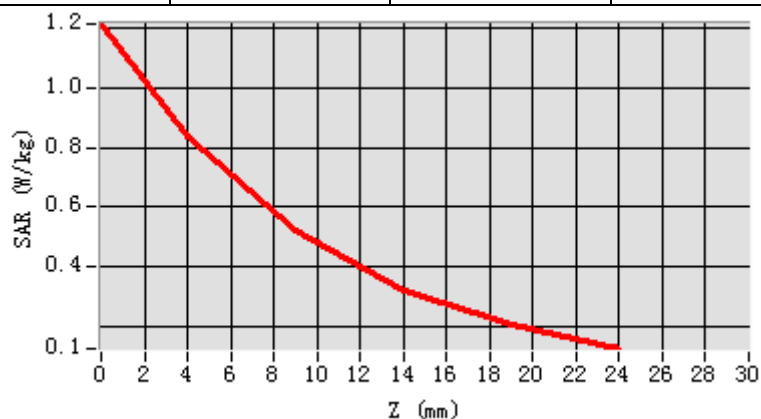
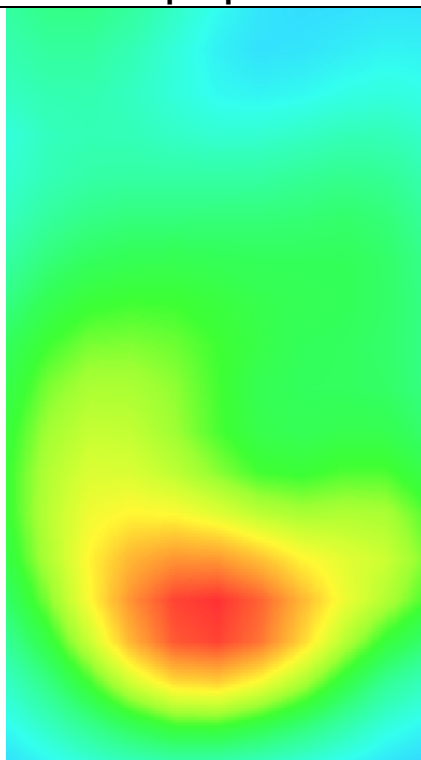


Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.2161	0.8382	0.5180	0.3211	0.2020



Hot spot position



LTE Band 5

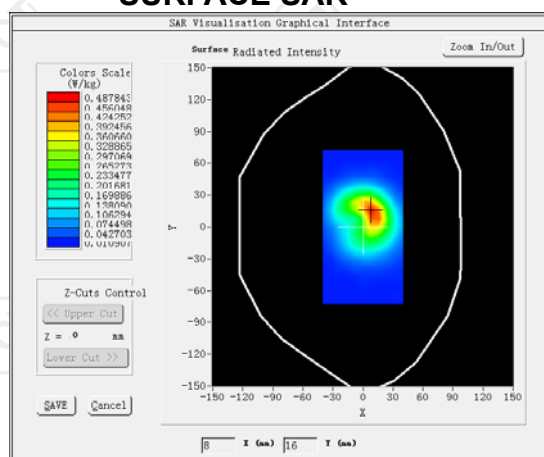
MEASUREMENT 1

Middle Band SAR (Channel 20525):

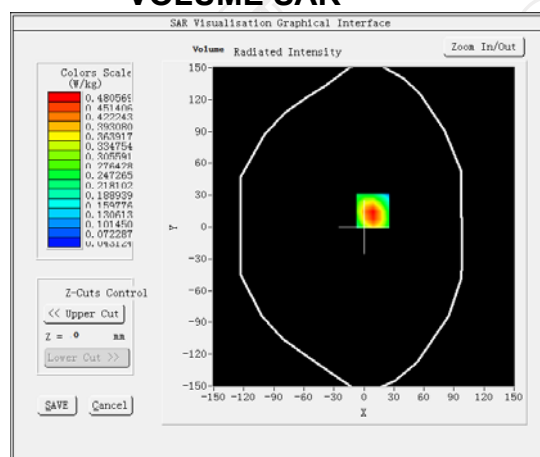
Date: 08/06/2021

Frequency (MHz)	836.500000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	-2.200000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body front(10mm)
Band	LTE band 5(1 RB#0)

SURFACE SAR

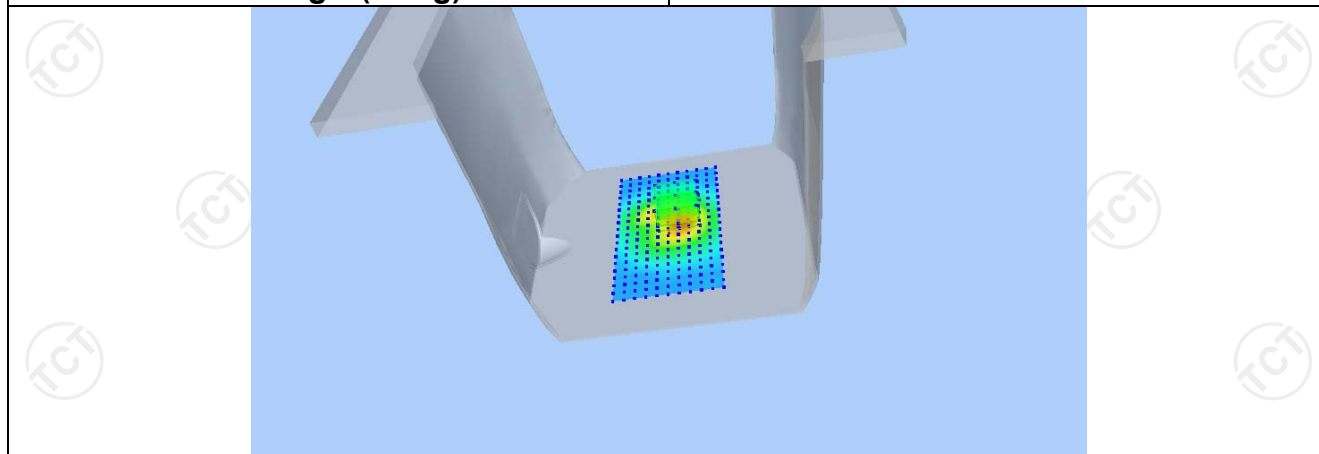


VOLUME SAR

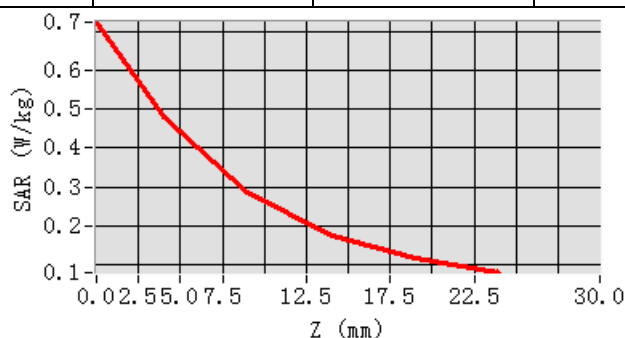


Maximum location: X=9.00, Y=15.00 SAR Peak: 0.74 W/kg

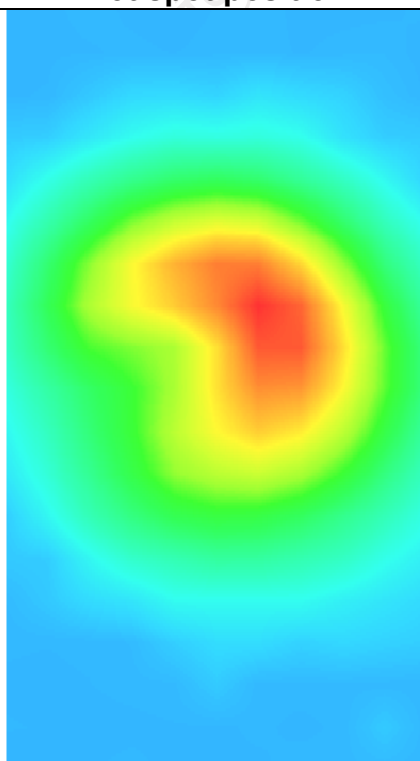
SAR 10g (W/Kg)	0.262925
SAR 1g (W/Kg)	0.457026



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.7259	0.4806	0.2848	0.1744	0.1149



Hot spot position



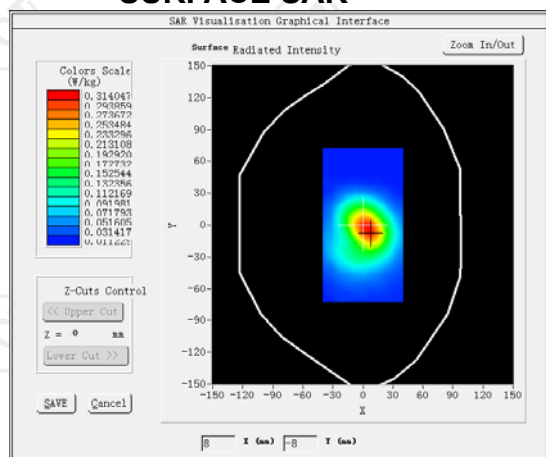
MEASUREMENT 2

Middle Band SAR (Channel 20525):

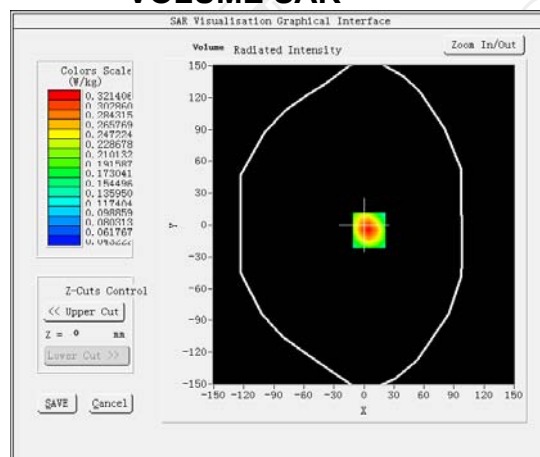
Date: 08/06/2021

Frequency (MHz)	836.500000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	-1.250000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(0mm)
Band	LTE band 5(1 RB#0)

SURFACE SAR

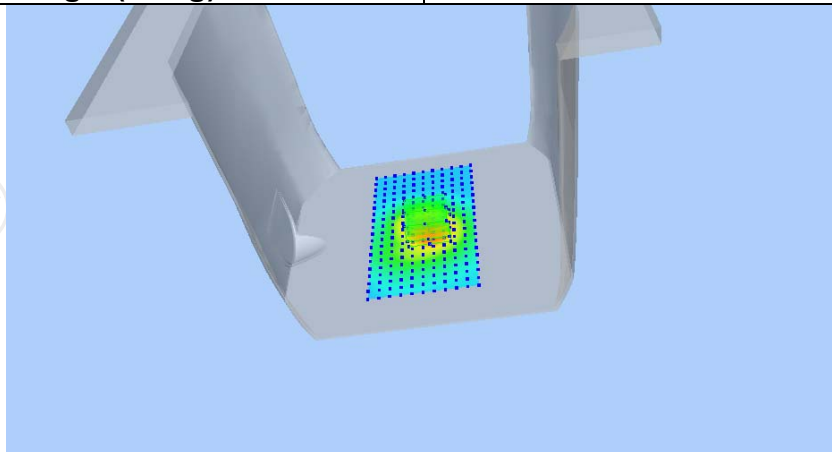


VOLUME SAR

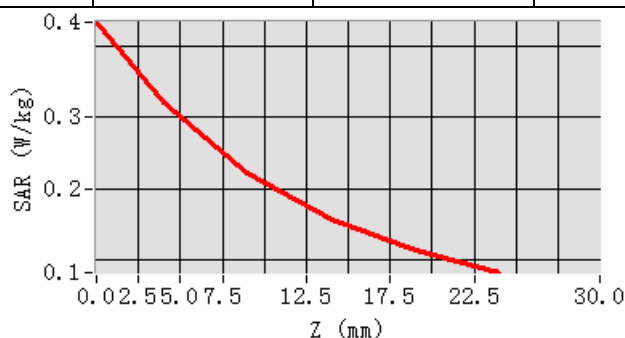


Maximum location: X=5.00, Y=-5.00 SAR Peak: 0.43 W/kg

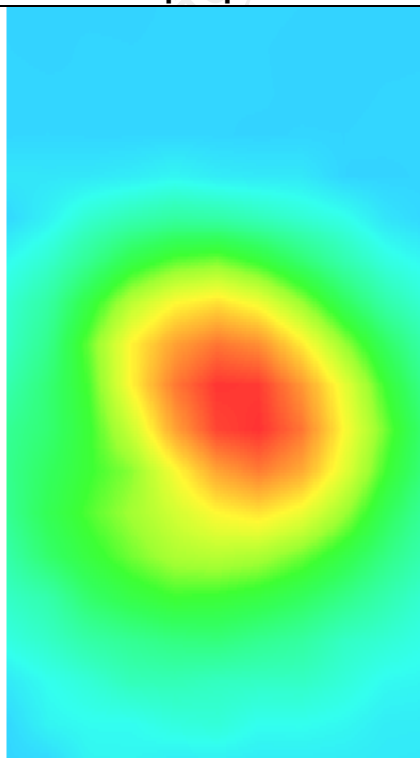
SAR 10g (W/Kg)	0.194024
SAR 1g (W/Kg)	0.303224



