# MEASUREMENT 3

Date of measurement: 20/5/2021

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 4 Cat M1
Channels	Middle
Signal	LTE (Crest factor: 1.0)

## B. SAR Measurement Results

Frequency (MHz)	1732.500000
Relative permittivity (real part)	40.510258
Relative permittivity (imaginary part)	13.904831
Conductivity (S/m)	1.338340
Variation (%)	-3.160000

SURFACE SAR	VOLUME SAR
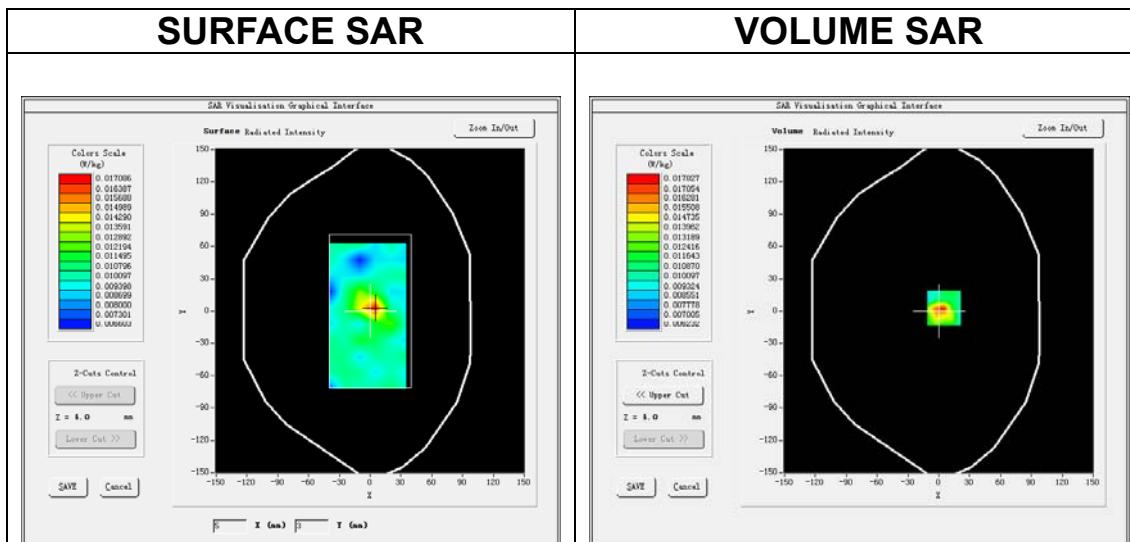
Maximum location: X=5.00, Y=3.00
SAR Peak: 0.03 W/kg

SAR 10g (W/Kg)	0.012202
SAR 1g (W/Kg)	0.017659

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0321	0.0178	0.0097	0.0096	0.0095	0.0092	0.0090

3D screen shot	Hot spot position
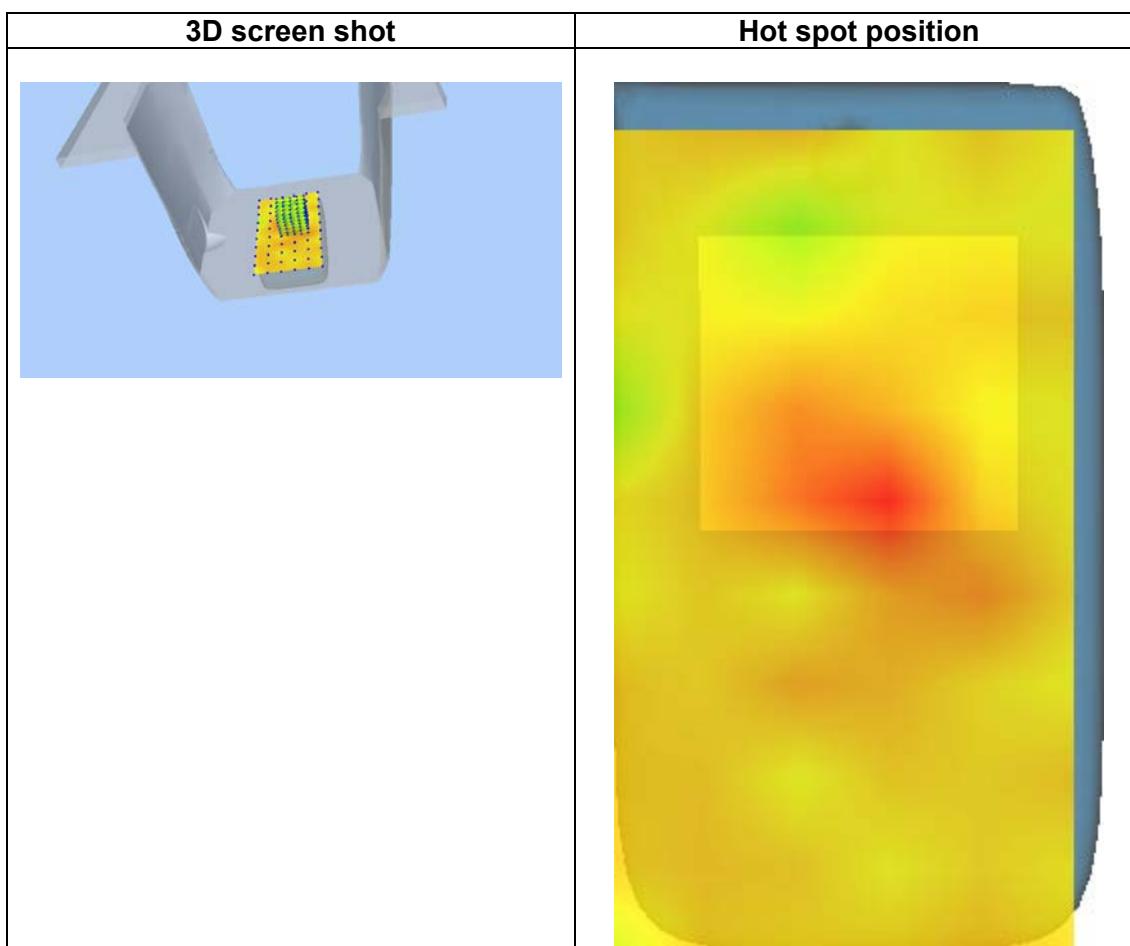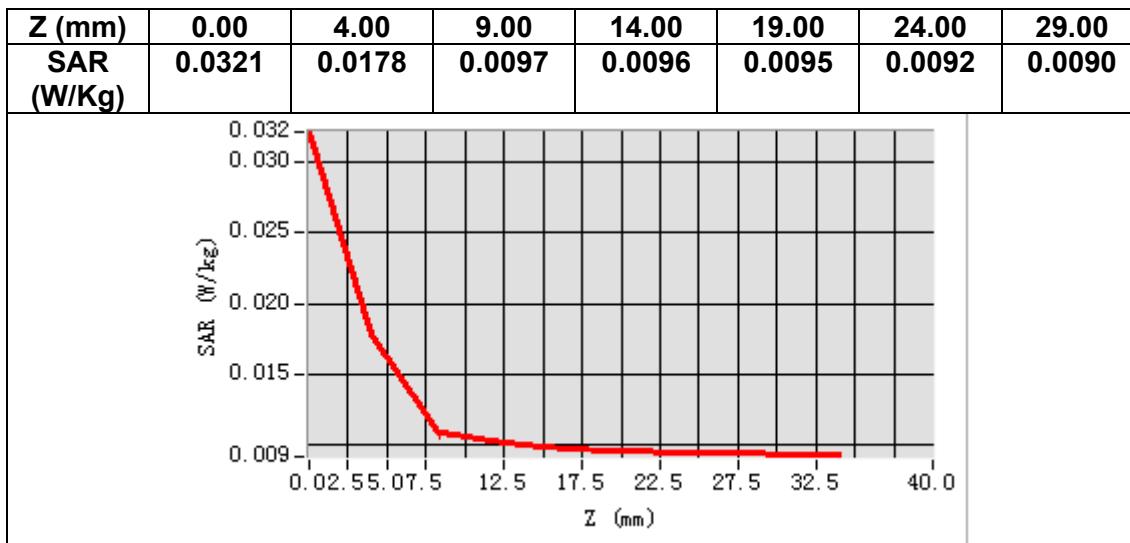
MEASUREMENT 4

