

MEASUREMENT 2

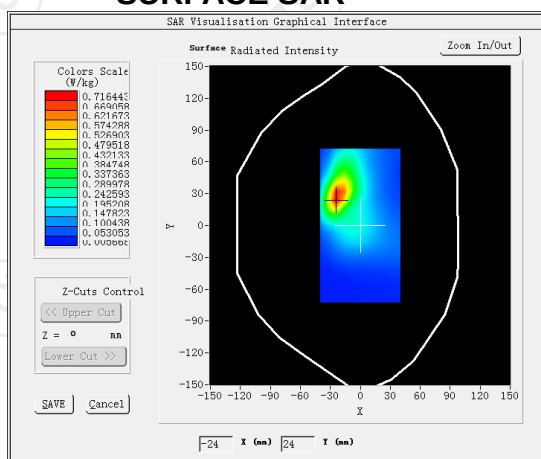
High Band SAR (Channel 20600):

Date: 03/08/2024

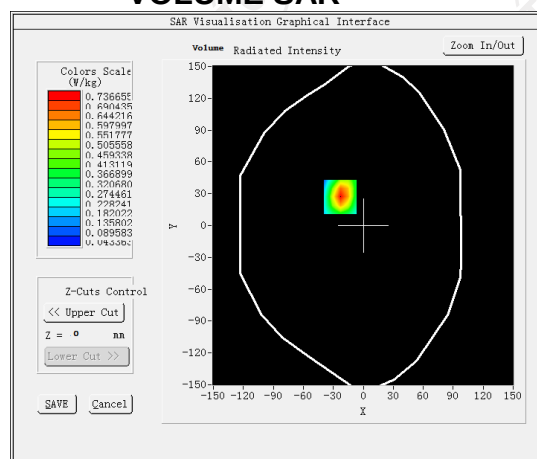
Frequency (MHz)	844.000000
Relative permittivity (real part)	41.500000
Relative permittivity (imaginary part)	19.400000
Conductivity (S/m)	0.901561
Variation (%)	-0.780000
Crest Factor	1.0
Probe Conversion factor	1.80
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=8mm dy=8mm</u> <u>dz=5mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back((hotspot 0mm)
Band	LTE band 5(1 RB#0)

