

3# SAR Measurement at U-NII-1 (Body, Validation Plane)

Date of measurement: 27/2/2025

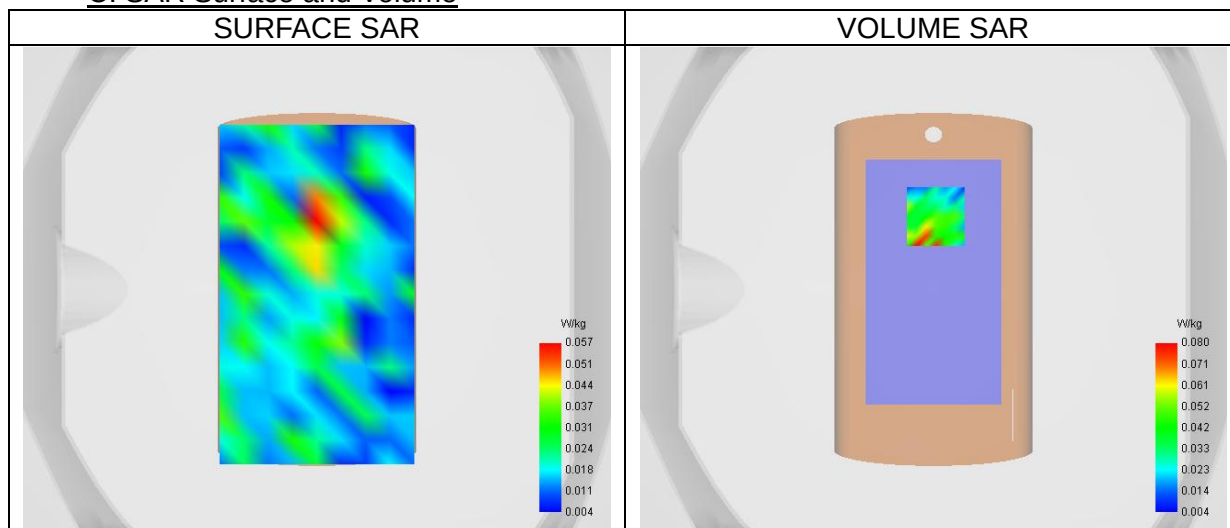
A. Experimental conditions.

Probe	4024-EPGO-442
ConvF	1.89
Area Scan	dx=10mm dy=10mm, Complete
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2.0mm,Complete
Phantom	Validation plane
Device Position	Body
Band	U-NII-1
Signal	IEEE 802.11 n
Channels/Frequency	Middle (46)/ frequency 5200.00 Mhz

B. Permittivity

Middle TX Frequency (MHz)	5230.00
Relative permittivity (real part)	37.19
Relative permittivity (imaginary part)	15.92
Conductivity (S/m)	4.63

C. SAR Surface and Volume



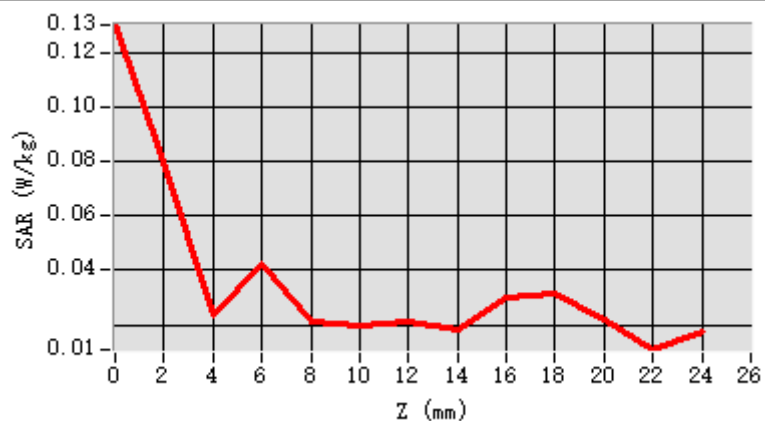
Maximum location: X=1.00, Y=30.00 ; SAR Peak: 0.17 W/kg