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4335	0.3214	0.2215	0.1557	0.1129



Hot spot position



LTE Band 7

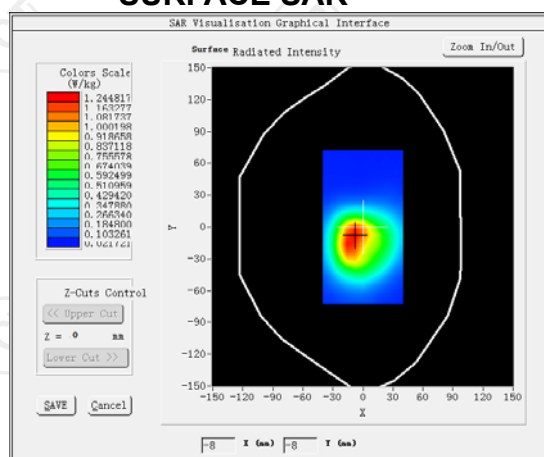
MEASUREMENT 1

Middle Band SAR (Channel 21100):

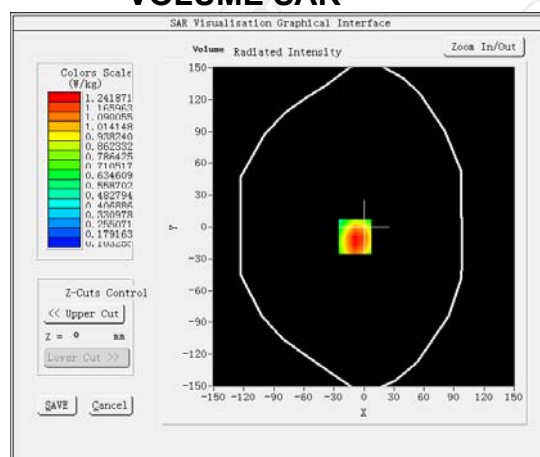
Date: 08/21/2021

Frequency (MHz)	2535.000000
Relative permittivity (real part)	52.131509
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	2.128245
Variation (%)	-1.490000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(10mm)
Band	LTE band 7(1 RB#49)

SURFACE SAR

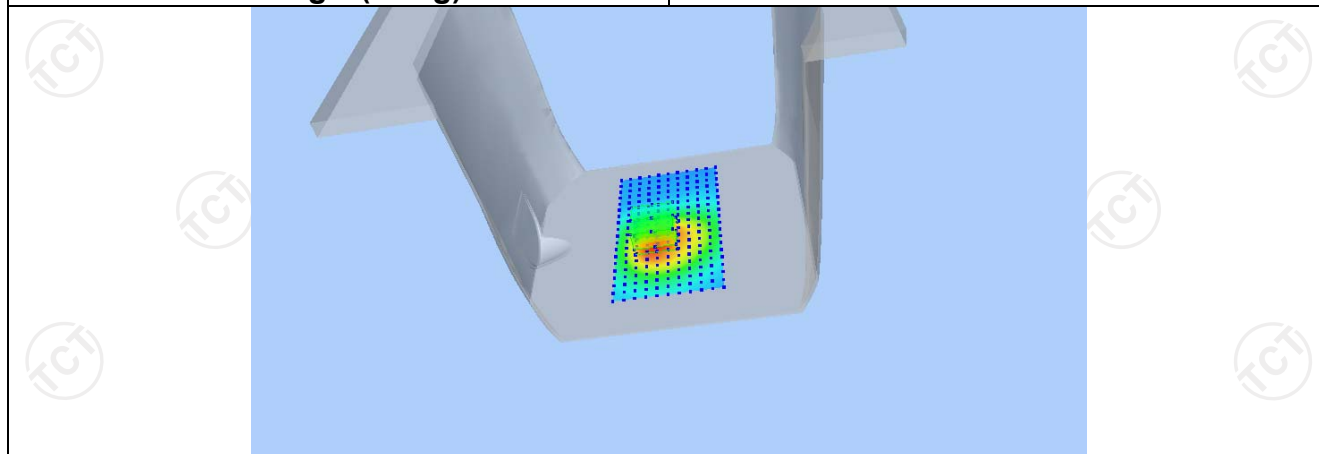


VOLUME SAR

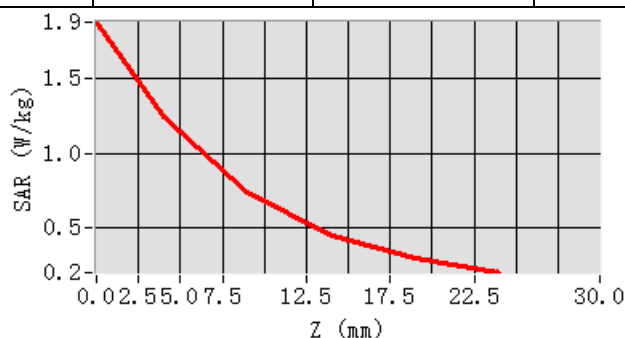


Maximum location: X=-9.00, Y=-9.00 SAR Peak: 1.90 W/kg

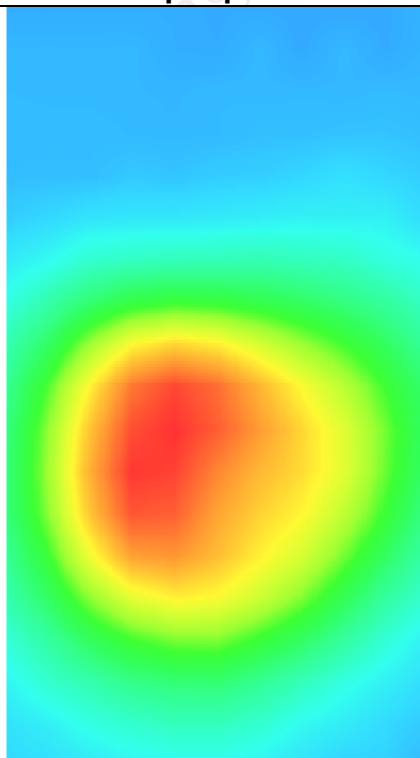
SAR 10g (W/Kg)	1.205370
SAR 1g (W/Kg)	0.738021



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.8828	1.2419	0.7315	0.4446	0.2902



Hot spot position



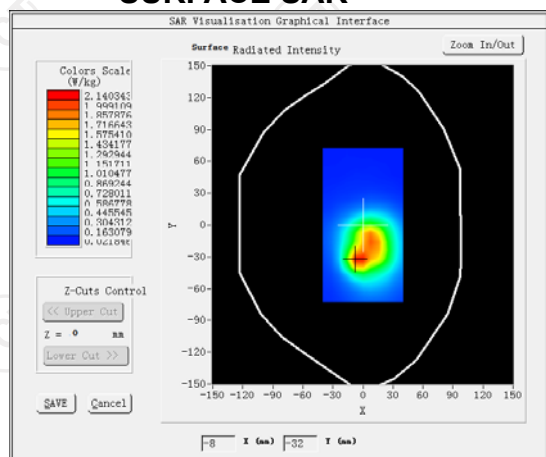
MEASUREMENT 2

Middle Band SAR (Channel 21100):

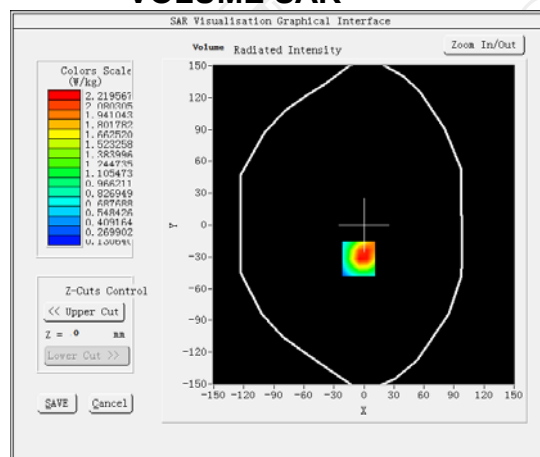
Date: 08/21/2021

Frequency (MHz)	2535.000000
Relative permittivity (real part)	52.131509
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	2.128245
Variation (%)	-0.270000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=8mm dy=8mm</u> <u>dz=5mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	<u>Validation plane</u>
Device Position	<u>Body back0mm)</u>
Band	<u>LTE band 7(1 RB#49)</u>

SURFACE SAR



VOLUME SAR



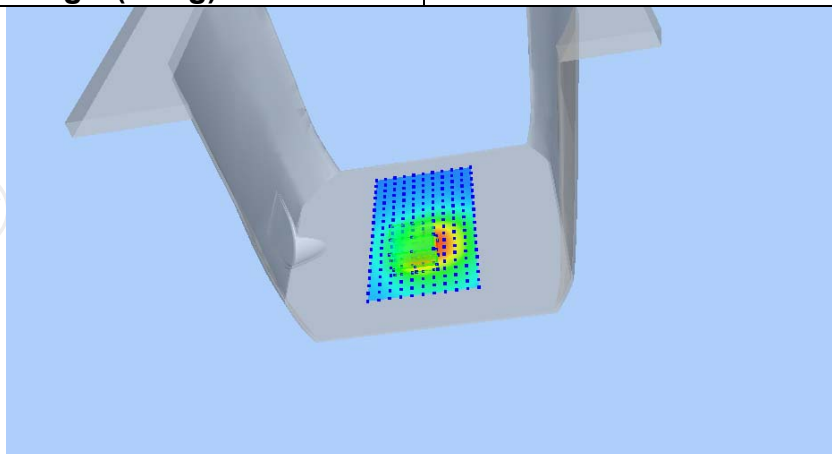
Maximum location: X=-5.00, Y=-32.00 SAR Peak: 3.43 W/kg

SAR 10g (W/Kg)

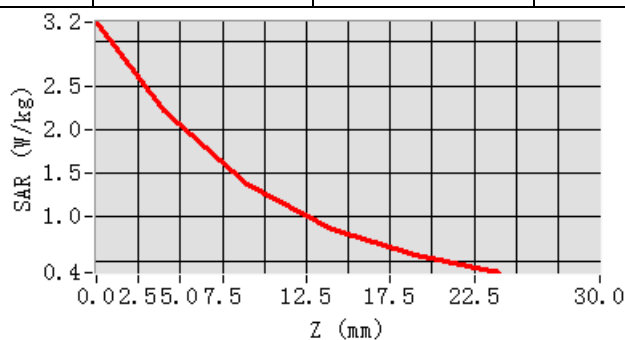
1.269268

SAR 1g (W/Kg)

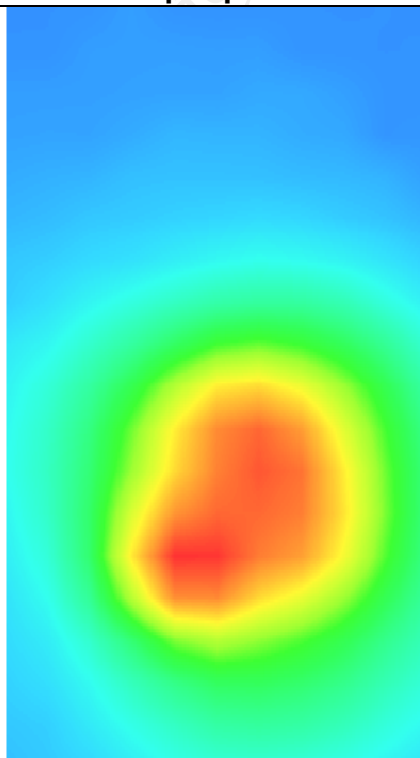
2.209759



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	3.2255	2.2196	1.3772	0.8666	0.5647