SURFACE SAR

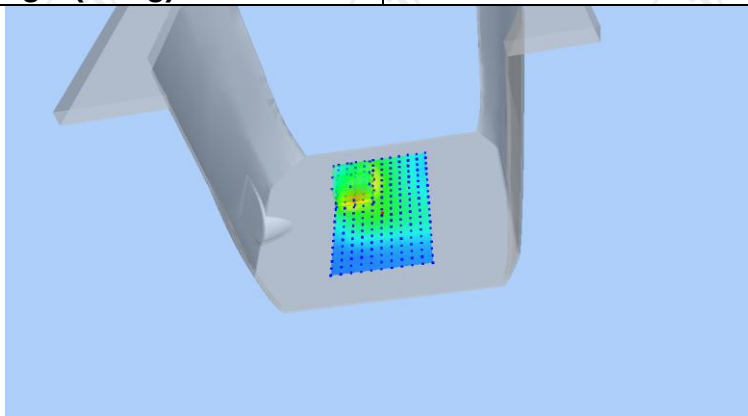


VOLUME SAR

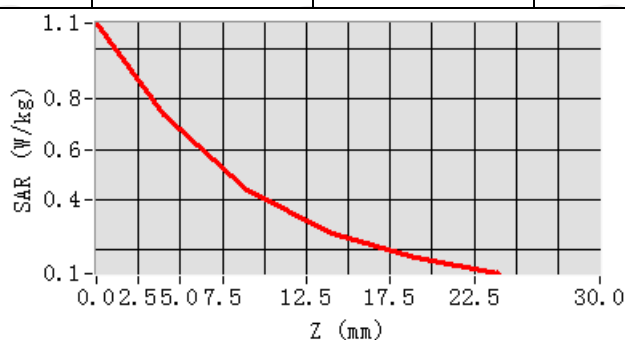


Maximum location: X=-23.00, Y=27.00 SAR Peak: 1.12W/kg

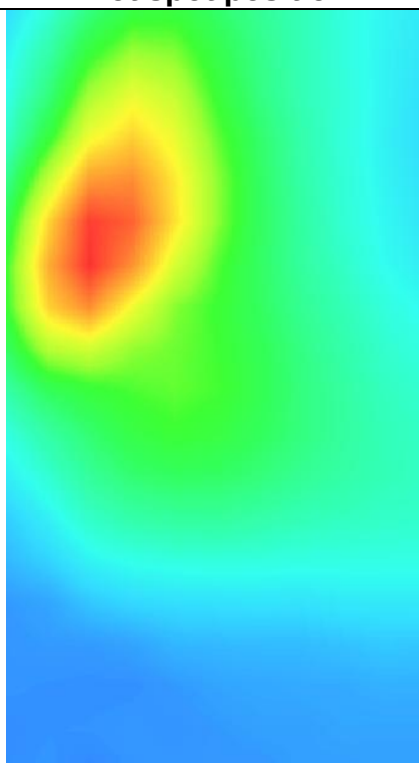
SAR 10g (W/Kg)	0.374761
SAR 1g (W/Kg)	0.685620



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.1048	0.7367	0.4371	0.2629	0.1648