D. SAR 1g & 10g

SAR 10g (W/Kg)	0.024
SAR 1g (W/Kg)	0.054
Variation (%)	-2.90
Horizontal validation criteria: minimum distance (mm)	8.00
Vertical validation criteria: SAR ratio M2/M1 (%)	65.15

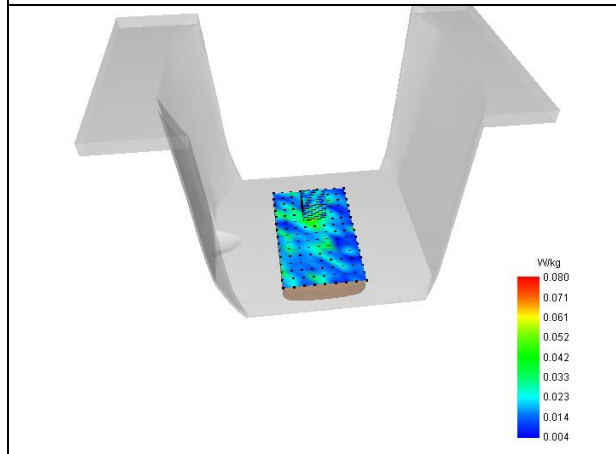
E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.0	12.0	14.0	16.0	18.0	20.0	22.0
						0	0	0	0	0	0	0
SAR (W/Kg)	0.13	0.08	0.02	0.04	0.02	0.02	0.02	0.01	0.03	0.03	0.02	0.01
	0	0	3	3	1	0	1	8	0	1	2	1

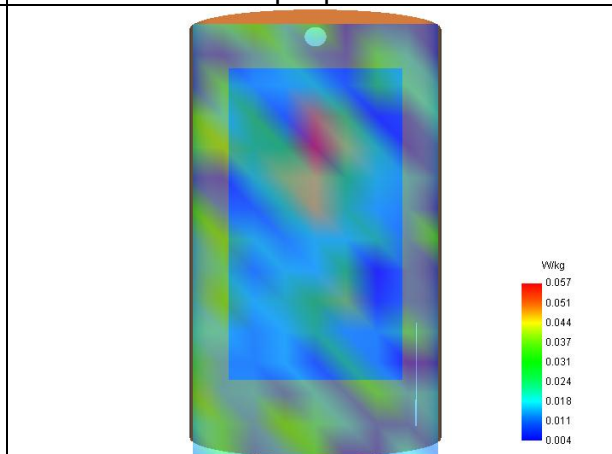


F. 3D Image

3D screen shot



Hot spot position



4# SAR Measurement at U-NII-3 (Body, Validation Plane)

Date of measurement: 28/2/2025

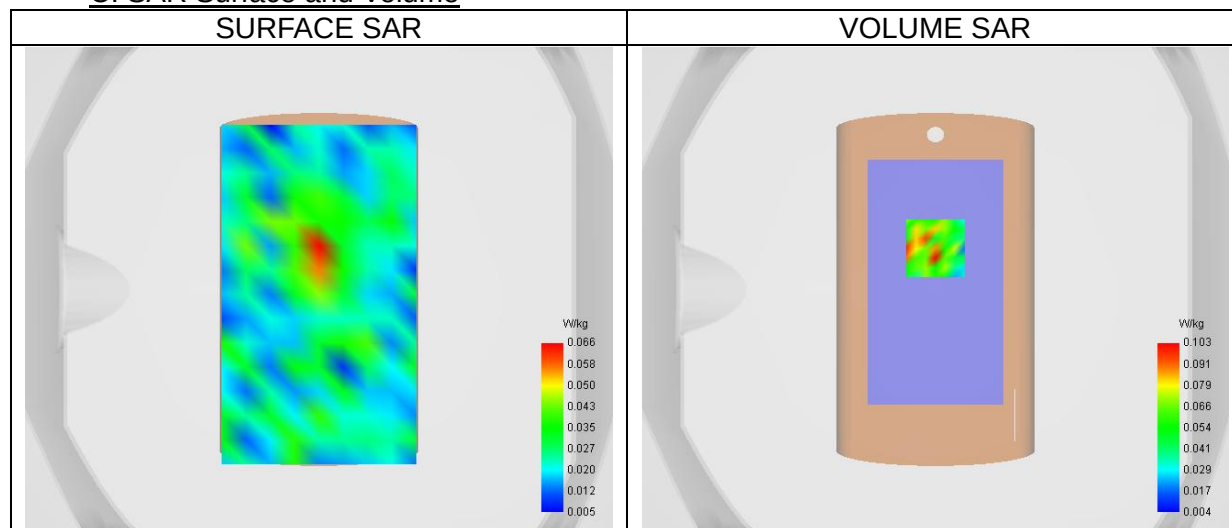
A. Experimental conditions.