Date of measurement: 20/5/2021

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 4 Cat NB1
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

| Frequency (MHz)	1732.500000
Relative permittivity (real part)	40.510258
Relative permittivity (imaginary part)	13.904831
Conductivity (S/m)	1.338340
Variation (%)	2.730000

SURFACE SAR	VOLUME SAR
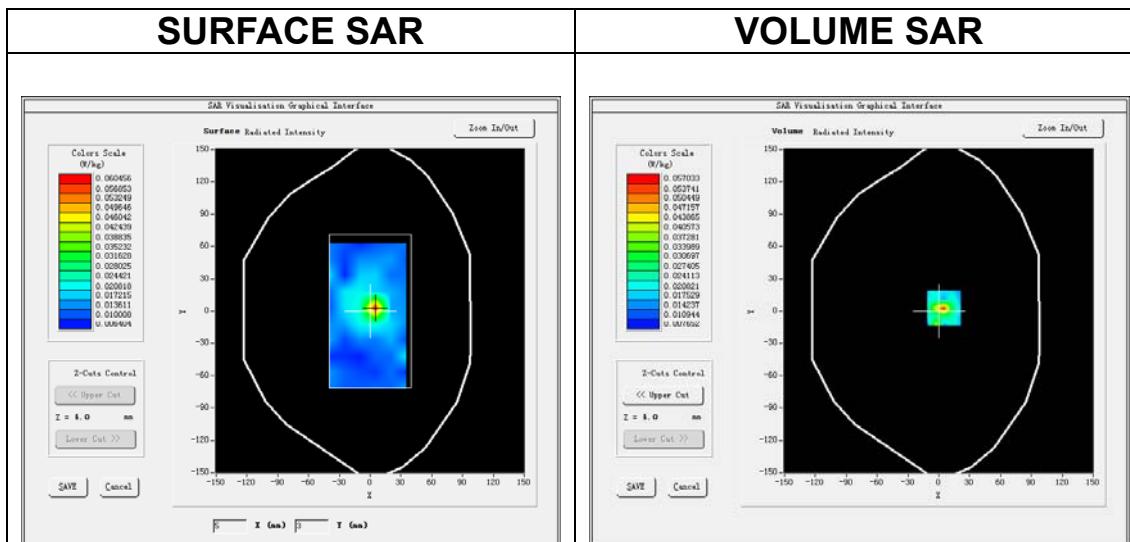
Maximum location: X=5.00, Y=3.00
SAR Peak: 0.12 W/kg

SAR 10g (W/Kg)	0.024066
SAR 1g (W/Kg)	0.050772

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.1166	0.0570	0.0227	0.0182	0.0126	0.0155	0.0109