Hot spot position

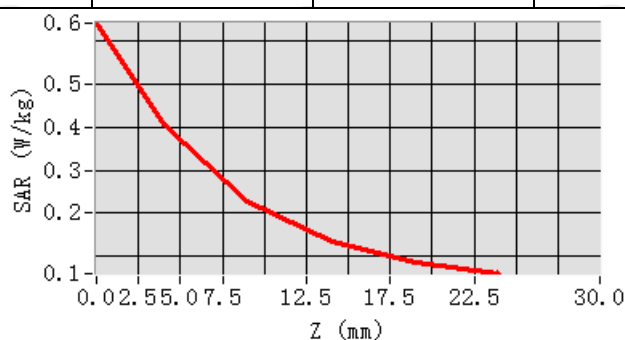


LTE Band 12

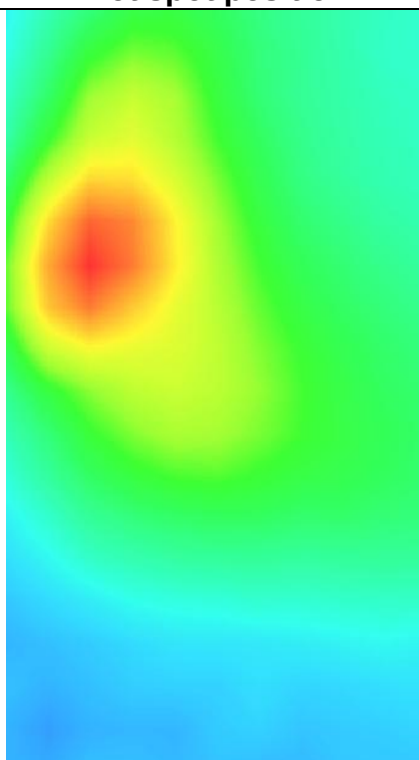
MEASUREMENT 1

High Band SAR (Channel 23130):		Date: 03/05/2024
Frequency (MHz)	710.000000	
Relative permittivity (real part)	42.126667	
Relative permittivity (imaginary part)	23.264000	
Conductivity (S/m)	0.914404	
Variation (%)	-1.130000	
Crest Factor	1.0	
Probe Conversion factor	1.71	
E-Field Probe:	SSE2 (SN 25/22 EPG0375)	
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#0)	
SURFACE SAR	VOLUME SAR	
SAR Visualisation Graphical Interface Surface Radiated Intensity Zoom In/Out Colors Scale (W/kg) 0.407925 0.381175 0.354521 0.327820 0.300718 0.273916 0.247115 0.220313 0.193512 0.166710 0.139908 0.113107 0.086305 0.059503 0.032702 0.005900 Z-Cuts Control << Upper Out Z = 0 mm Lower Out >> SAVE Cancel 150 120 90 60 30 0 -30 -60 -90 -120 -150 Y -150 -120 -90 -60 -30 0 30 60 90 120 150 X -24 24 mm Volume Radiated Intensity Zoom In/Out Colors Scale (W/kg) 0.407675 0.380925 0.354673 0.331620 0.308267 0.280914 0.255562 0.230208 0.204856 0.179503 0.154151 0.128798 0.103445 0.078092 0.052740 0.027387 Z-Cuts Control << Upper Out Z = 0 mm Lower Out >> SAVE Cancel 150 120 90 60 30 0 -30 -60 -90 -120 -150 Y -150 -120 -90 -60 -30 0 30 60 90 120 150 X -24 24 mm		
Maximum location: X=-23.00, Y=25.00 SAR Peak:0.65 W/kg		
SAR 10g (W/Kg)	0.210764	
SAR 1g (W/Kg)	0.388034	
</		

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.6419	0.4077	0.2283	0.1334	0.0863



Hot spot position



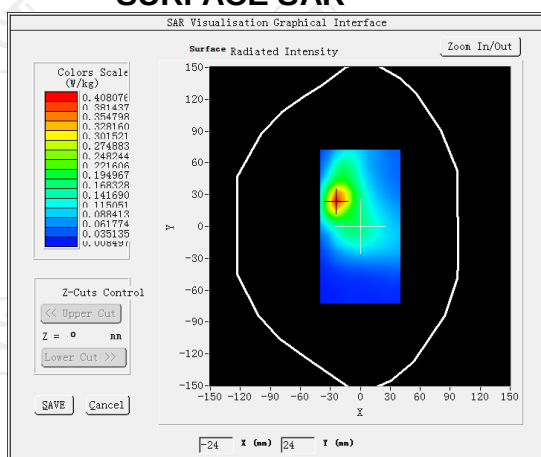
MEASUREMENT 2

High Band SAR (Channel 23130):

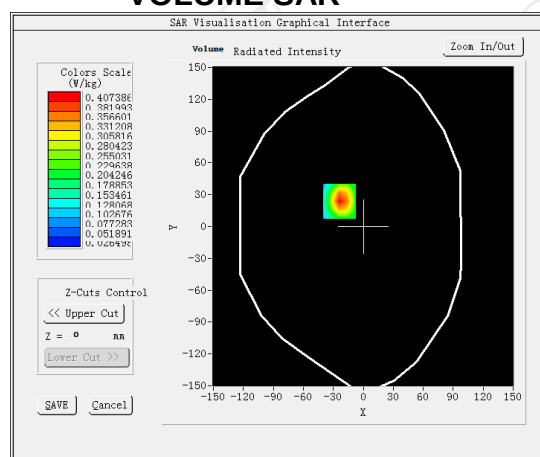
Date: 03/05/2024

Frequency (MHz)	710.000000
Relative permittivity (real part)	42.126667
Relative permittivity (imaginary part)	23.264000
Conductivity (S/m)	0.914404
Variation (%)	-0.600000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
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(hotspot 0mm)
Band	LTE band 12(1 RB#0)

