquid

The below table summarize the ConvF for the calibrated liquid. The curves give examples for the measured SAR depending on the voltage in some liquid.

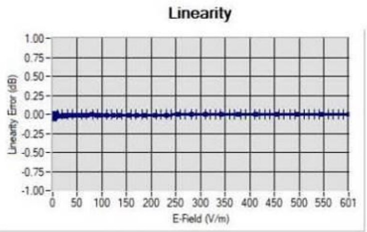
| Liquid | Frequency (MHz*) | ConvF |
|---|---|---|
| HL450 | 450 | 0.86 |
| BL450 | 450 | 0.78 |
| HL750 | 750 | 0.80 |
| BL750 | 750 | 0.87 |
| HL850 | 835 | 0.81 |
| BL850 | 835 | 0.80 |
| HL900 | 900 | 0.76 |
| BL900 | 900 | 0.87 |
| HL1800 | 1800 | 0.96 |
| BL1800 | 1800 | 1.01 |
| HL1900 | 1900 | 1.04 |
| BL1900 | 1900 | 1.11 |
| HL2100 | 2100 | 1.00 |
| BL2100 | 2100 | 1.16 |
| HL2300 | 2300 | 1.11 |
| BL2300 | 2300 | 1.23 |
| HL2450 | 2450 | 1.11 |
| BL2450 | 2450 | 1.32 |
| HL2600 | 2600 | 1.03 |
| BL2600 | 2600 | 1.19 |
| HL5200 | 5200 | 1.18 |
| BL5200 | 5200 | 0.97 |
| HL5400 | 5400 | 1.17 |
| BL5400 | 5400 | 1.00 |
| HL5600 | 5600 | 1.20 |
| BL5600 | 5600 | 0.95 |
| HL5800 | 5800 | 1.15 |
| BL5800 | 5800 | 1.05 |

(*) Frequency validity is +/-50MHz below 600MHz, +/-100MHz from 600MHz to 6GHz and +/-700MHz above 6GHz

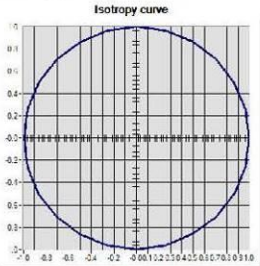



## 6 VERIFICATION RESULTS

The figures below represent the measured linearity and axial isotropy for this probe. The probe specification is +/-0.2 dB for linearity and +/-0.15 dB for axial isotropy.




Linearity:+/-1.48% (+/-0.06dB)




Isotropy:+/-0.25% (+/-0.01dB)

## 7 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 | 08/2021 | 08/2024 |
| Network Analyzer | Agilent 8753ES | MY40003210 | 10/2019 | 10/2023 |
| Network Analyzer – Calibration kit | HP 85033D | 3423A08186 | 06/2021 | 06/2027 |
| Network Analyzer – Calibration kit | Rohde & Schwarz ZV-Z235 | 101223 | 07/2022 | 07/2025 |
| 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. |
| Fluoroptic Thermometer | LumaSense Luxtron 812 | 94264 | 09/2022 | 09/2025 |
| Coaxial cell | MVG | SN 32/16 COAXCELL_1 | Validated. No cal required. | Validated. No cal required. |
| Waveguide | MVG | SN 32/16 WG2_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_0G600_1 | Validated. No cal required. | Validated. 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. |
| 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. |
| Waveguide | MVG | SN 32/16 WG14_1 | Validated. No cal required. | Validated. No cal required. |
| Liquid transition | MVG | SN 32/16 WGLIQ_7G000_1 | Validated. No cal required. | Validated. No cal required. |
| Temperature / Humidity Sensor | Testo 184 H1 | 44225320 | 06/2021 | 06/2024 |

# SAR Reference Dipole Calibration Report

Ref : ACR.329.9.21.BES.A

**SHENZHEN BCTC TECHNOLOGY CO., LTD.**
**1 ~2/ F, NO. B FACTORY BUILDING, PENGZHOU INDUSTRIAL PARK, FUYUAN 1ST ROAD, TANGWEI COMMUNITY, FUHAI STREET, BAO'AN DISTRICT, SHENZHEN, GUANGDONG,CHINA**
**MVG COMOSAR REFERENCE DIPOLE**
**FREQUENCY: 835 MHZ**
**SERIAL NO.: SN 47/21 DIP 0G835-621**