Hot spot position



LTE Band 12

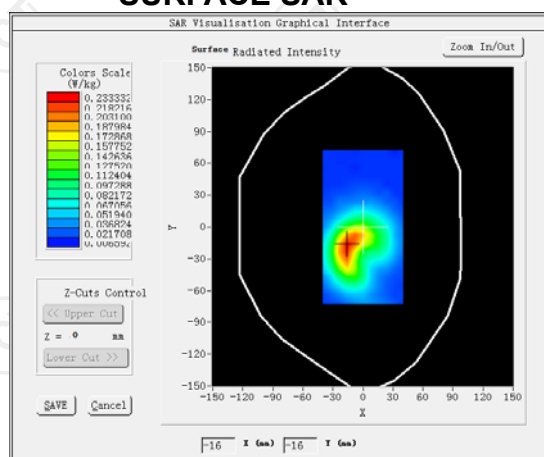
MEASUREMENT 1

High Band SAR (Channel 23130):

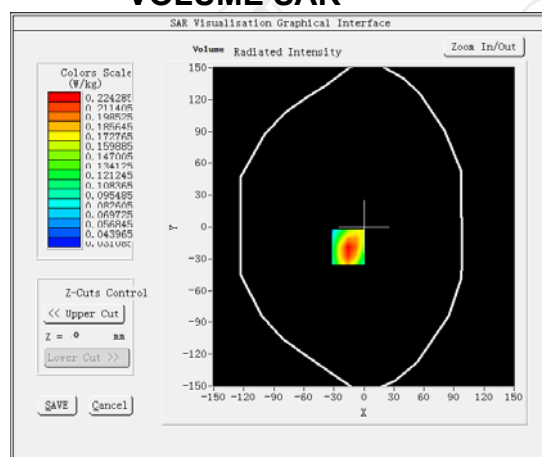
Date: 08/02/2021

Frequency (MHz)	711.000000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	-2.300000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body front(10mm)
Band	LTE band 12(1 RB#24)

SURFACE SAR



VOLUME SAR



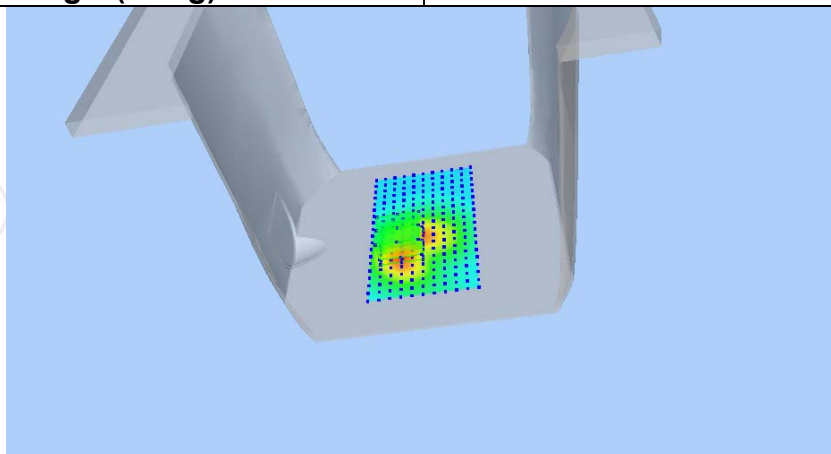
Maximum location: X=-16.00, Y=-19.00 SAR Peak: 0.33 W/kg

SAR 10g (W/Kg)

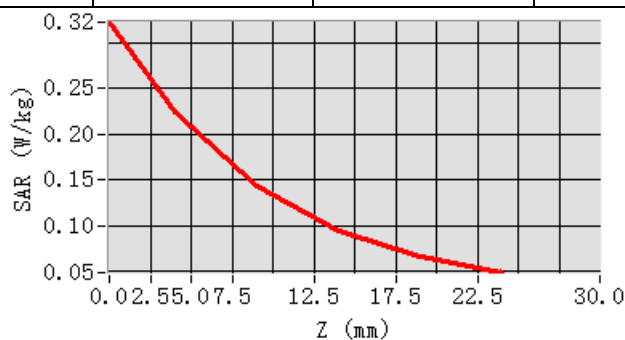
0.133139

SAR 1g (W/Kg)

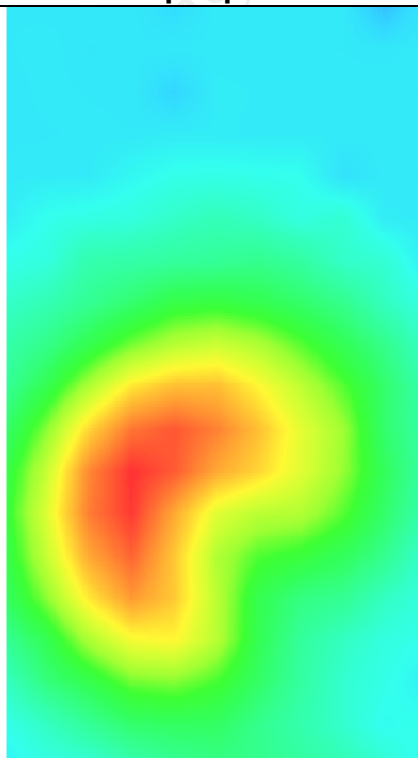
0.217636



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.3227	0.2243	0.1428	0.0944	0.0668



Hot spot position



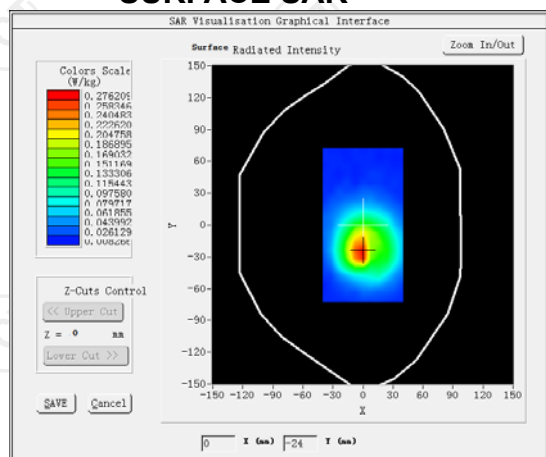
MEASUREMENT 2

Hight Band SAR (Channel 23130):

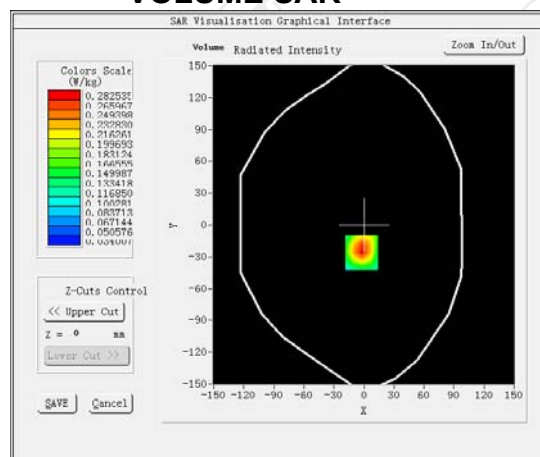
Date: 08/02/2021

Frequency (MHz)	711.000000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	-1.490000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(0mm)
Band	LTE band 12(1 RB#24)

SURFACE SAR

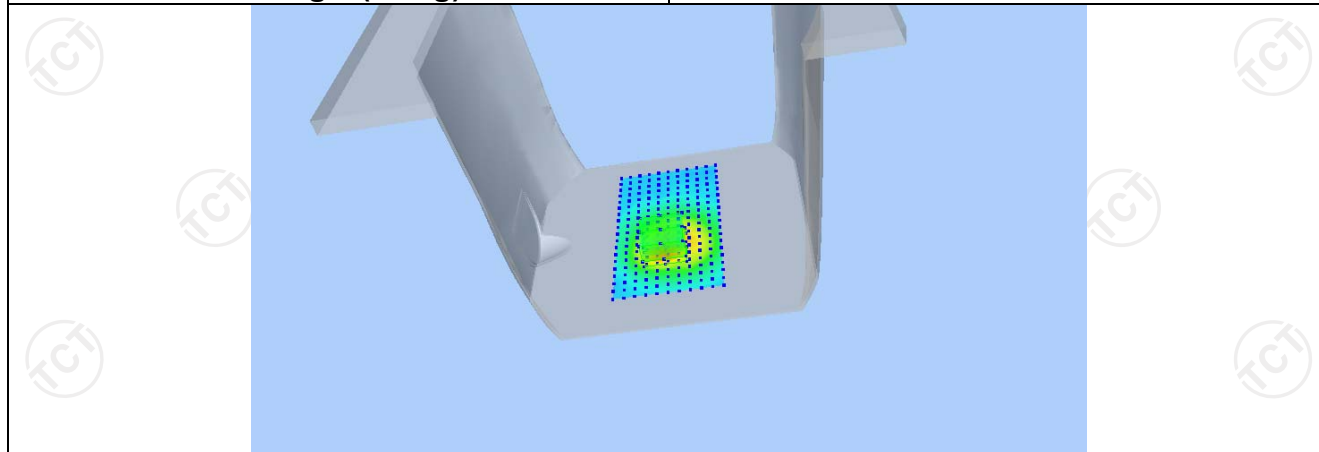


VOLUME SAR

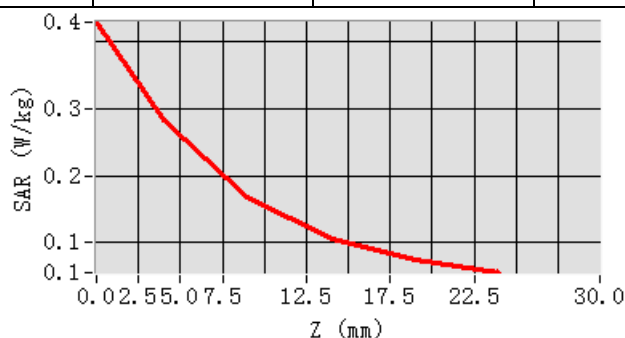


Maximum location: X=-2.00, Y=-26.00 SAR Peak: 0.43 W/kg

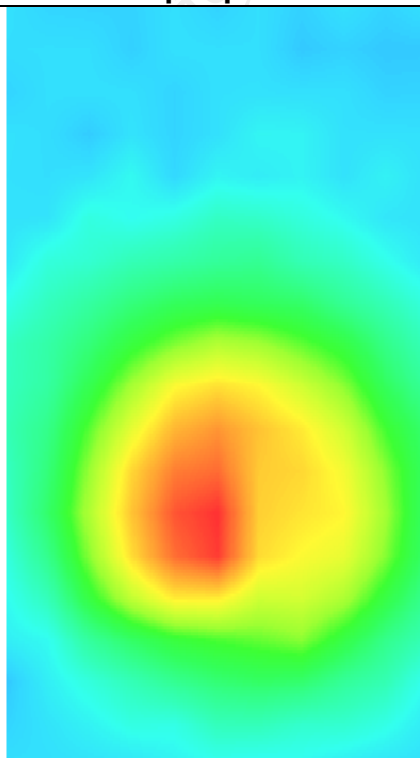
SAR 10g (W/Kg)	0.160829
SAR 1g (W/Kg)	0.273561



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4288	0.2825	0.1681	0.1060	0.0745



Hot spot position



LTE Band 13

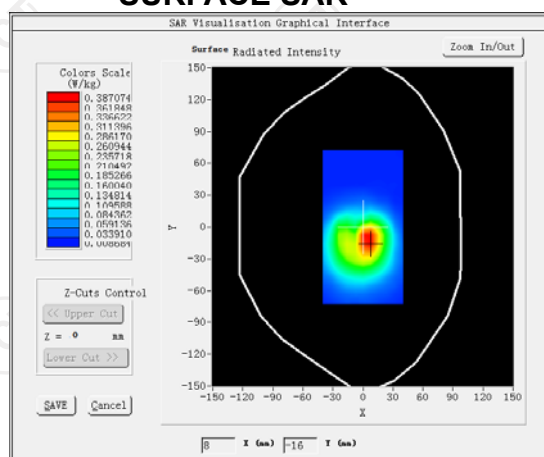
MEASUREMENT 1

Middle Band SAR (Channel 23230):