3D screen shot	Hot spot position
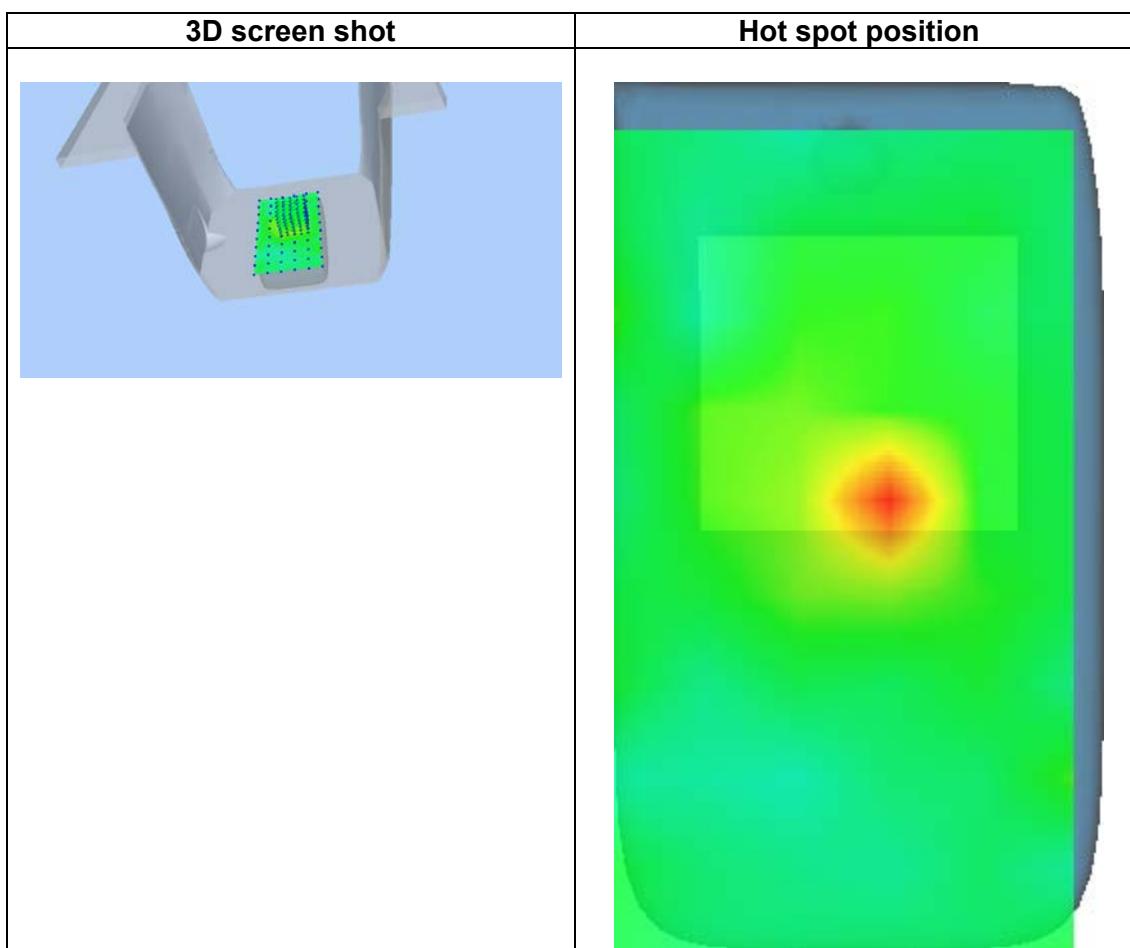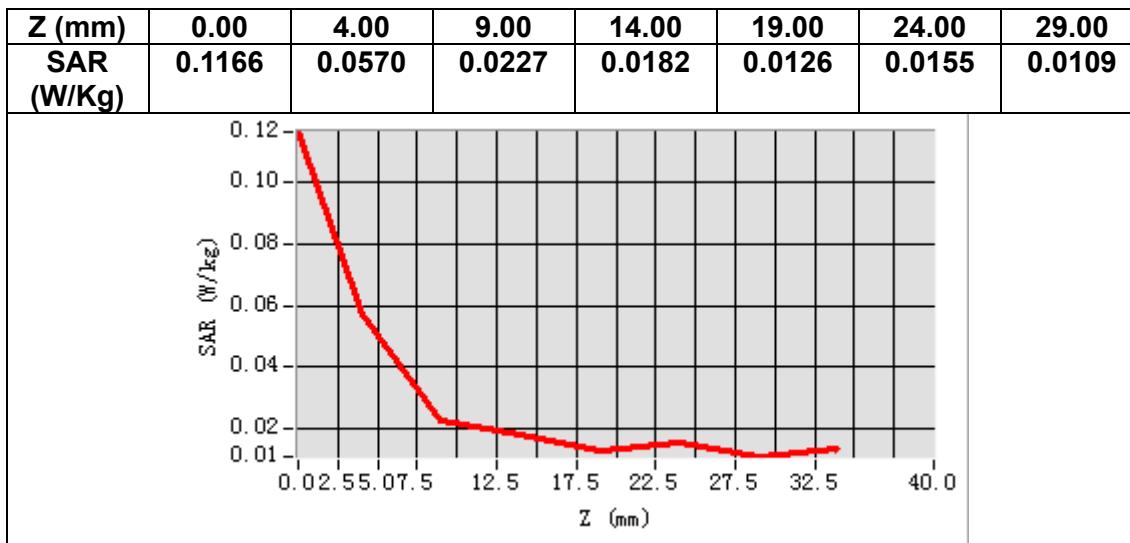
MEASUREMENT 5

Date of measurement: 19/5/2021

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 12 Cat M1
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	707.500000
Relative permittivity (real part)	41.375233
Relative permittivity (imaginary part)	21.736685
Conductivity (S/m)	0.854372
Variation (%)	-0.970000

SURFACE SAR	VOLUME SAR
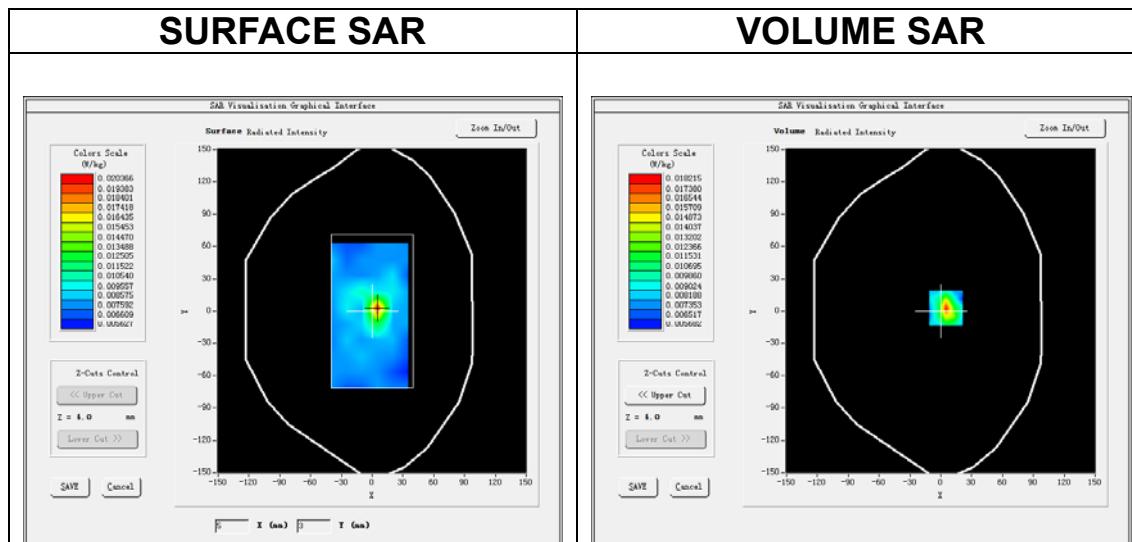
Maximum location: X=5.00, Y=3.00
SAR Peak: 0.03 W/kg

SAR 10g (W/Kg)	0.010508
SAR 1g (W/Kg)	0.016502

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0273	0.0182	0.0114	0.0096	0.0081	0.0068	0.0078