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

**Calibration date: 11/25/2021**

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



*Summary:*

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

| | *Name* | *Function* | *Date* | *Signature* |
|---|---|---|---|---|
| *Prepared by :* | Jérôme Luc | Technical Manager | 11/25/2021 | JS |
| *Checked by :* | Jérôme Luc | Technical Manager | 11/25/2021 | JS |
| *Approved by :* | Yann Toutain | Laboratory Director | 11/25/2021 | Yann TOUTAIN 2021.11.25 11:52:29 +01'00' |

| | *Customer Name* |
|---|---|
| *Distribution :* | Shenzhen BCTC Technology Co., Ltd. |

| *Issue* | *Name* | *Date* | *Modifications* |
|---|---|---|---|
| A | Jérôme Luc | 11/25/2021 | Initial release |
| | | | |
| | | | |
| | | | |

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# 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 835 MHz REFERENCE DIPOLE |
| Manufacturer | MVG |
| Model | SID835 |
| Serial Number | SN 47/21 DIP 0G835-621 |
| Product Condition (new / used) | New |

# 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*

## 4 MEASUREMENT METHOD

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.

### 4.1 RETURN LOSS REQUIREMENTS

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

### 4.2 MECHANICAL REQUIREMENTS

The 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.

## 5 MEASUREMENT UNCERTAINTY

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

### 5.1 RETURN LOSS

The following uncertainties apply to the return loss measurement:

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

### 5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

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

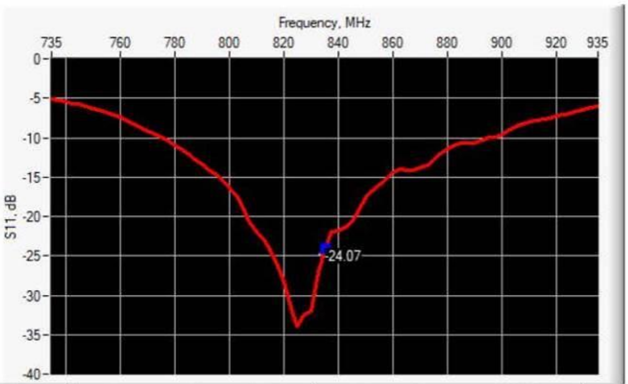
### 5.3 VALIDATION MEASUREMENT

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

| Scan Volume | Expanded Uncertainty |
|---|---|
| 1 g | 19 % (SAR) |
| 10 g | 19 % (SAR) |

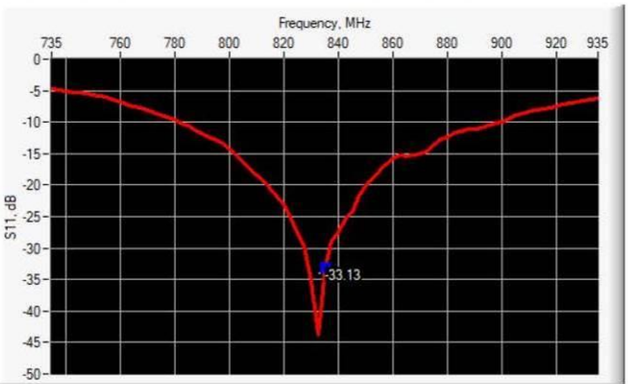
## 6 CALIBRATION MEASUREMENT RESULTS

### 6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 835 | -24.07 | -20 | 55.3 Ω - 3.3 jΩ |

### 6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID




| Frequency (MHz) | Return Loss (dB) | Requirement (dB) | Impedance |
|---|---|---|---|
| 835 | -33.13 | -20 | 52.2 Ω - 0.4 jΩ |