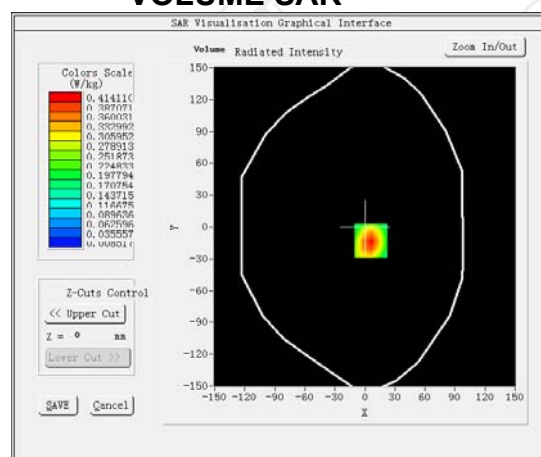
Date: 08/02/2021

Frequency (MHz)	782.000000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	-0.080000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body front(10mm)
Band	LTE band 13(1 RB#0)

SURFACE SAR

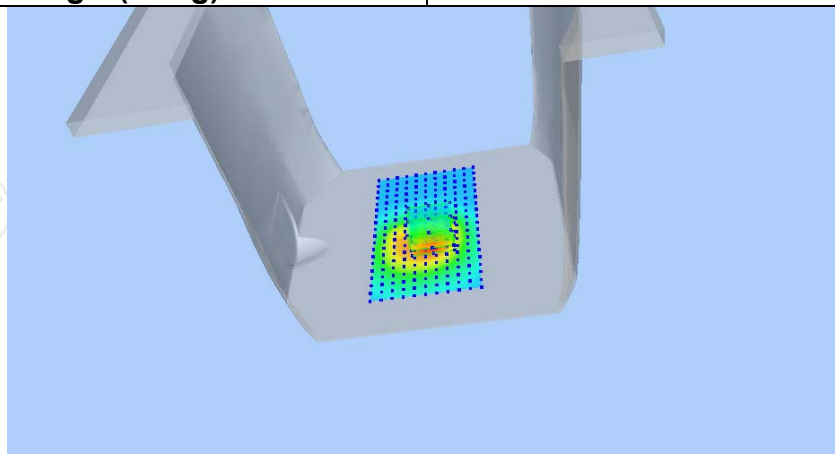


VOLUME SAR

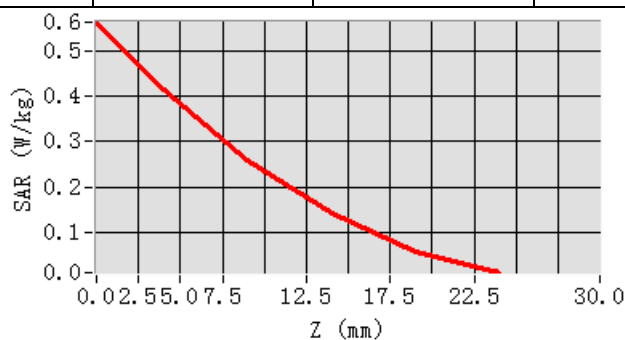


Maximum location: X=6.00, Y=-13.00 SAR Peak: 0.57 W/kg

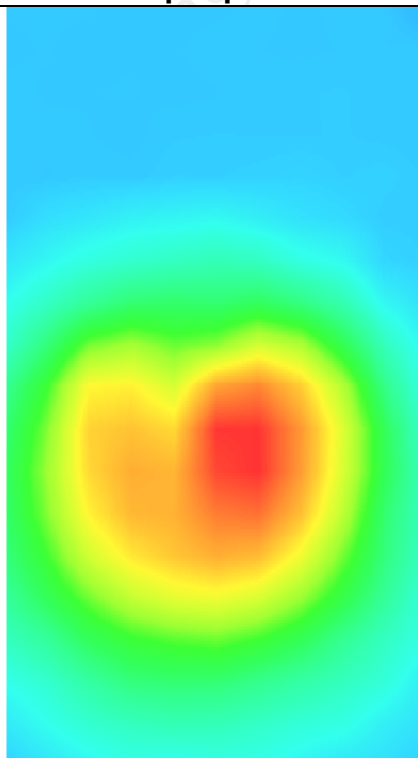
SAR 10g (W/Kg)	0.217975
SAR 1g (W/Kg)	0.384077



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.5629	0.4141	0.2601	0.1417	0.0589



Hot spot position



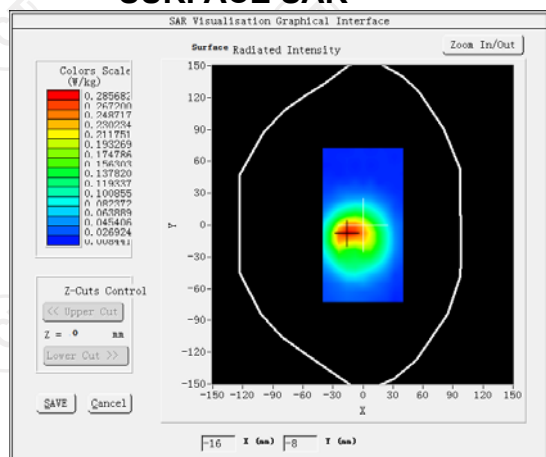
MEASUREMENT 2

Middle Band SAR (Channel 23230):

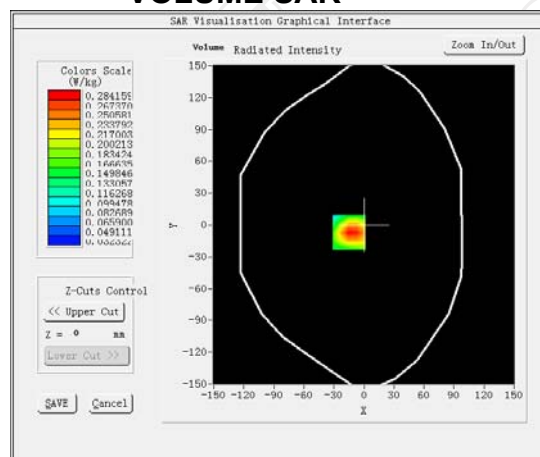
Date: 08/02/2021

Frequency (MHz)	782.000000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	-1.220000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(0mm)
Band	LTE band 13(1 RB#0)

SURFACE SAR

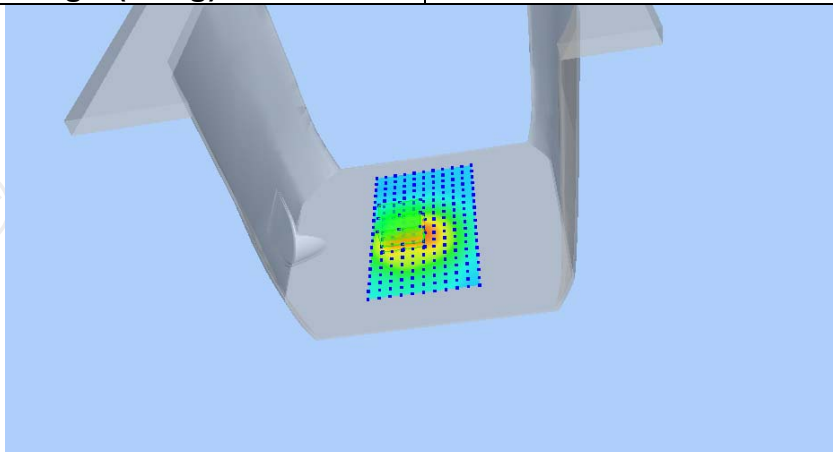


VOLUME SAR

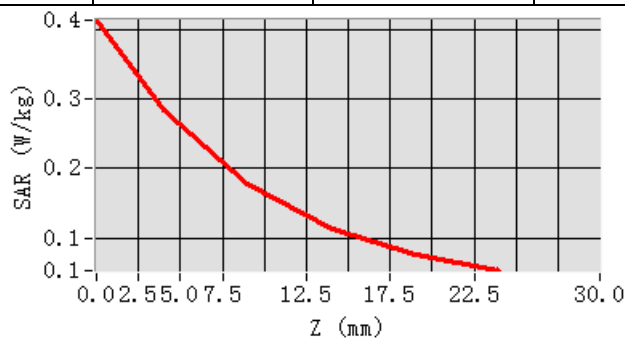


Maximum location: X=-15.00, Y=-7.00 SAR Peak: 0.42 W/kg

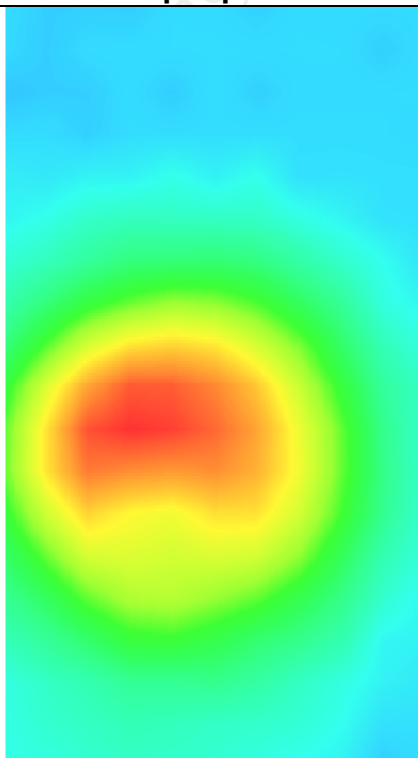
SAR 10g (W/Kg)	0.164354
SAR 1g (W/Kg)	0.269664



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4131	0.2842	0.1773	0.1137	0.0770



Hot spot position



LTE Band 14

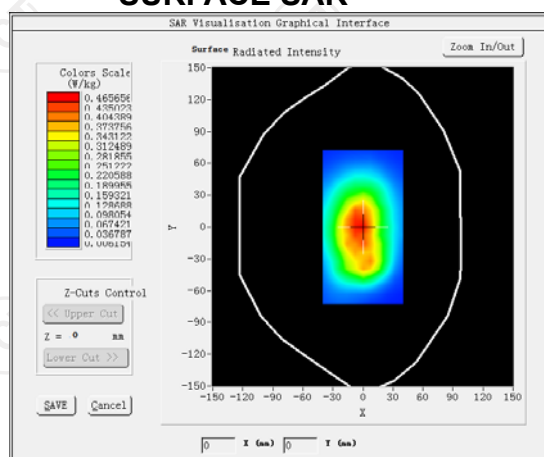
MEASUREMENT 1

Middle Band SAR (Channel 23330):

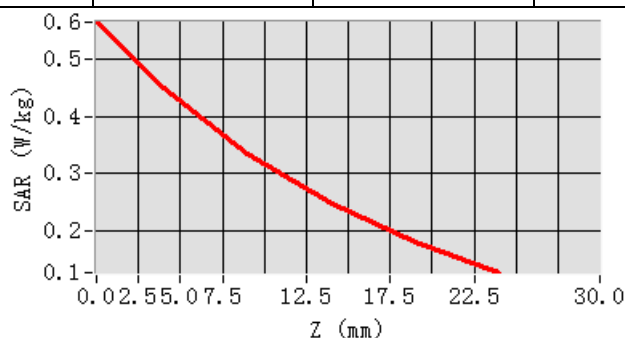
Date: 08/02/2021

Frequency (MHz)	793.000000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	1.140000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body front(10mm)
Band	LTE band 14 (1 RB#0)

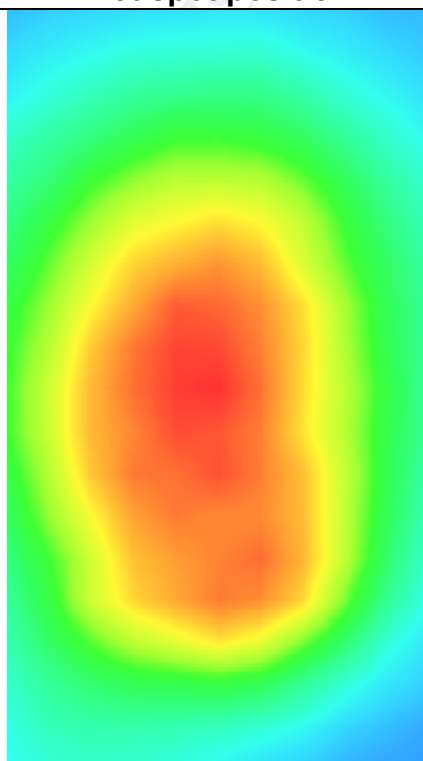
SURFACE SAR



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.5960	0.4500	0.3404	0.2484	0.1810