SURFACE SAR

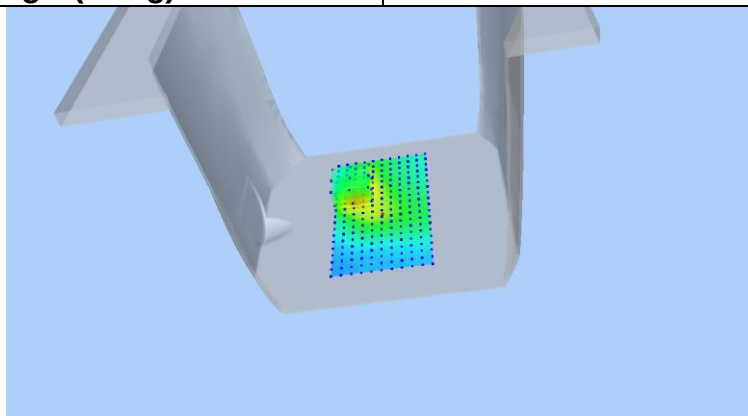


VOLUME SAR

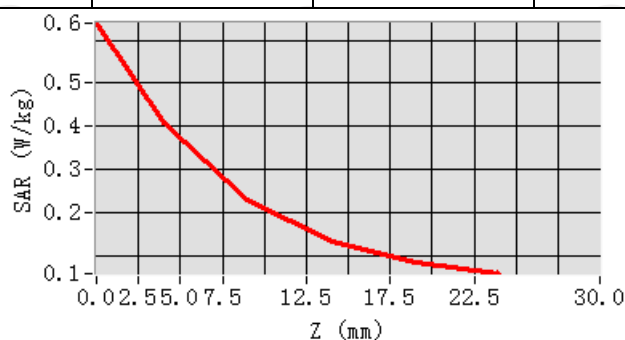


Maximum location: X=-24.00, Y=24.00 SAR Peak: 0.65W/kg

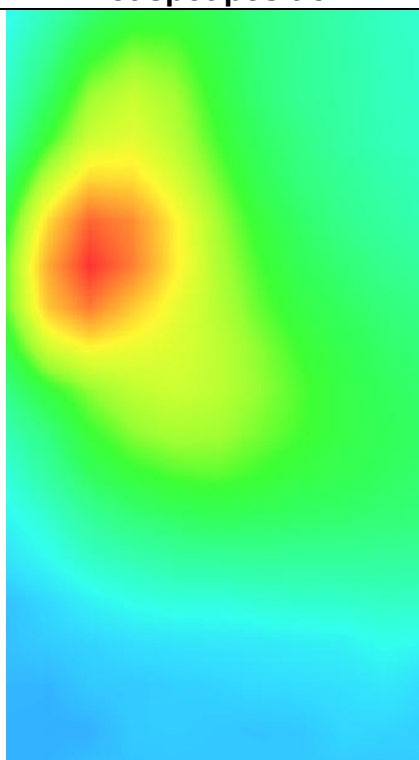
SAR 10g (W/Kg)	0.211542
SAR 1g (W/Kg)	0.388340



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.6391	0.4074	0.2291	0.1340	0.0864