| 3D screen shot	Hot spot position
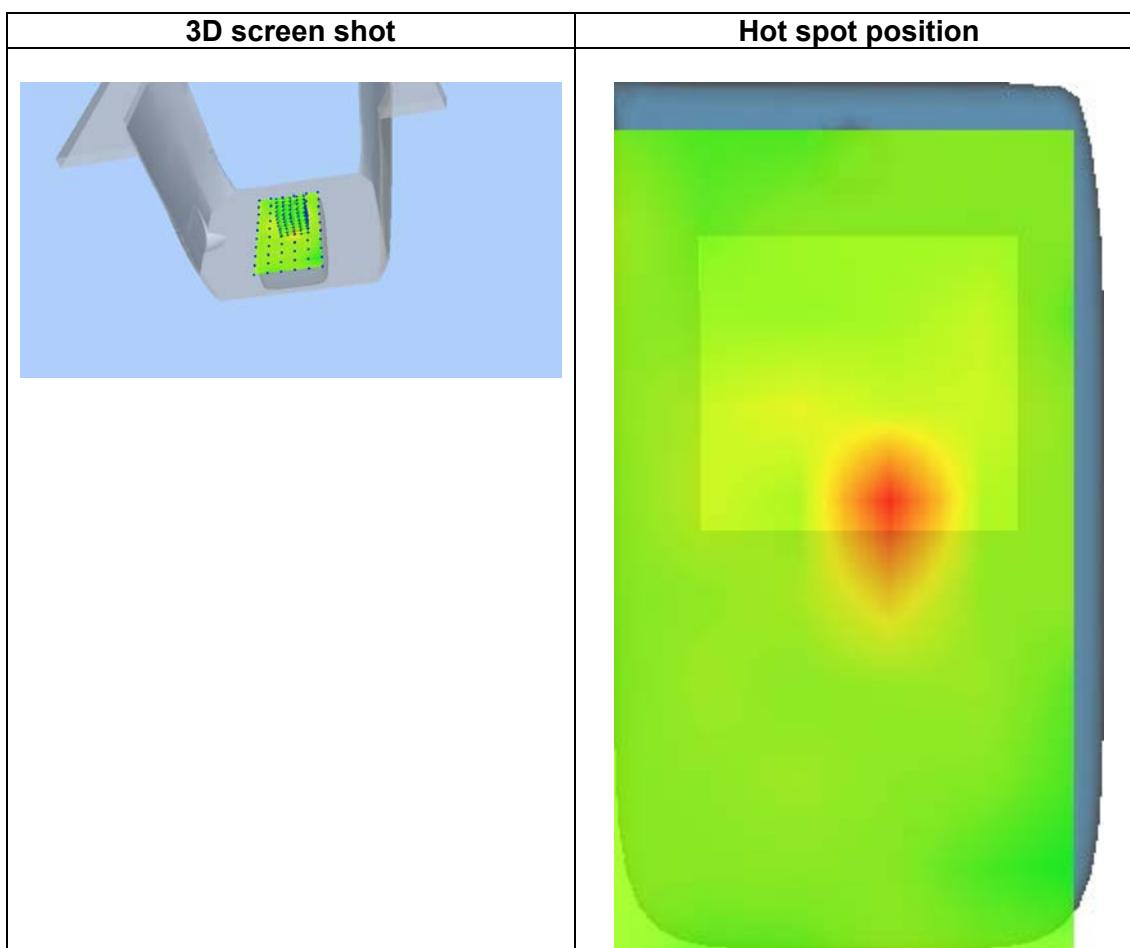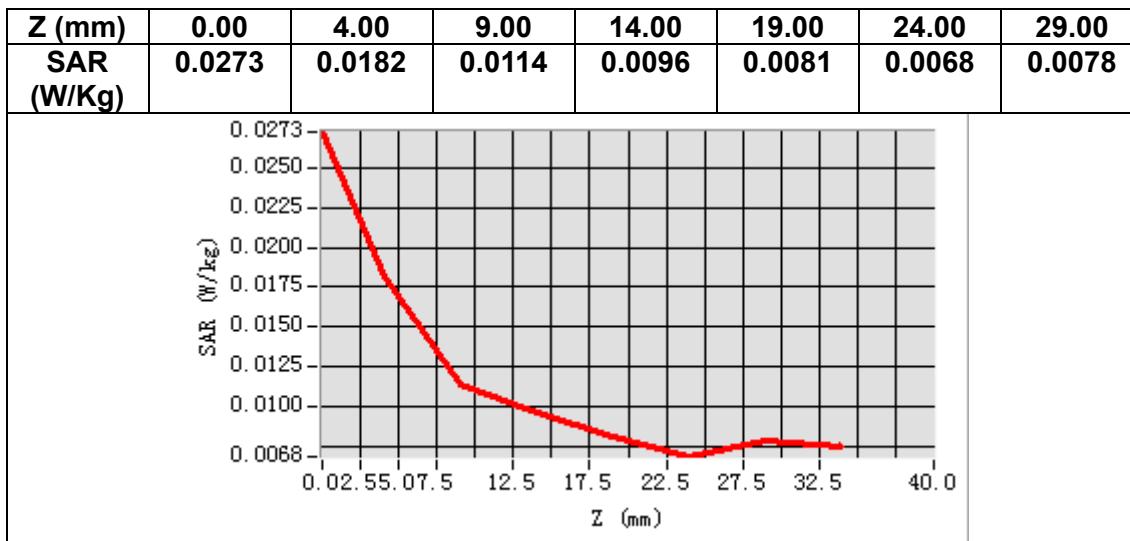
MEASUREMENT 6

Date of measurement: 19/5/2021

A. Experimental conditions.

| Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 12 Cat NB1
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	707.500000
Relative permittivity (real part)	41.375233
Relative permittivity (imaginary part)	21.736685
Conductivity (S/m)	0.854372
Variation (%)	2.760000

SURFACE SAR	VOLUME SAR
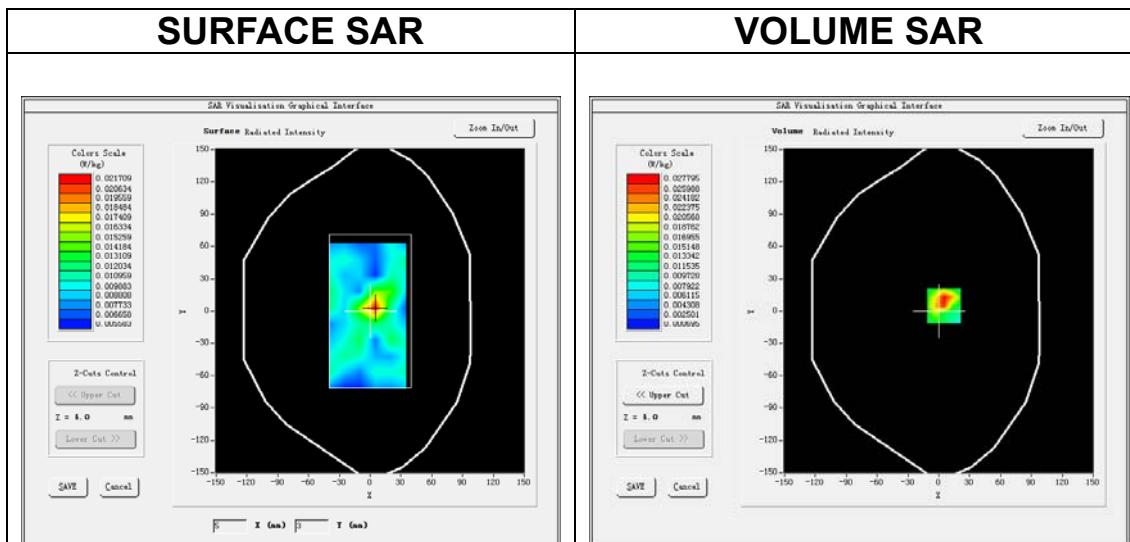
Maximum location: X=5.00, Y=5.00
SAR Peak: 0.05 W/kg