Probe	4024-EPGO-442
ConvF	1.90
Area Scan	dx=10mm dy=10mm, Complete
Zoom Scan	7x7x12,dx=4mm dy=4mm dz=2.0mm,Complete
Phantom	Validation plane
Device Position	Body
Band	U-NII-3
Signal	IEEE 802.11 ac
Channels/Frequency	Middle (159)/ frequency 5795.00 Mhz

B. Permittivity

Middle TX Frequency (MHz)	5795.00
Relative permittivity (real part)	36.32
Relative permittivity (imaginary part)	15.94
Conductivity (S/m)	5.12

C. SAR Surface and Volume



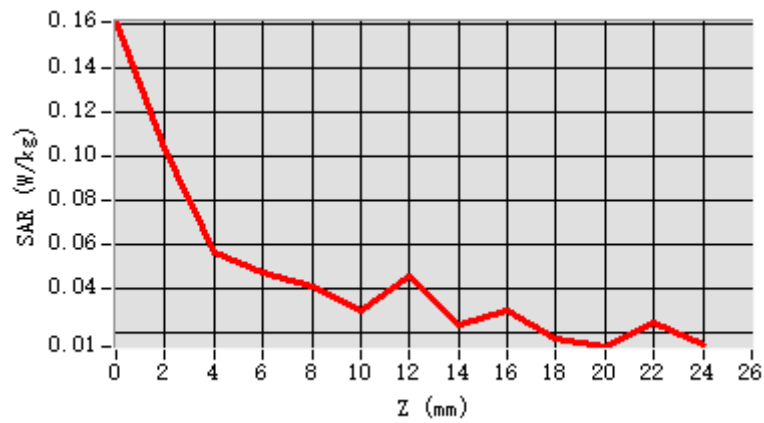
Maximum location: X=0.00, Y=17.00 ; SAR Peak: 0.35 W/kg