Hot spot position

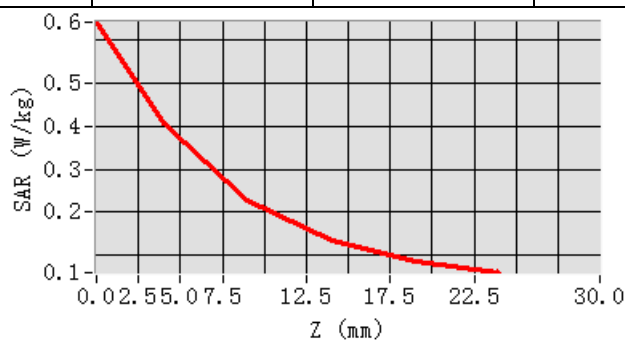


LTE Band 17

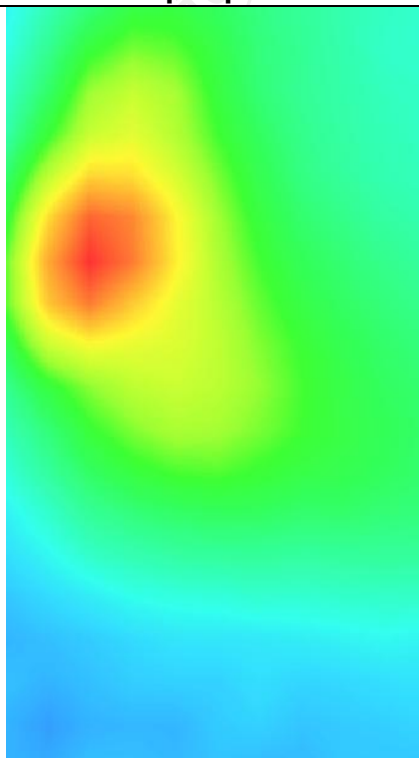
MEASUREMENT 1

High Band SAR (Channel 23130):		Date: 03/05/2024						
Frequency (MHz)	710.000000							
Relative permittivity (real part)	42.126667							
Relative permittivity (imaginary part)	23.264000							
Conductivity (S/m)	0.914404							
Variation (%)	-1.130000							
Crest Factor	1.0							
Probe Conversion factor	1.71							
E-Field Probe:	SSE2 (SN 25/22 EPG0375)							
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#0)							
SURFACE SAR	VOLUME SAR							
SAR Visualisation Graphical Interface Surface Radiated Intensity Zoom In/Out Colors Scale (W/kg) 0.407925 0.381175 0.354521 0.327870 0.300718 0.273916 0.247115 0.220313 0.193512 0.166710 0.139908 0.113107 0.086305 0.059503 0.032702 0.005900 Z-Cuts Control << Upper Out Z = 0 mm Lower Out >> SAVE Cancel 150 120 90 60 30 0 -30 -60 -90 -120 -150 Y -150 -120 -90 -60 -30 0 30 60 90 120 150 X -24 X (mm) 24 Y (mm) Volume Radiated Intensity Zoom In/Out Colors Scale (W/kg) 0.40767E 0.38072E 0.354973 0.331620 0.308267 0.280914 0.255562 0.230209 0.204856 0.179503 0.154151 0.128798 0.103445 0.078092 0.052740 0.027387 Z-Cuts Control << Upper Out Z = 0 mm Lower Out >> SAVE Cancel 150 120 90 60 30 0 -30 -60 -90 -120 -150 Y -150 -120 -90 -60 -30 0 30 60 90 120 150 X Maximum location: X=-23.00, Y=25.00 SAR Peak:0.65 W/kg SAR 10g (W/Kg) SAR 1g (W/Kg) <tr><td colspan="2">0.210764</td><td>0.388034</td></tr> <tr><td colspan="3"> </td></tr>			0.210764		0.388034			
0.210764		0.388034						

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.6419	0.4077	0.2283	0.1334	0.0863



Hot spot position



MEASUREMENT 2

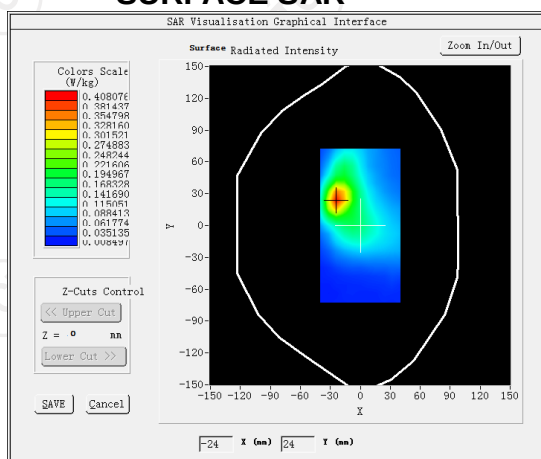
High Band SAR (Channel 23130):