SAR 10g (W/Kg)	0.015509
SAR 1g (W/Kg)	0.028011

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0588	0.0278	0.0121	0.0122	0.0123	0.0109	0.0099

3D screen shot	Hot spot position
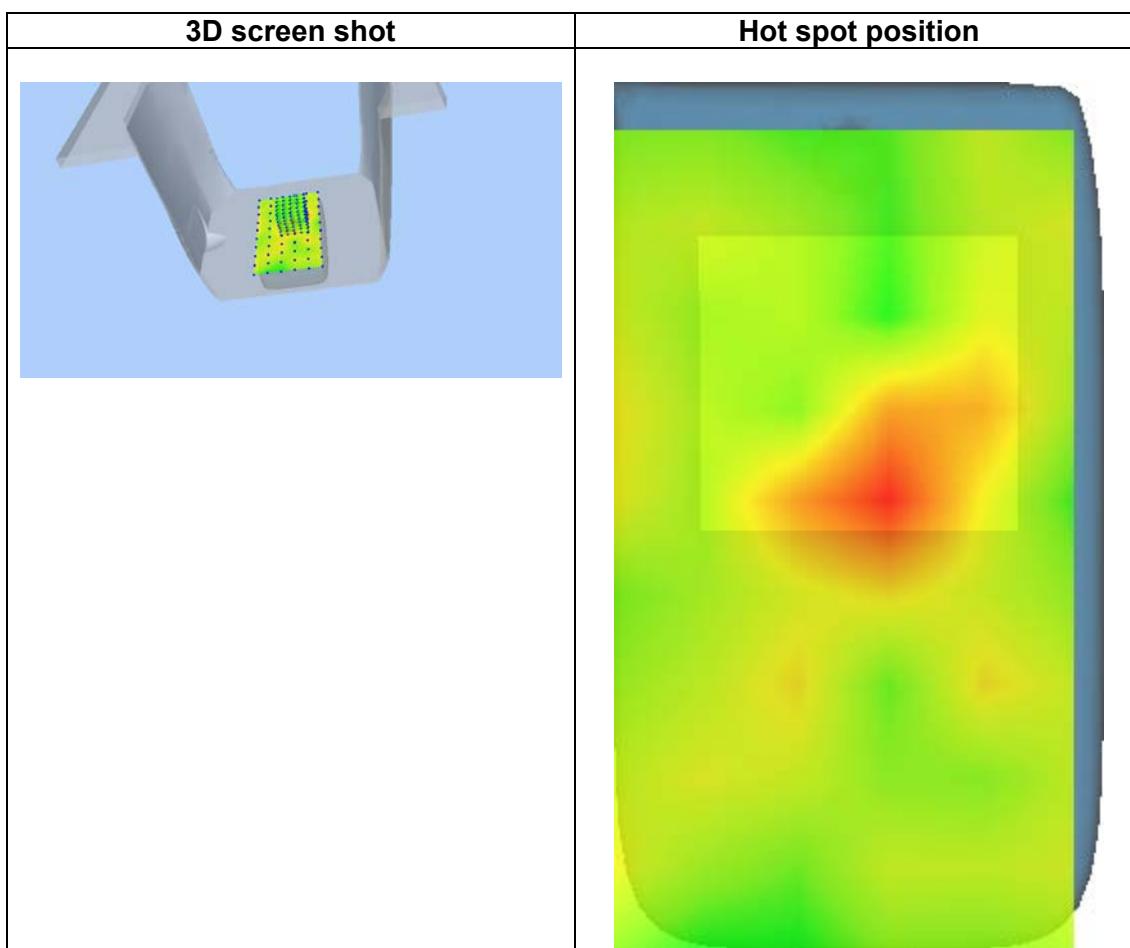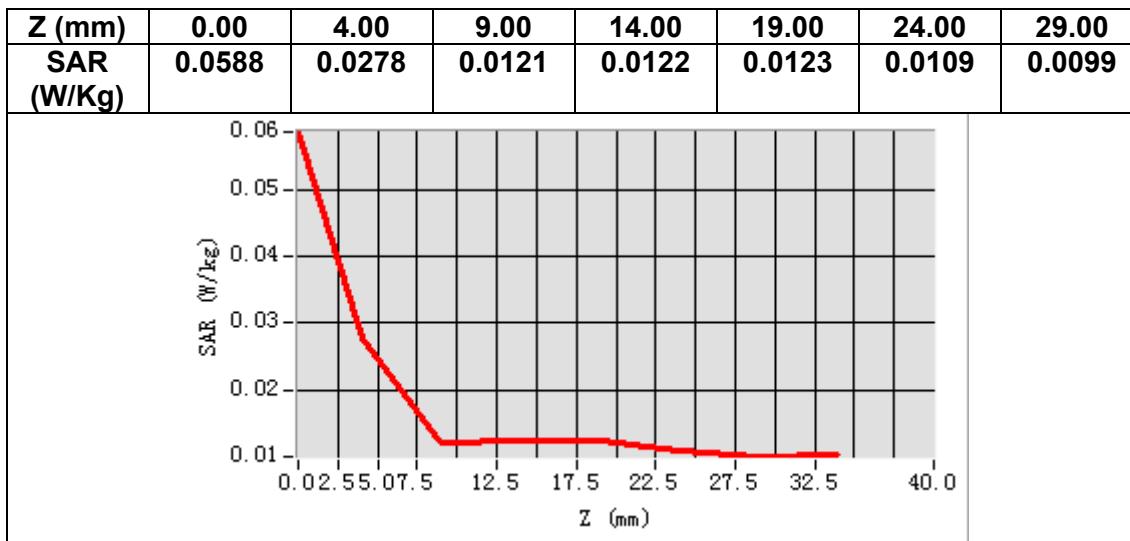
MEASUREMENT 7

Date of measurement: 19/5/2021

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 13 Cat M1
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	782.000000
Relative permittivity (real part)	40.541382
Relative permittivity (imaginary part)	20.528734
Conductivity (S/m)	0.891289
Variation (%)	-4.340000