D. SAR 1g & 10g

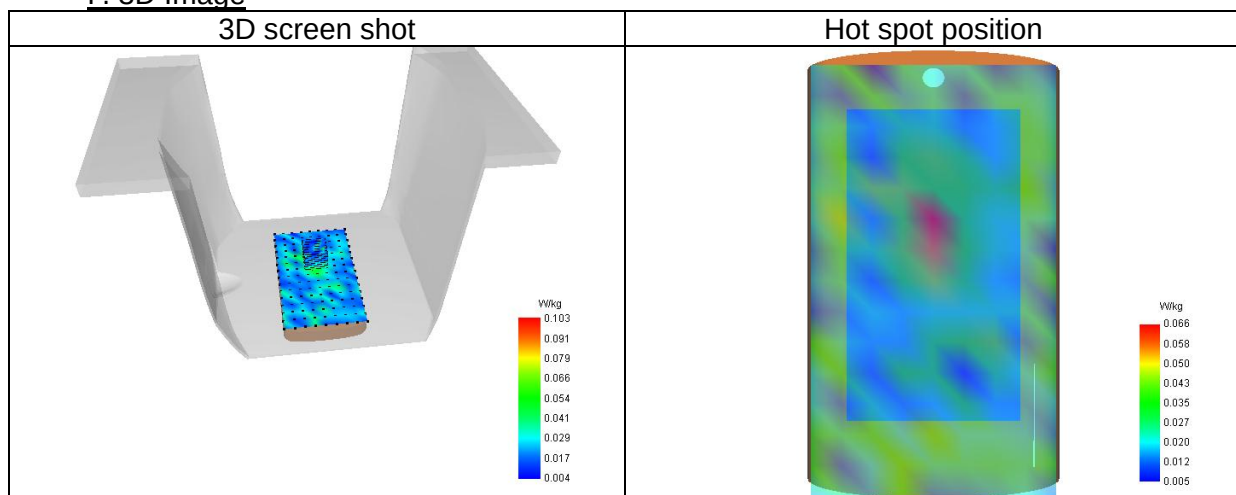
SAR 10g (W/Kg)	0.031
SAR 1g (W/Kg)	0.061
Variation (%)	-4.50
Horizontal validation criteria: minimum distance (mm)	8.00
Vertical validation criteria: SAR ratio M2/M1 (%)	82.82

E. Z Axis Scan

Z (mm)	0.00	2.00	4.00	6.00	8.00	10.0	12.0	14.0	16.0	18.0	20.0	22.0
						0	0	0	0	0	0	0
SAR (W/Kg)	0.16	0.10	0.05	0.04	0.04	0.03	0.04	0.02	0.03	0.01	0.01	0.02
	1	3	7	8	1	0	6	4	0	8	4	4



F. 3D Image



5# SAR Measurement at ISM (Body, Validation Plane)

Date of measurement: 26/2/2025

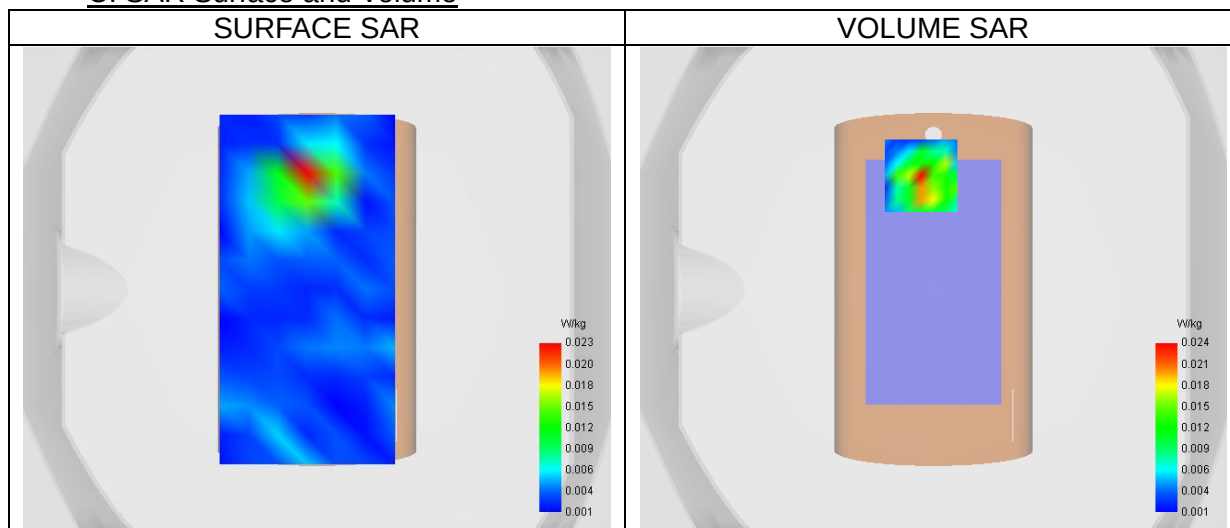
A. Experimental conditions.