Hot spot position



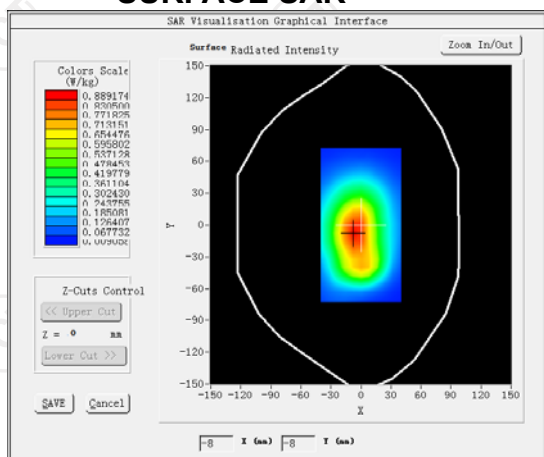
MEASUREMENT 2

Middle Band SAR (Channel 23330):

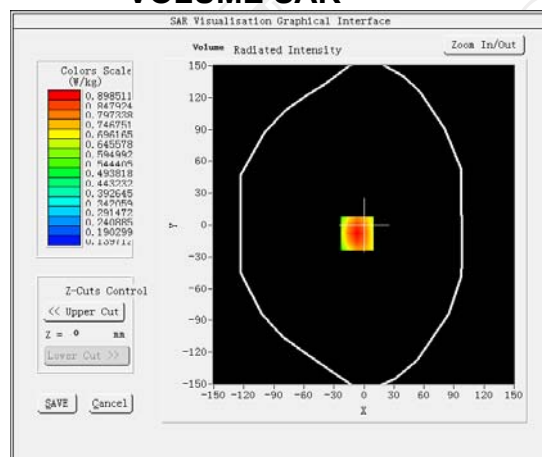
Date: 08/02/2021

Frequency (MHz)	793.000000
Relative permittivity (real part)	55.260832
Relative permittivity (imaginary part)	12.468860
Conductivity (S/m)	0.934272
Variation (%)	-1.130000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(0mm)
Band	LTE band 14(1 RB#0)

SURFACE SAR



VOLUME SAR



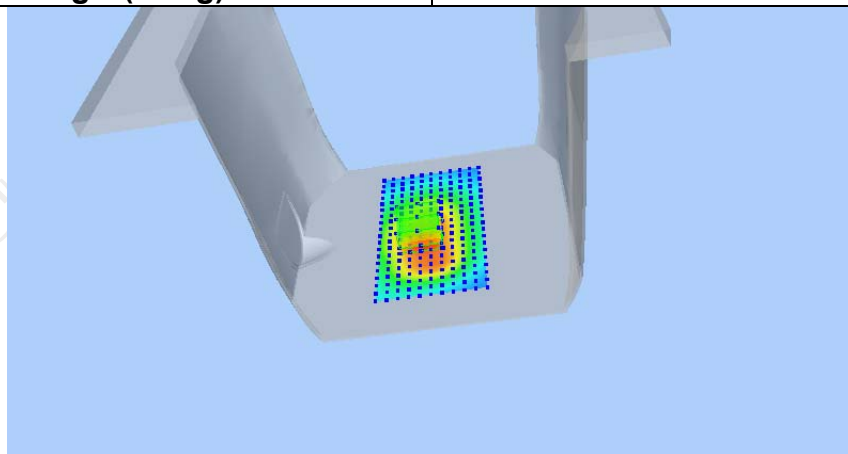
Maximum location: X=-17.00, Y=-18.00 SAR Peak: 1.18 W/kg

SAR 10g (W/Kg)

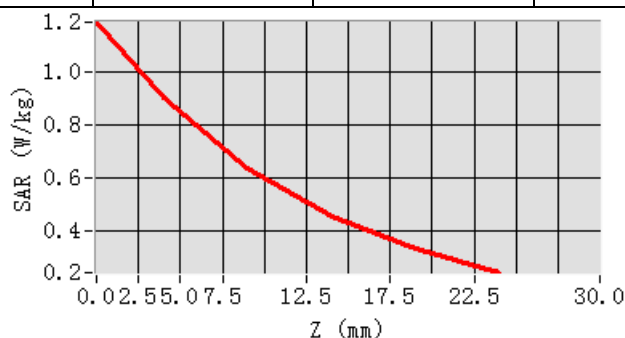
0.462450

SAR 1g (W/Kg)

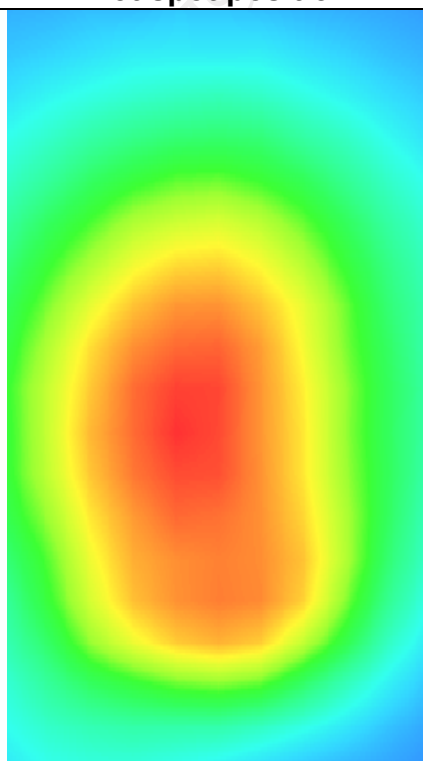
0.871432



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.1851	0.9016	0.6420	0.4625	0.3340



Hot spot position



LTE Band 17

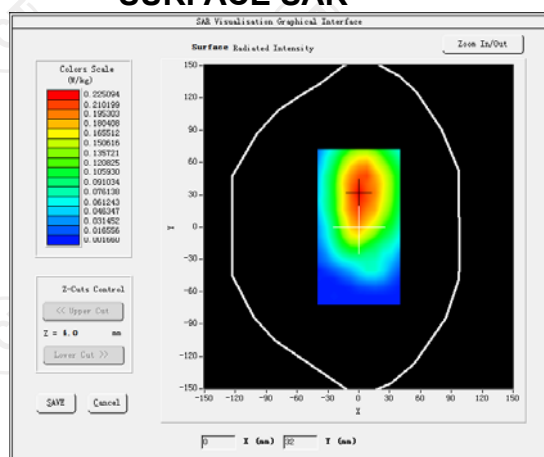
MEASUREMENT 1

Middle Band SAR (Channel 23790):

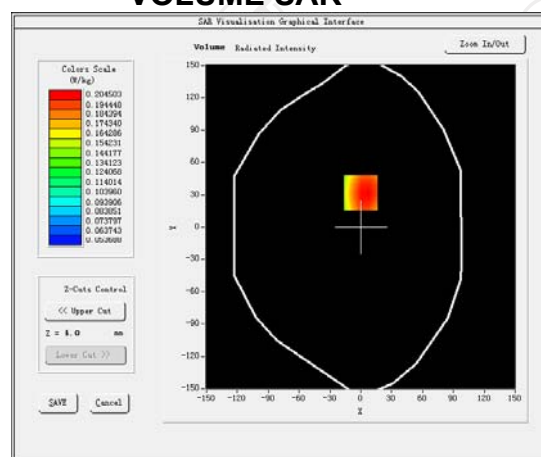
Date: 08/02/2021

Frequency (MHz)	710.000000
Relative permittivity (real part)	55.263812
Relative permittivity (imaginary part)	12.468867
Conductivity (S/m)	0.930822
Variation (%)	-1.360000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body front(10mm)
Band	LTE band 17(1 RB#24)

SURFACE SAR

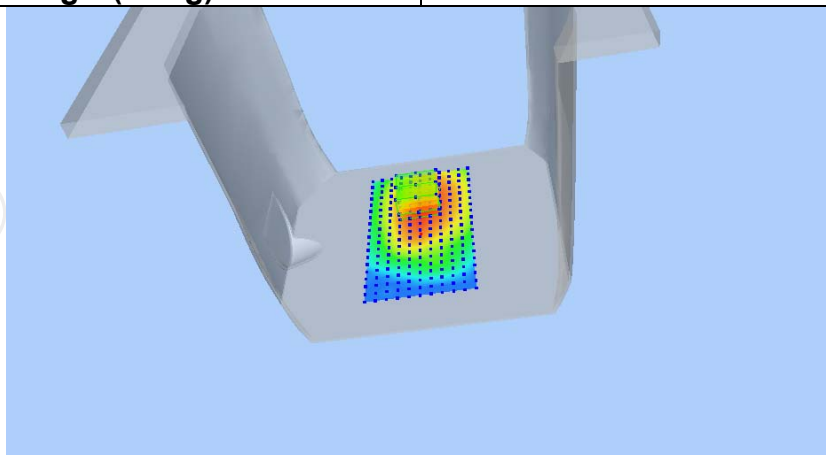


VOLUME SAR

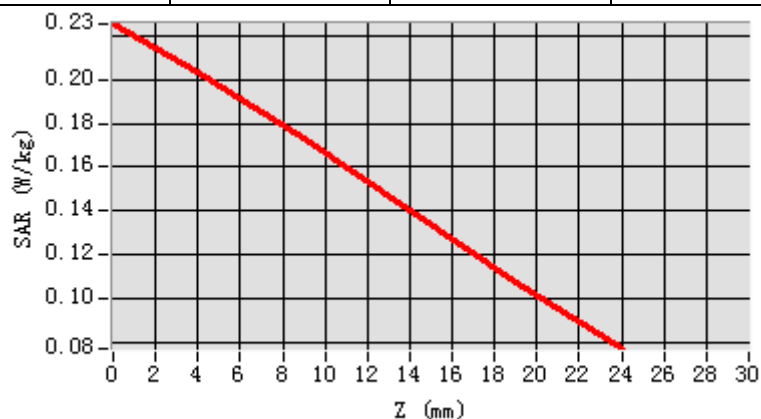


Maximum location: X=0.00, Y=32.00 SAR Peak: 0.23 W/kg

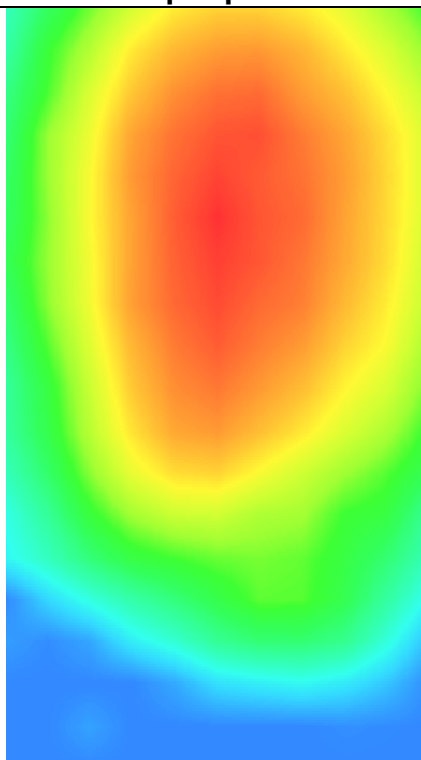
SAR 10g (W/Kg)	0.163761
SAR 1g (W/Kg)	0.211528



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2255	0.2037	0.1731	0.1402	0.1071



Hot spot position



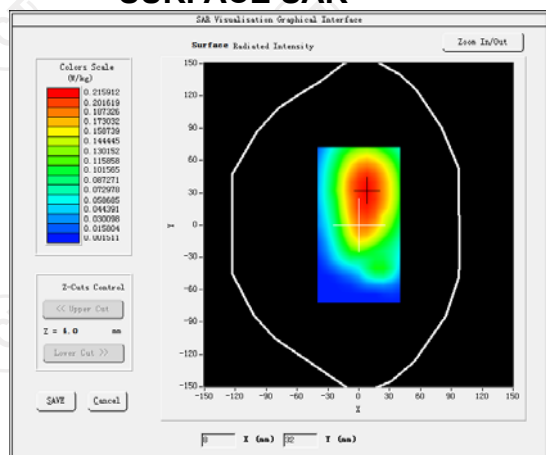
MEASUREMENT 2

Middle Band SAR (Channel 23790):

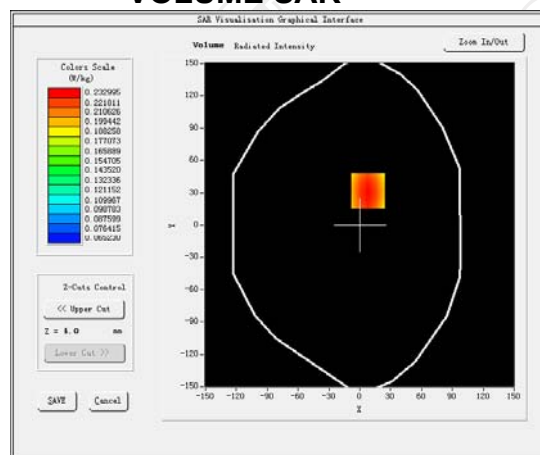
Date: 08/02/2021

Frequency (MHz)	710.000000
Relative permittivity (real part)	55.263812
Relative permittivity (imaginary part)	12.468867
Conductivity (S/m)	0.881392
Variation (%)	3.610000
Crest Factor	1.0
Probe Conversion factor	1.86
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7, dx=8mm dy=8mm dz=5mm, Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(0mm)
Band	LTE band 17(1 RB#24)