SURFACE SAR	VOLUME SAR
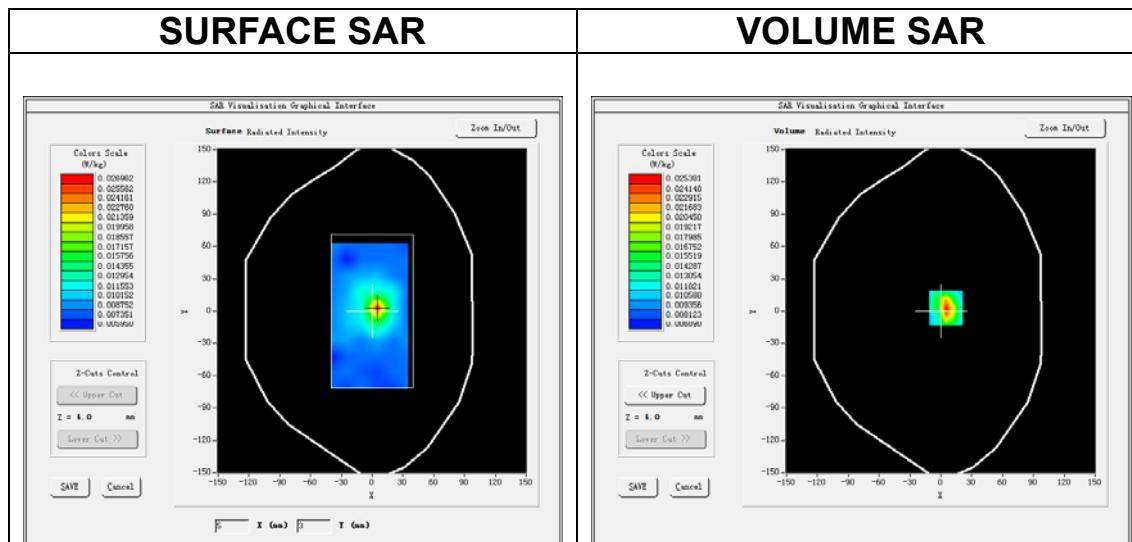
Maximum location: X=5.00, Y=3.00
SAR Peak: 0.04 W/kg

SAR 10g (W/Kg)	0.014156
SAR 1g (W/Kg)	0.023754

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0394	0.0254	0.0150	0.0107	0.0084	0.0085	0.0082

3D screen shot	Hot spot position
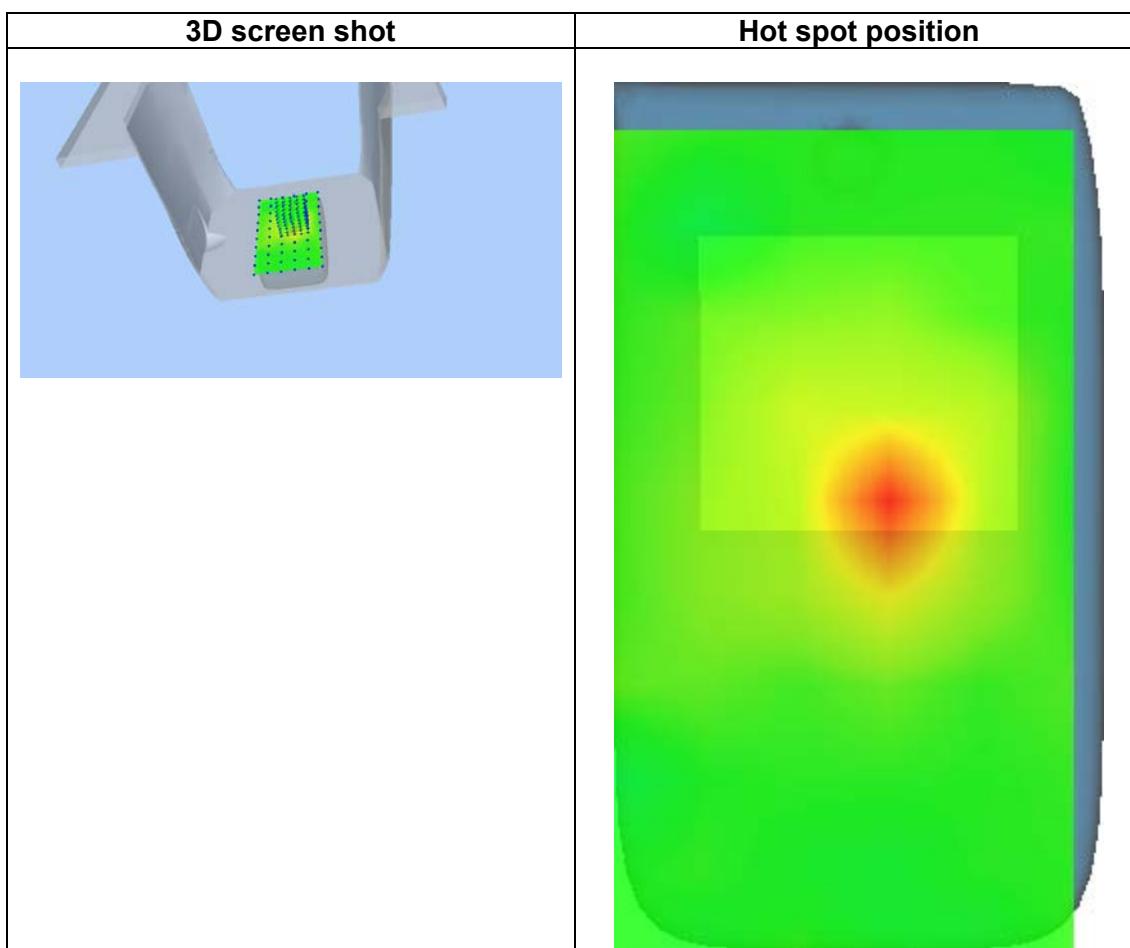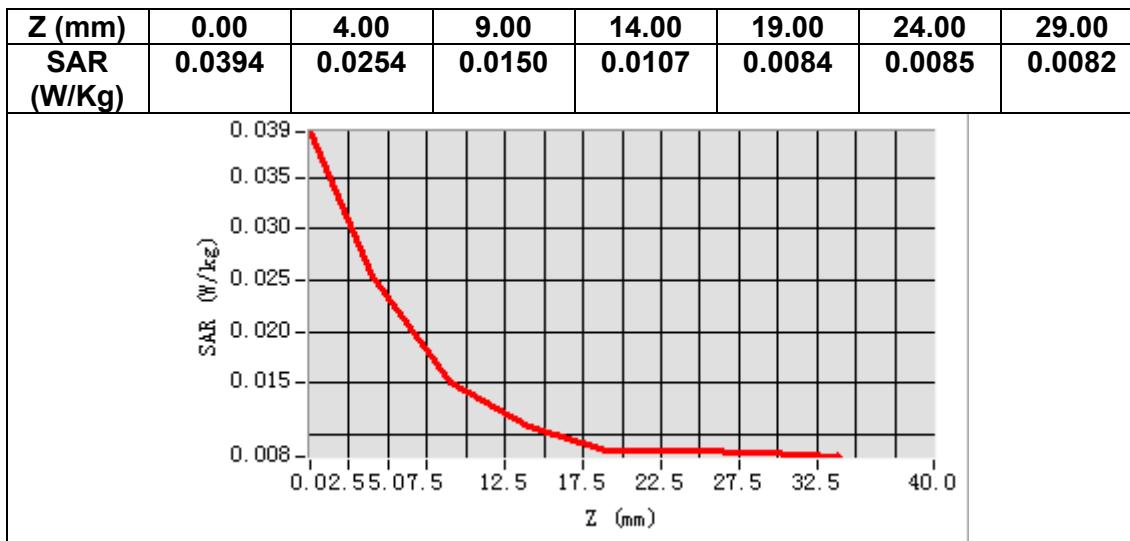
MEASUREMENT 8