Probe	4024-EPGO-442
ConvF	2.74
Area Scan	dx=12mm dy=12mm, Complete
Zoom Scan	7x7x7,dx=5mm dy=5mm dz=5.0mm,Complete
Phantom	Validation plane
Device Position	Body
Band	ISM
Signal	IEEE 802.11 b
Channels/Frequency	Middle (6)/ frequency 2437.00 Mhz

B. Permittivity

Middle TX Frequency (MHz)	2437.00
Relative permittivity (real part)	38.25
Relative permittivity (imaginary part)	12.92
Conductivity (S/m)	1.75

C. SAR Surface and Volume



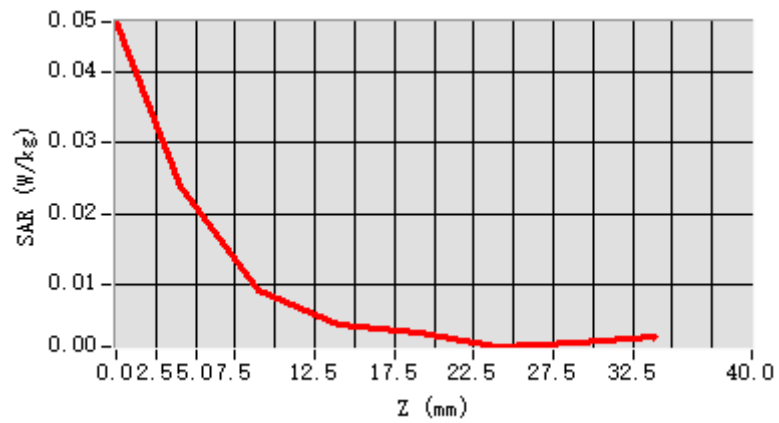
Maximum location: X=-5.00, Y=47.00 ; SAR Peak: 0.05 W/kg

D. SAR 1g & 10g

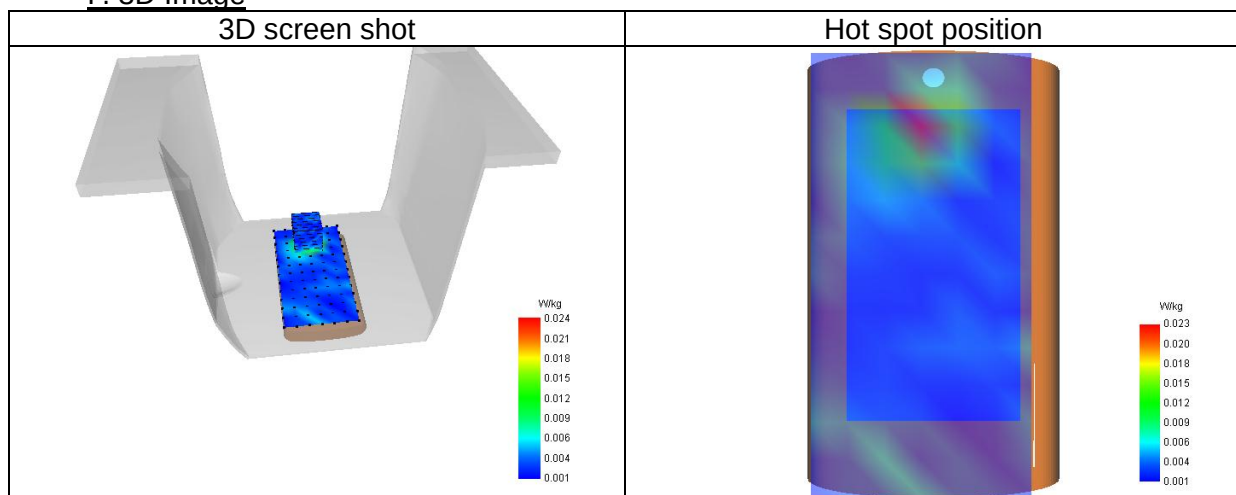
SAR 10g (W/Kg)	0.008
SAR 1g (W/Kg)	0.016
Variation (%)	0.54
Horizontal validation criteria: minimum distance (mm)	7.07
Vertical validation criteria: SAR ratio M2/M1 (%)	69.57

E. Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.047	0.024	0.009	0.004	0.003	0.001	0.002



F. 3D Image



13. Appendix D. Calibration Certificate

Table of contents
E Field Probe - 4024-EPGO-442
2450 MHz Dipole - SN 03/15 DIP 2G450-352
5000-6000 MHz Dipole - SN 13/14 WGA 33

Docusign Envelope ID: 223C1A7C-4751-4B95-8502-1618DC0951E3



COMOSAR E-Field Probe Calibration Report

Ref : ACR.278.12.24.BES.A

**SHENZHEN NTEK TESTING TECHNOLOGY
CO., LTD.**

**BUILDING E, FENDA SCIENCE PARK, SANWEI
COMMUNITY, XIXIANG STREET,
BAO'AN DISTRICT, SHENZHEN GUANGDONG, CHINA
MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: 4024-EPGO-442**

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 10/04/2024



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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).

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	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Cyrille ONNEE	Measurement Responsible	10/4/2024	
<i>Checked & approved by:</i>	Pedro Ruiz	Technical Manager	10/4/2024	
<i>Authorized by:</i>	Pedro Ruiz	Laboratory Director	10/4/2024	

Assinado por:
Pedro RUIZ
 29093B31C46F428...

	<i>Customer Name</i>
<i>Distribution :</i>	SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

<i>Issue</i>	<i>Name</i>	<i>Date</i>	<i>Modifications</i>
A	Cyrille ONNEE	10/4/2024	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	4024-EPGO-442
Product Condition (new / used)	New
Frequency Range of Probe	0.15 GHz-7.5GHz
Resistance of Three Dipoles at Connector	Dipole 1: $R1=0.206 \text{ M}\Omega$ Dipole 2: $R2=0.223 \text{ M}\Omega$ Dipole 3: $R3=0.235 \text{ M}\Omega$

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 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.

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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:

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

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

Δ_{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., $\delta \approx 14 \text{ mm}$ at 3 GHz;

ΔSAR_{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%).

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3.5 PROBE MODULATION RESPONSE

MVG's probe were evaluated experimentally with various modulated signal and the deviation from CW response were found neglectable in the used power range of the probe. So the correction to taking into account the linearization parameters for different modulation is null, therefore the CW factor given in this report can be used whatever the measured modulation

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.

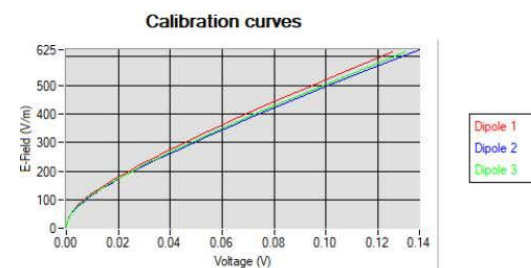
The estimated expanded uncertainty (k=2) in calibration for SAR (W/kg) is +/-14% for the frequency range 600-7500MHz.

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.

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

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where

V_i =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 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$)
0.73	0.79	0.78

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
105	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.

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

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

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

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:

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

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:

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

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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
HL750	750	2.42
HL850	835	2.34
HL900	900	2.24
HL1800	1800	2.51
HL1900	1900	2.57
HL2000	2000	2.64
HL2300	2300	2.73
HL2450	2450	2.74
HL2600	2600	2.51
HL3300	3300	2.11
HL3500	3500	2.15
HL3700	3700	2.08
HL3900	3900	2.27
HL4200	4200	2.39
HL4600	4600	2.30
HL4900	4900	2.13
HL5200	5200	1.89
HL5400	5400	1.97
HL5600	5600	1.88
HL5800	5800	1.90

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