### 6.3 MECHANICAL DIMENSIONS

| Frequency MHz | L mm | | h mm | | d mm | |
|---|---|---|---|---|---|---|
| | required | measured | required | measured | required | measured |
| 300 | 420.0 ±1 %. | | 250.0 ±1 %. | | 6.35 ±1 %. | |
| 450 | 290.0 ±1 %. | | 166.7 ±1 %. | | 6.35 ±1 %. | |
| 750 | 176.0 ±1 %. | | 100.0 ±1 %. | | 6.35 ±1 %. | |
| 835 | 161.0 ±1 %. | 161.47 | 89.8 ±1 %. | 89.78 | 3.6 ±1 %. | 3.61 |
| 900 | 149.0 ±1 %. | | 83.3 ±1 %. | | 3.6 ±1 %. | |
| 1450 | 89.1 ±1 %. | | 51.7 ±1 %. | | 3.6 ±1 %. | |
| 1500 | 86.2 ±1 %. | | 50.0 ±1 %. | | 3.6 ±1 %. | |
| 1640 | 79.0 ±1 %. | | 45.7 ±1 %. | | 3.6 ±1 %. | |
| 1750 | 75.2 ±1 %. | | 42.9 ±1 %. | | 3.6 ±1 %. | |
| 1800 | 72.0 ±1 %. | | 41.7 ±1 %. | | 3.6 ±1 %. | |
| 1900 | 68.0 ±1 %. | | 39.5 ±1 %. | | 3.6 ±1 %. | |
| 1950 | 66.3 ±1 %. | | 38.5 ±1 %. | | 3.6 ±1 %. | |
| 2000 | 64.5 ±1 %. | | 37.5 ±1 %. | | 3.6 ±1 %. | |
| 2100 | 61.0 ±1 %. | | 35.7 ±1 %. | | 3.6 ±1 %. | |
| 2300 | 55.5 ±1 %. | | 32.6 ±1 %. | | 3.6 ±1 %. | |
| 2450 | 51.5 ±1 %. | | 30.4 ±1 %. | | 3.6 ±1 %. | |
| 2600 | 48.5 ±1 %. | | 28.8 ±1 %. | | 3.6 ±1 %. | |
| 3000 | 41.5 ±1 %. | | 25.0 ±1 %. | | 3.6 ±1 %. | |
| 3300 | - | | - | | - | |
| 3500 | 37.0±1 %. | | 26.4 ±1 %. | | 3.6 ±1 %. | |
| 3700 | 34.7±1 %. | | 26.4 ±1 %. | | 3.6 ±1 %. | |
| 3900 | - | | - | | - | |
| 4200 | - | | - | | - | |
| 4600 | - | | - | | - | |
| 4900 | - | | - | | - | |

## 7 VALIDATION MEASUREMENT

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.

## 7.1 HEAD LIQUID MEASUREMENT

| Frequency MHz | Relative permittivity ($\varepsilon_r'$) | | Conductivity ($\sigma$) S/m | |
|---|---|---|---|---|
| | required | measured | required | measured |
| 300 | 45.3 ±10 % | | 0.87 ±10 % | |
| 450 | 43.5 ±10 % | | 0.87 ±10 % | |
| 750 | 41.9 ±10 % | | 0.89 ±10 % | |
| 835 | 41.5 ±10 % | 39.9 | 0.90 ±10 % | 0.91 |
| 900 | 41.5 ±10 % | | 0.97 ±10 % | |
| 1450 | 40.5 ±10 % | | 1.20 ±10 % | |
| 1500 | 40.4 ±10 % | | 1.23 ±10 % | |
| 1640 | 40.2 ±10 % | | 1.31 ±10 % | |
| 1750 | 40.1 ±10 % | | 1.37 ±10 % | |
| 1800 | 40.0 ±10 % | | 1.40 ±10 % | |
| 1900 | 40.0 ±10 % | | 1.40 ±10 % | |
| 1950 | 40.0 ±10 % | | 1.40 ±10 % | |
| 2000 | 40.0 ±10 % | | 1.40 ±10 % | |
| 2100 | 39.8 ±10 % | | 1.49 ±10 % | |
| 2300 | 39.5 ±10 % | | 1.67 ±10 % | |
| 2450 | 39.2 ±10 % | | 1.80 ±10 % | |
| 2600 | 39.0 ±10 % | | 1.96 ±10 % | |
| 3000 | 38.5 ±10 % | | 2.40 ±10 % | |
| 3300 | 38.2 ±10 % | | 2.71 ±10 % | |
| 3500 | 37.9 ±10 % | | 2.91 ±10 % | |
| 3700 | 37.7 ±10 % | | 3.12 ±10 % | |
| 3900 | 37.5 ±10 % | | 3.32 ±10 % | |
| 4200 | 37.1 ±10 % | | 3.63 ±10 % | |
| 4600 | 36.7 ±10 % | | 4.04 ±10 % | |
| 4900 | 36.3 ±10 % | | 4.35 ±10 % | |

## 7.2 SAR MEASUREMENT RESULT 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.