Date of measurement: 19/5/2021

A. Experimental conditions.

Area Scan	dx=15mm dy=15mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm
Phantom	Validation plane
Device Position	Body
Band	LTE band 13 Cat NB1
Channels	Middle
Signal	LTE (Crest factor: 1.0)

B. SAR Measurement Results

Frequency (MHz)	782.000000
Relative permittivity (real part)	40.541382
Relative permittivity (imaginary part)	20.528734
Conductivity (S/m)	0.891289
Variation (%)	-2.870000

SURFACE SAR	VOLUME SAR
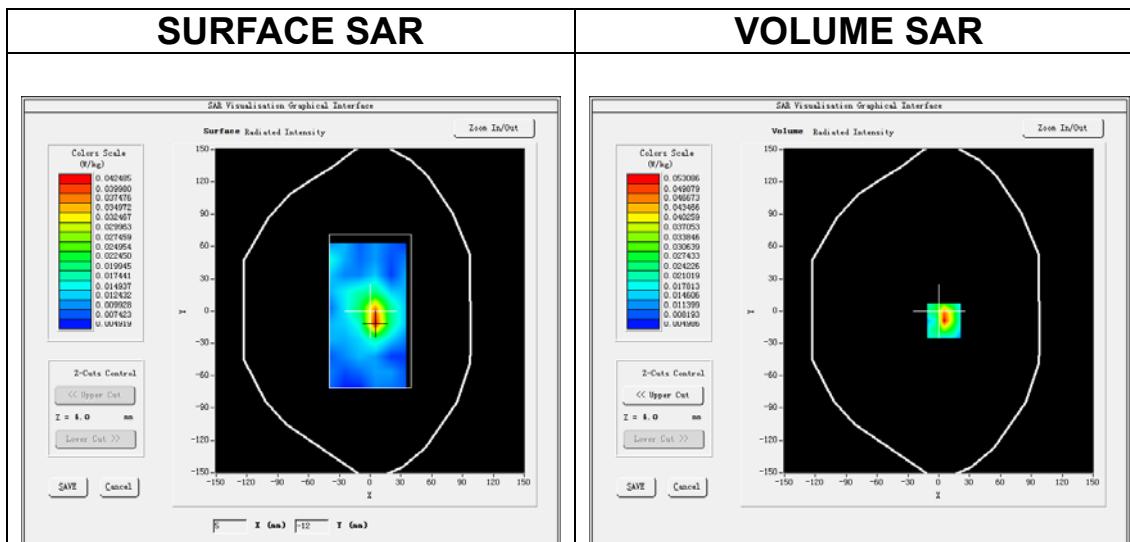
Maximum location: X=5.00, Y=-9.00
SAR Peak: 0.10 W/kg

SAR 10g (W/Kg)	0.025205
SAR 1g (W/Kg)	0.049944

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0975	0.0531	0.0255	0.0172	0.0137	0.0117	0.0115

3D screen shot	Hot spot position
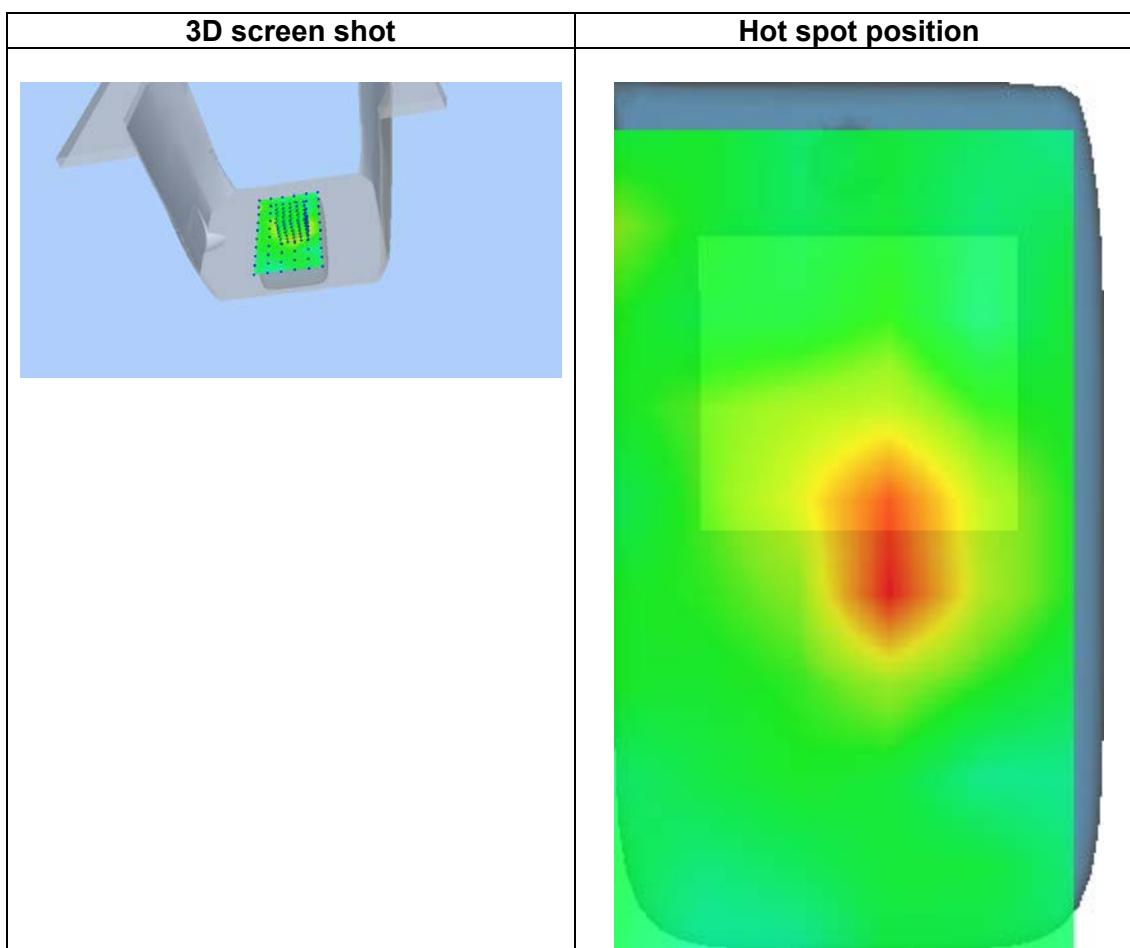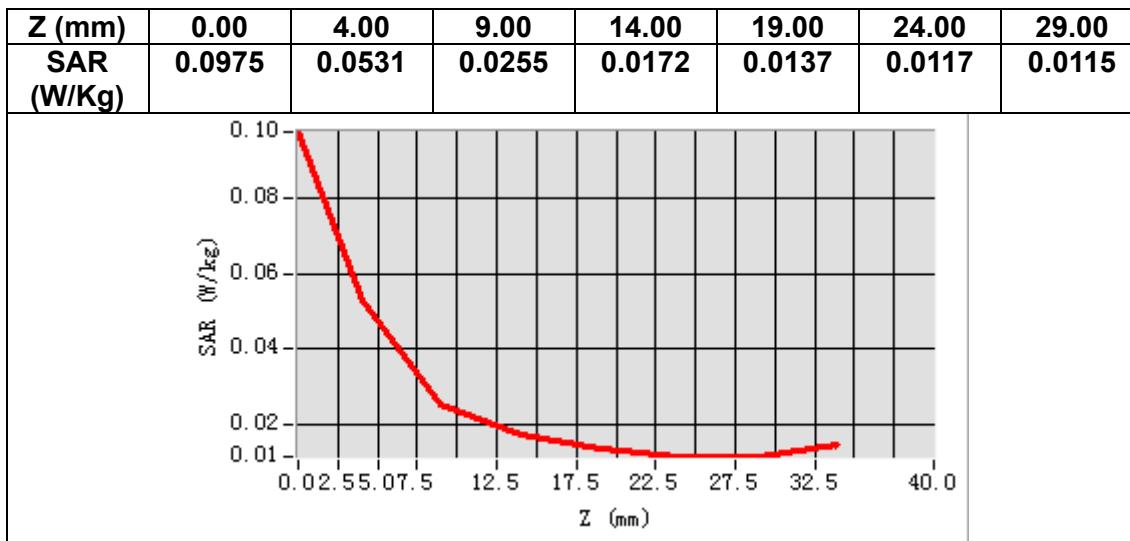
13. Appendix D. Calibration Certificate