SURFACE SAR

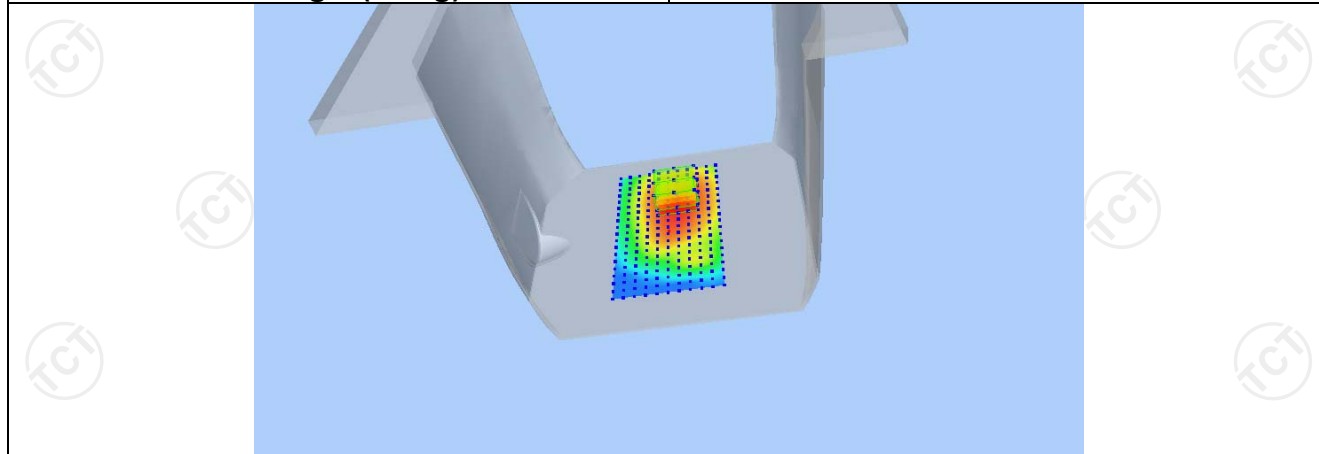


VOLUME SAR

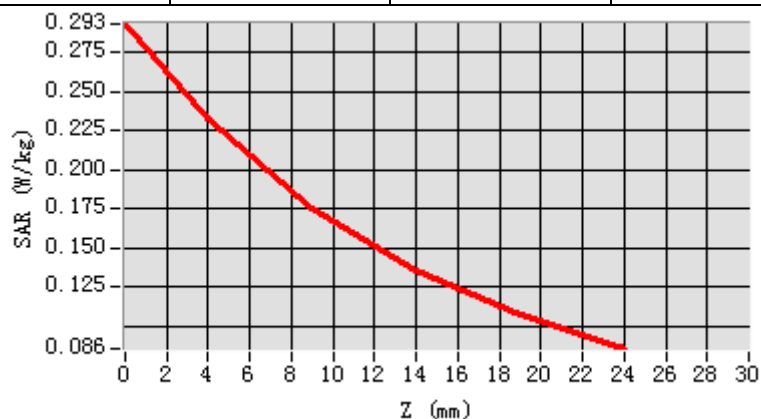


Maximum location: X=8.00, Y=32.00 SAR Peak: 0.29 W/kg

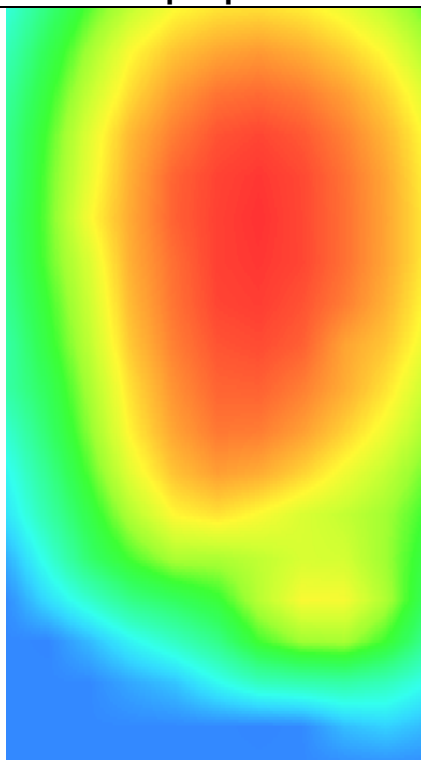
SAR 10g (W/Kg)	0.174627
SAR 1g (W/Kg)	0.238358



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2934	0.2330	0.1761	0.1359	0.1077



Hot spot position

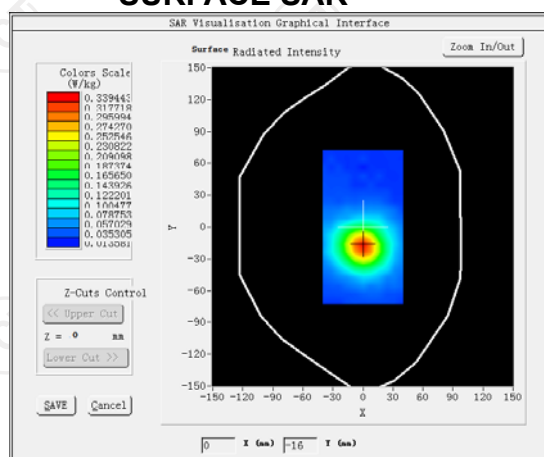


WLAN 2.4G

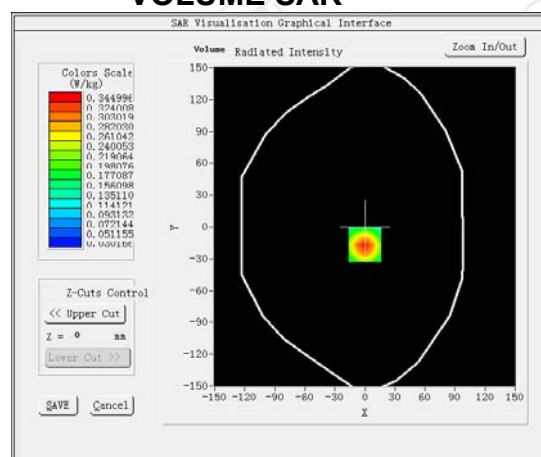
MEASUREMENT 1

Hight Band SAR (Channel11):		Date: 08/16/2021
Frequency (MHz)	2462.00000	
Relative permittivity (real part)	54.630667	
Relative permittivity (imaginary part)	14.318428	
Conductivity (S/m)	1.982536	
Variation (%)	-0.920000	
Crest Factor	1.0	
Probe Conversion factor	2.37	
E-Field Probe:	SSE2 (SN 36/20 EPG0346)	
Area Scan	dx=8mm dy=8mm, h= 5.00 mm	
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm	
Phantom	Validation plane	
Device Position	Body front(10mm)	
Band	IEEE 802.11b ISM	

SURFACE SAR

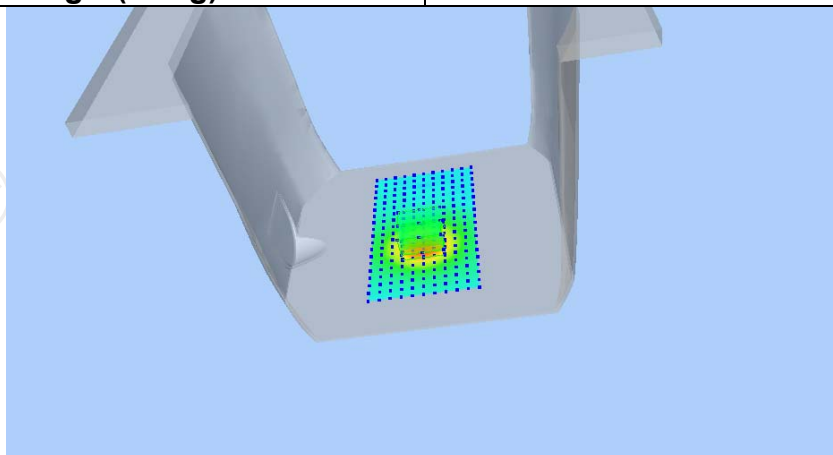


VOLUME SAR

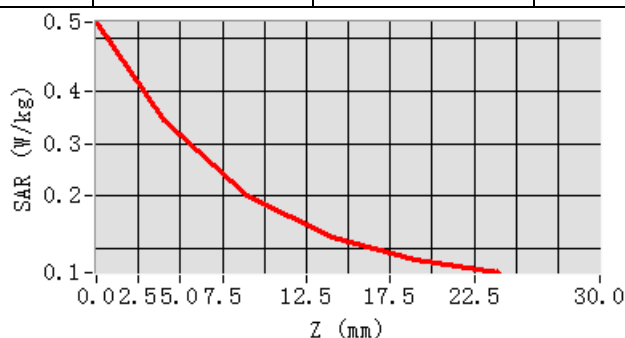


Maximum location: X=0.00, Y=-17.00 SAR Peak: 0.53 W/kg

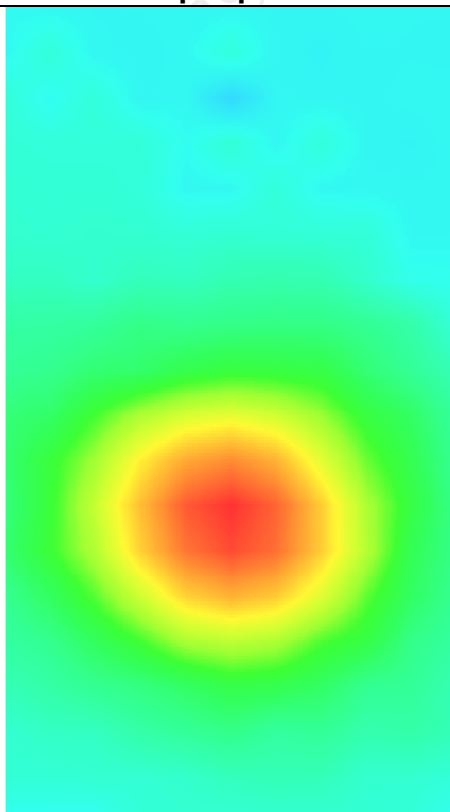
SAR 10g (W/Kg)	0.183656
SAR 1g (W/Kg)	0.324113



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.5314	0.3450	0.1993	0.1197	0.0785



Hot spot position



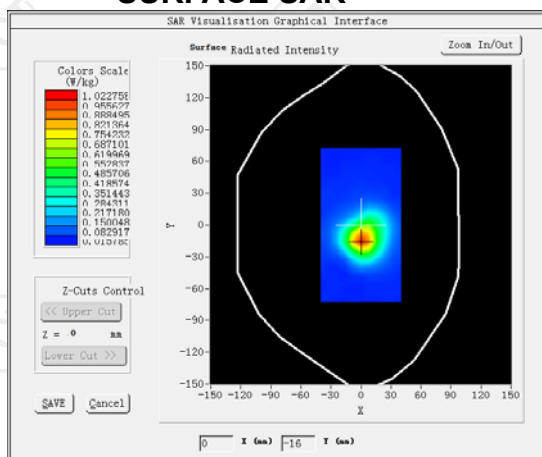
MEASUREMENT 2

Hight Band SAR (Channel11):

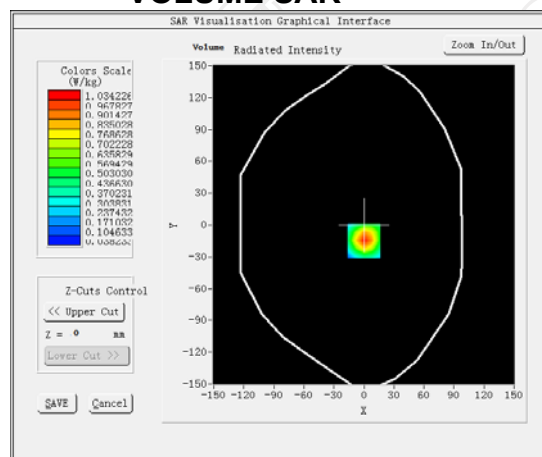
Date: 08/16/2021

Frequency (MHz)	2462.000000
Relative permittivity (real part)	54.630667
Relative permittivity (imaginary part)	14.318428
Conductivity (S/m)	1.982536
Variation (%)	-0.760000
Crest Factor	1.0
Probe Conversion factor	2.37
E-Field Probe:	SSE2 (SN 36/20 EPG0346)
Area Scan	dx=8mm dy=8mm, h= 5.00 mm
ZoomScan	5x5x7,dx=8mm dy=8mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm
Phantom	Validation plane
Device Position	Body back(0mm)
Band	IEEE 802.11b ISM