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E Field Probe - SN 08/16 EPGO287
750 MHz Dipole - SN 03/15 DIP 0G750-355
1800 MHz Dipole - SN 03/15 DIP 1G800-349
1900 MHz Dipole - SN 03/15 DIP 1G900-350

COMOSAR E-Field Probe Calibration Report

Ref : ACR.60.1.21.MVGB.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.: SN 08/16 EPGO287

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

Calibration date: 03/01/2021

Accreditations #2-6789 and #2-6814
Scope available on 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.60.1.21.MVGB.A

	Name	Function	Date	Signature
Prepared by :	Jérôme Luc	Technical Manager	3/1/2021	
Checked by :	Jérôme Luc	Technical Manager	3/1/2021	
Approved by :	Yann Toutain	Laboratory Director	3/1/2021	Yann Toutain

Mode d'emploi
2021.03.0
1 13:07:12
+01'00'

PHILIPS

Distribution :	Customer Name
	SHENZHEN NTEK TESTING TECHNOLOGY CO., LTD.

Issue	Name	Date	Modifications
A	Jérôme Luc	3/1/2021	Initial release

COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.60.1.21.MVGB.A

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COMOSAR E-FIELD PROBE CALIBRATION REPORT   Ref: ACR.60.1.21.MVGB.A

1   DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	SN 08/16 EPGO287
Product Condition (new / used)	Used
Frequency Range of Probe	0.15 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.211 MΩ
	Dipole 2: R2=0.199 MΩ
	Dipole 3: R3=0.199 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.

COMOSAR E-FIELD PROBE CALIBRATION REPORT   Ref: ACR.60.1.21.MVGB.A

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:

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

where

$\text{SAR}_{uncertainty}$ 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., $\delta \approx 14$ 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.

COMOSAR E-FIELD PROBE CALIBRATION REPORT   Ref: ACR.60.1.21.MVGB.A

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

4   MEASUREMENT UNCERTAINTY

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

Uncertainty analysis of the probe calibration in waveguide					
ERROR SOURCES	**Uncertainty value (%)**	**Probability Distribution**	**Divisor**	**ci**	**Standard Uncertainty (%)**
Expanded uncertainty 95 % confidence level k = 2					14 %

5   CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Liquid Temperature	20 +/- 1 °C
Lab Temperature	20 +/- 1 °C
Lab Humidity	30-70 %

5.1   SENSITIVITY IN AIR

Normx dipole 1 $(\mu V/(V/m)^2)$	Normy dipole 2 $(\mu V/(V/m)^2)$	Normz dipole 3 $(\mu V/(V/m)^2)$
0.72	0.66	0.77

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
107	110	110

Calibration curves ei=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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**COMOSAR E-FIELD PROBE CALIBRATION REPORT**   Ref: ACR.60.1.21.MVGB.A

Calibration curves
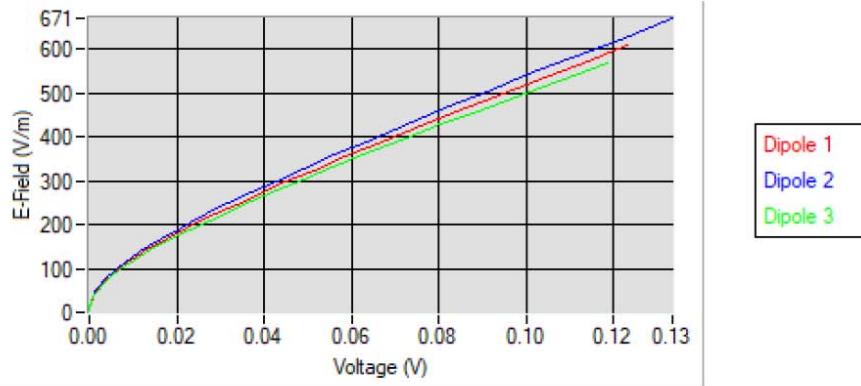
5.2 LINEARITY

Linearity

Linearity:+/-1.90% (+/-0.08dB)