SURFACE SAR

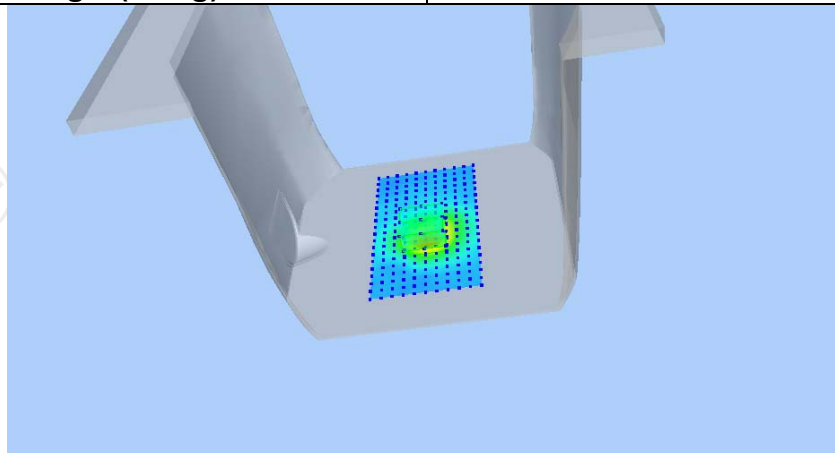


VOLUME SAR

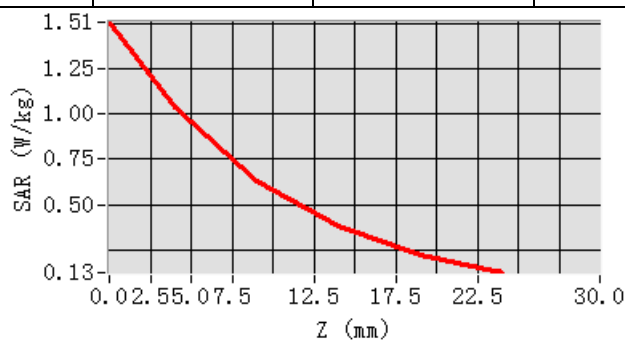


Maximum location: X=0.00, Y=-15.00 SAR Peak: 1.53 W/kg

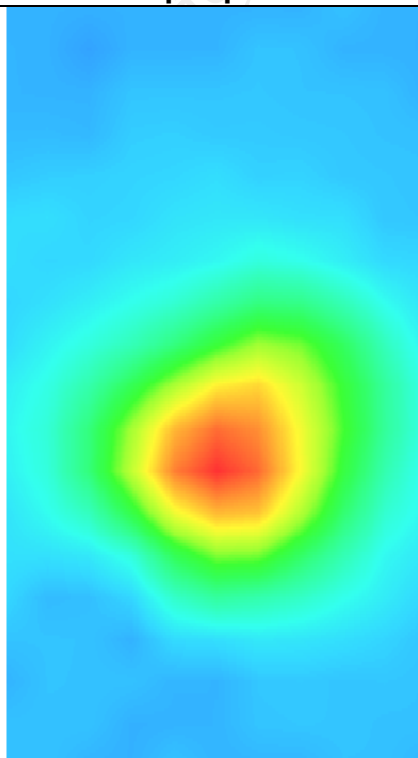
SAR 10g (W/Kg)	0.503467
SAR 1g (W/Kg)	0.953655



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.5063	1.0342	0.6312	0.3795	0.2260



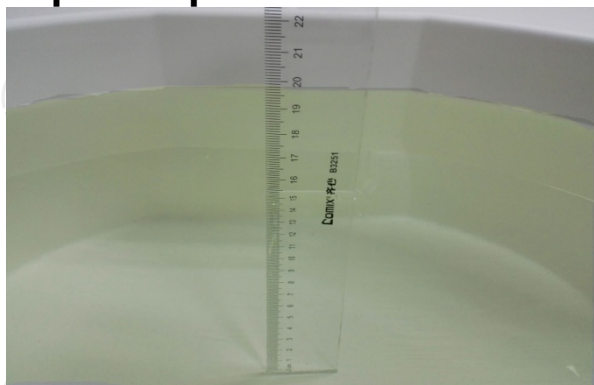
Hot spot position



13. Appendix A: EUT Photos



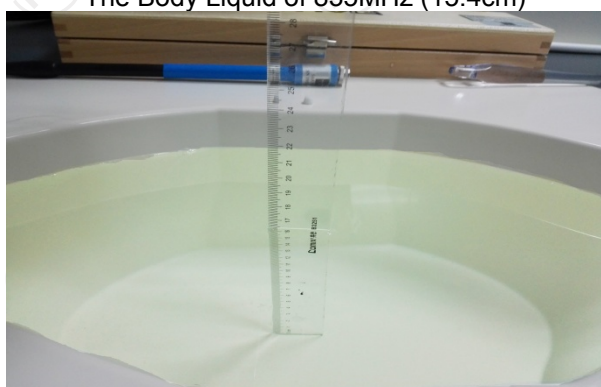
Liquid depth



The Body Liquid of 835MHz (15.4cm)



The Body Liquid of 1800MHz (15.2 cm)



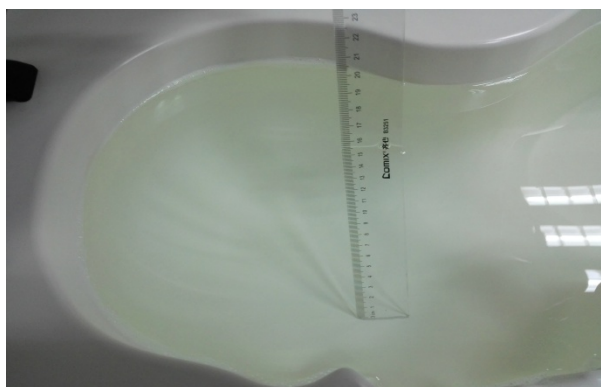
The Body Liquid of 1900MHz (16.4 cm)



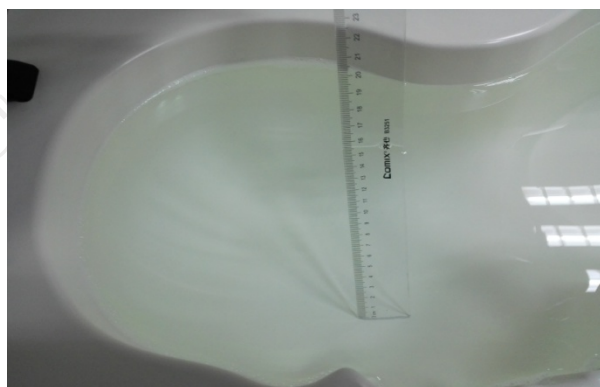
The Body Liquid of 2450MHz (15.3cm)



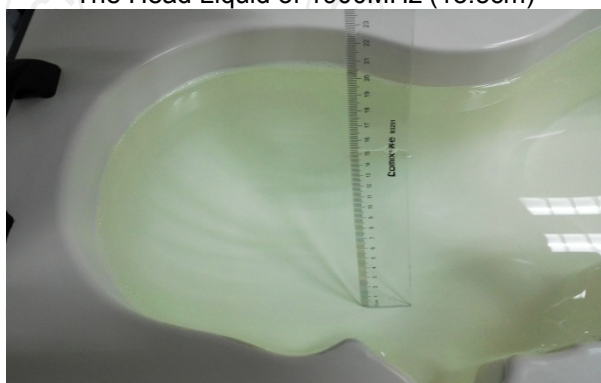
The Body Liquid of 2600MHz (16.5cm)



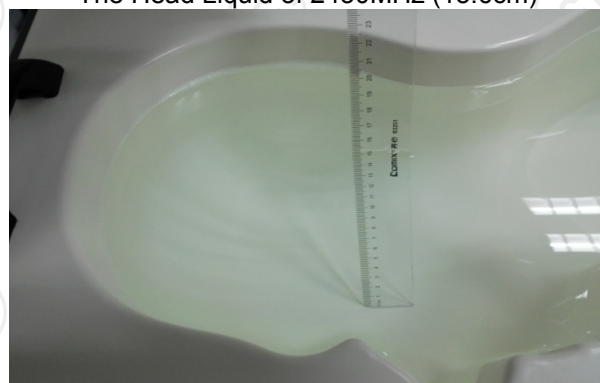
The Head Liquid of 1900MHz (15.5cm)



The Head Liquid of 2450MHz (15.6cm)



The Head Liquid of 835MHz (15.3cm)

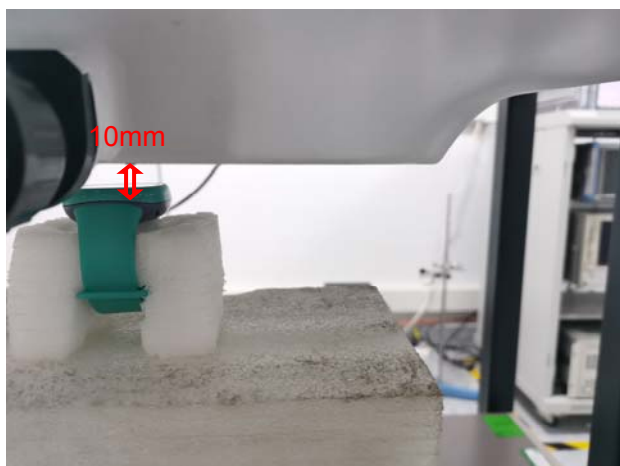


The Head Liquid of 1800MHz (15.2cm)



The Head Liquid of 1800MHz (15.2cm)

Appendix B: Test Setup Photos



Front to face-Front (10mm)



Wrist Worn -Back (0 mm)

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 EPGO346

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

Calibration date: 10/23/2020



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.297.1.20.MVGB.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Technical Manager	10/23/2020	<i>JS</i>
Checked by :	Jérôme LUC	Technical Manager	10/23/2020	<i>JS</i>
Approved by :	Yann Toutain	Laboratory Director	10/26/2020	<i>Yann Toutain</i>

2020.10.2
6 09:25:59
+01'00'

	Customer Name
Distribution :	SHENHEN TONGCE TESTING LAB.

Issue	Name	Date	Modifications
A	Jérôme LUC	10/23/2020	Initial release



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

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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 Dipole 2: R2=0.245 MΩ 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.



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:

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

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., $\delta \approx 14$ 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.297.1.20.MVGB.A

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 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 1 (μV/(V/m) ²)	Normy dipole 2 (μV/(V/m) ²)	Normz dipole 3 (μV/(V/m) ²)
0.81	0.71	0.80

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (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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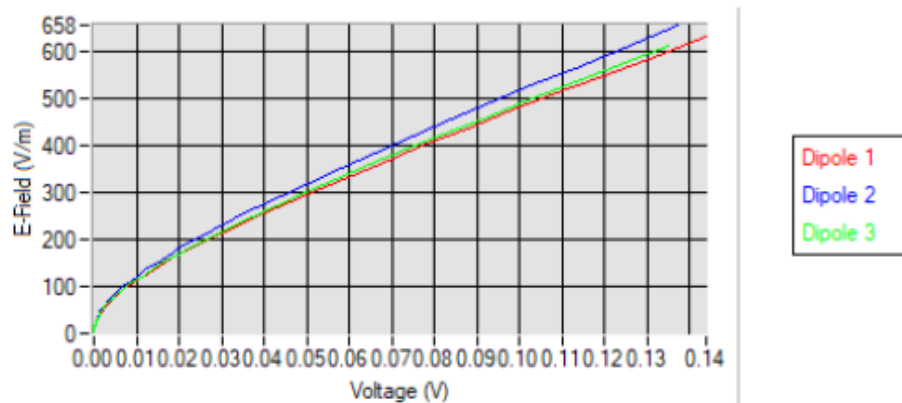
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COMOSAR E-FIELD PROBE CALIBRATION REPORT

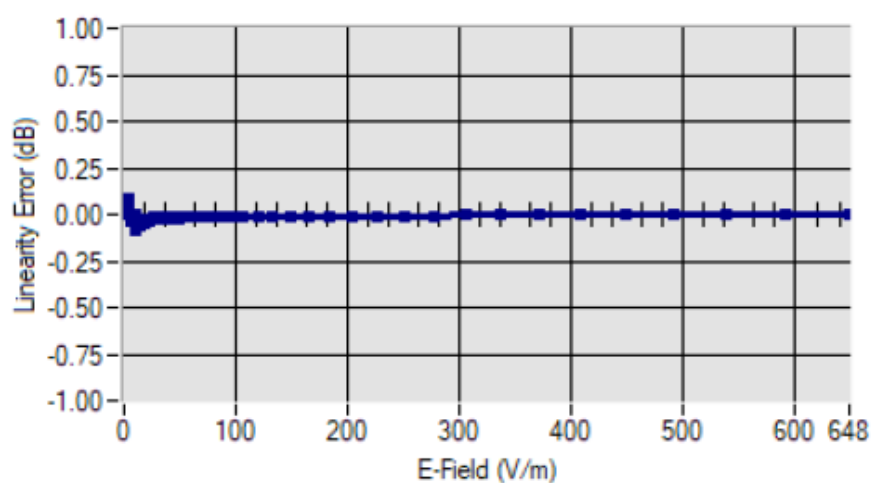
Ref: ACR.297.1.20.MVGB.A

Calibration curves



5.2 LINEARITY

Linearity



Linearity: $\pm 1.97\%$ ($\pm 0.09\text{dB}$)



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

5.3 SENSITIVITY IN LIQUID

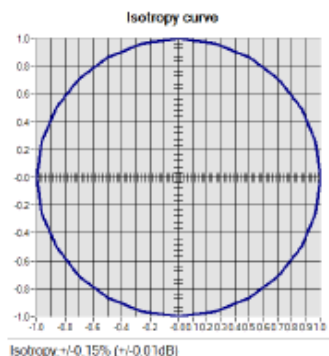
Liquid	Frequency (MHz +/- 100MHz)	ConvF	Epsilon (S/m)	Permittivity
HL750	750	1.71	0.93	40.76
BL750	750	1.78	0.98	56.70
HL900	900	1.91	0.93	41.94
BL900	900	1.96	0.98	54.62
HL1800	1800	2.08	1.29	40.86
BL1800	1800	2.16	1.47	52.27
HL2000	2000	2.03	1.42	38.37
BL2000	2000	2.10	1.52	52.03
HL2450	2450	2.31	1.80	38.72
BL2450	2450	2.37	1.97	54.91
HL2600	2600	2.16	1.89	39.98
BL2600	2600	2.23	2.18	54.42
HL5200	5200	2.01	4.45	36.68
BL5200	5200	2.08	5.46	49.02
HL5800	5800	2.06	5.08	34.81
BL5800	5800	2.13	6.12	47.81

LOWER DETECTION LIMIT: 8mW/kg



5.4 ISOTROPY

HL1800 MHz





COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.297.1.20.MVGB.A

6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
Flat Phantom	MVG	SN-20/09-SAM71	Validated. No cal required.	Validated. No cal required.
COMOSAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rohde & Schwarz ZVM	100203	05/2019	05/2022
Network Analyzer – Calibration kit	Rohde & Schwarz ZV-Z235	101223	05/2019	05/2022
Multimeter	Keithley 2000	1160271	02/2020	02/2023
Signal Generator	Rohde & Schwarz SMB	106589	04/2019	04/2022
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	NI-USB 5680	170100013	05/2019	05/2022
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Waveguide	Mega Industries	069Y7-158-13-712	Validated. No cal required.	Validated. No cal required.
Waveguide Transition	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Waveguide Termination	Mega Industries	069Y7-158-13-701	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44220687	05/2020	05/2023

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Dielectric Probe Calibration Report

Ref : ACR.138.4.33.SATU.A

SHENZHEN TONGCE TESTING LAB.
TCT TESTING INDUSTRIAL PARK, FUQIAO 5TH INDUSTRIAL
ZONE, FUHAI STREET, BAOAN DISTRICT, SHENZHEN CHINA
MVG COMOSAR DOSIMETRIC E-FIELD PROBE

FREQUENCY: 0.3-6 GHZ
SERIAL NO.: SN 19/15 OCPG 71

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 06/05/2021

Summary:

This document presents the method and results from an accredited Dielectric Probe calibration performed in MVG USA using the LIMESAR test bench. All calibration results are traceable to national metrology institutions.



SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.138.4.33.SATUA

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	06/05/2021	<i>JS</i>
Checked by :	Jérôme LUC	Product Manager	06/05/2021	<i>JS</i>
Approved by :	Kim RUTKOWSKI	Quality Manager	06/05/2021	<i>Kim Rutkowski</i>

	Customer Name
Distribution :	SHENZHEN TONGCE TESTING LAB

Issue	Date	Modifications
A	06/05/2021	Initial release

Page: 2/7

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SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.138.4.33..SATU.A

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SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.138.4.33..SATU.A

1 INTRODUCTION

This document contains a summary of the suggested methods and requirements set forth by the IEEE 1528 and CEI/IEC 62209 standards for liquid permittivity measurements 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	LIMESAR DIELECTRIC PROBE
Manufacturer	MVG
Model	SCLMP
Serial Number	SN 19/15 OCPG 71
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

MVG's Dielectric Probes are built in accordance to the IEEE 1528 and CEI/IEC 62209 standards. The product is designed for use with the LIMESAR test bench only.

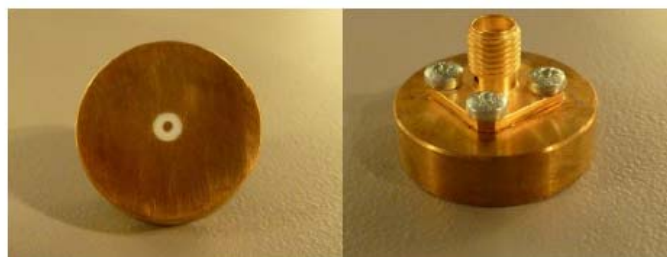


Figure 1 – MVG LIMESAR Dielectric Probe

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4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209-1 & 2 standards outline techniques for dielectric property measurements. The LIMESAR test bench employs one of the methods outlined in the standards, using a contact probe or open-ended coaxial transmission-line probe and vector network analyzer. The standards recommend the measurement of two reference materials that have well established and stable dielectric properties to validate the system, one for the calibration and one for checking the calibration. The LIMESAR test bench uses De-ionized water as the reference for the calibration and either DMS or Methanol as the reference for checking the calibration. The following measurements were performed to verify that the product complies with the fore mentioned standards.

4.1 LIQUID PERMITTIVITY MEASUREMENTS

The permittivity of a liquid with well established dielectric properties was measured and the measurement results compared to the values provided in the fore mentioned standards.

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 DIELECTRIC PERMITTIVITY MEASUREMENT

The following uncertainties apply to the Dielectric Permittivity measurement:

Uncertainty analysis of Permittivity Measurement					
ERROR SOURCES	Uncertainty value (+/- %)	Probability Distribution	Divisor	ci	Standard Uncertainty (+/- %)
Repeatability (n repeats, mid-band)	4.00%	N	1	1	4.000%
Deviation from reference liquid	5.00%	R	$\sqrt{3}$	1	2.887%
Network analyser-drift, linearity	2.00%	R	$\sqrt{3}$	1	1.155%
Test-port cable variations	0.00%	U	$\sqrt{2}$	1	0.000%
Combined standard uncertainty					5.066%
Expanded uncertainty (confidence level of 95%, $k = 2$)					10.0%

Uncertainty analysis of Conductivity Measurement					
ERROR SOURCES	Uncertainty value (+/- %)	Probability Distribution	Divisor	ci	Standard Uncertainty (+/- %)
Repeatability (n repeats, mid-band)	3.50%	N	1	1	3.500%
Deviation from reference liquid	3.00%	R	$\sqrt{3}$	1	1.732%
Network analyser-drift, linearity	2.00%	R	$\sqrt{3}$	1	1.155%
Test-port cable variations	0.00%	U	$\sqrt{2}$	1	0.000%
Combined standard uncertainty					4.072%
Expanded uncertainty (confidence level of 95%, $k = 2$)					8.1%

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SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.138.4.33..SATU.A

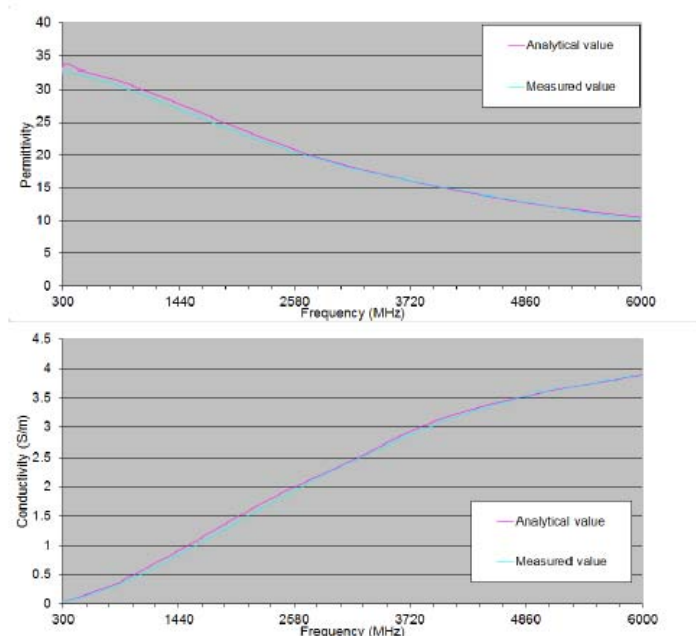
6 CALIBRATION MEASUREMENT RESULTS

Measurement Condition

Software	LIMESAR
Liquid Temperature	21°C
Lab Temperature	21°C
Lab Humidity	44%

6.1 LIQUID PERMITTIVITY MEASUREMENT

A liquid of known characteristics (methanol at 20°C) is measured with the probe and the results (complex permittivity $\epsilon' + j\epsilon''$) are compared with the well-known theoretical values for this liquid.



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SAR DIELECTRIC PROBE CALIBRATION REPORT

Ref: ACR.138.4.33..SATU.A

7 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
LIMESAR Test Bench	Version 3	NA	Validated. No cal required.	Validated. No cal required.
Network Analyzer	Rhode & Schwarz ZVA	SN100132	02/2021	02/2024
Methanol CAS 67-56-1	Alpha Aesar	Lot D13W011	Validated. No cal required.	Validated. No cal required.
Temperature and Humidity Sensor	Control Company	11-661-9	09/2021	09/2022

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14. Appendix D: Dipole Calibration Report

SID 750



SAR Reference Dipole Calibration Report

Ref : ACR.156.3.15.SATU.A

SHENZHEN TONGCE TESTING LAB.
TCT TESTING INDUSTRIAL PARK, FUQIAO 5TH INDUSTRIAL
ZONE, FUHAI STREET, BAOAN DISTRICT, SHENZHEN
GUANGDONG, 518103, PEOPLES REPUBLIC OF CHINA

COMOSAR REFERENCE DIPOLE
FREQUENCY: 750 MHZ
SERIAL NO.: SN 16/15 DIP 0G750-368

Calibrated at MVG US
2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 06/05/2021

Summary:

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



SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.3.15.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	06/05/2021	<i>JS</i>
Checked by :	Jérôme LUC	Product Manager	06/05/2021	<i>JS</i>
Approved by :	Kim RUTKOWSKI	Quality Manager	06/05/2021	<i>Kim Rutkowski</i>

	Customer Name
Distribution :	SHENZHEN TONGC TESTING LAB

Issue	Date	Modifications
A	06/05/2021	Initial release

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.3.15.SATU.A

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs and CEI/IEC 62209 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 750 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID750
Serial Number	SN 16/15 DIP 0G750-368
Product Condition (new / used)	Used

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

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



Figure 1 – MVG COMOSAR Validation Dipole

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4 MEASUREMENT METHOD

The IEEE 1528, FCC KDBs and CEI/IEC 62209 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.

4.2 MECHANICAL REQUIREMENTS

The IEEE Std. 1528 and CEI/IEC 62209 standards specify the mechanical components and dimensions of the validation dipoles, with the dimensions 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.

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	0.1 dB

5.2 DIMENSION MEASUREMENT

The following uncertainties apply to the dimension measurements:

Length (mm)	Expanded Uncertainty on Length
3 - 300	0.05 mm

5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

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