Date: 03/05/2024

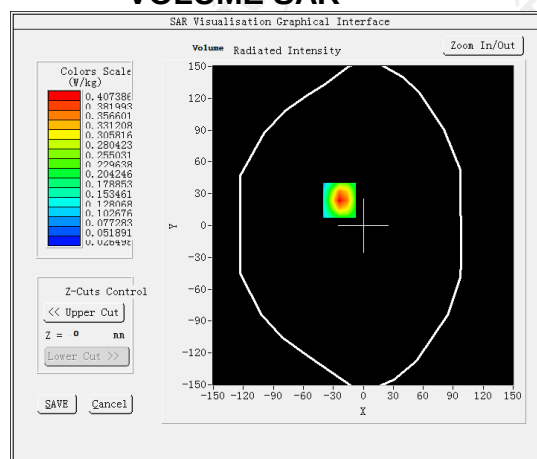
Frequency (MHz)	710.000000
Relative permittivity (real part)	42.126667
Relative permittivity (imaginary part)	23.264000
Conductivity (S/m)	0.914404
Variation (%)	-0.600000
Crest Factor	1.0
Probe Conversion factor	1.71
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=8mm dy=8mm</u> <u>dz=5mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back(hotspot 0mm)
Band	LTE band 12(1 RB#0)

SURFACE SAR

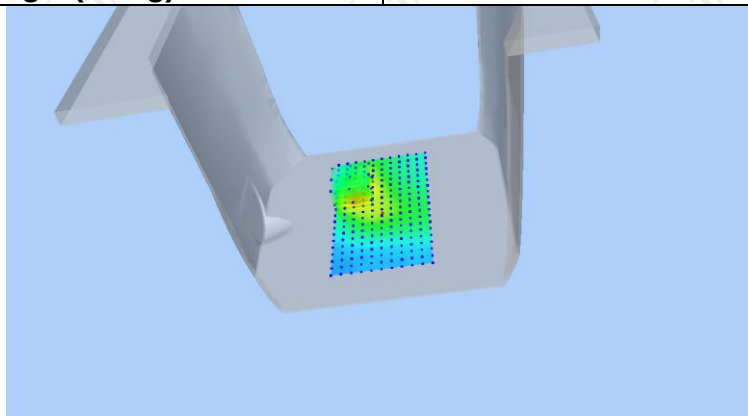


VOLUME SAR

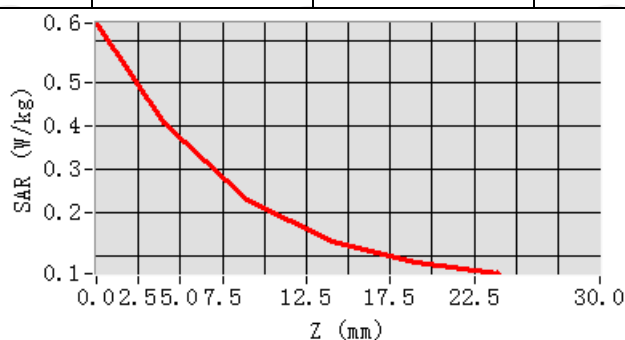


Maximum location: X=-24.00, Y=24.00 SAR Peak: 0.65W/kg

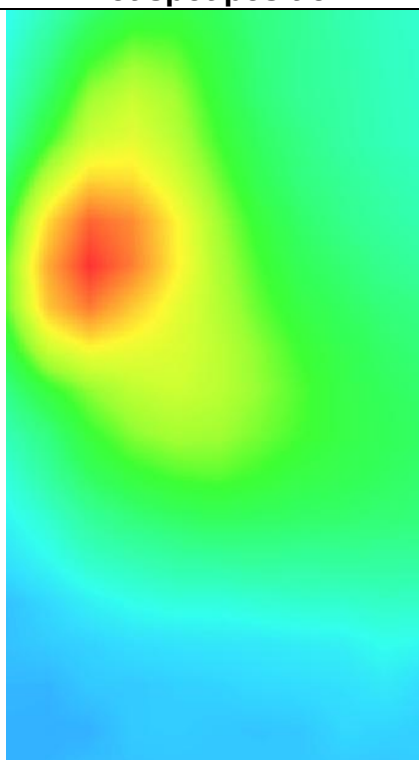
SAR 10g (W/Kg)	0.211542
SAR 1g (W/Kg)	0.388340



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.6391	0.4074	0.2291	0.1340	0.0864



Hot spot position



LTE Band 41

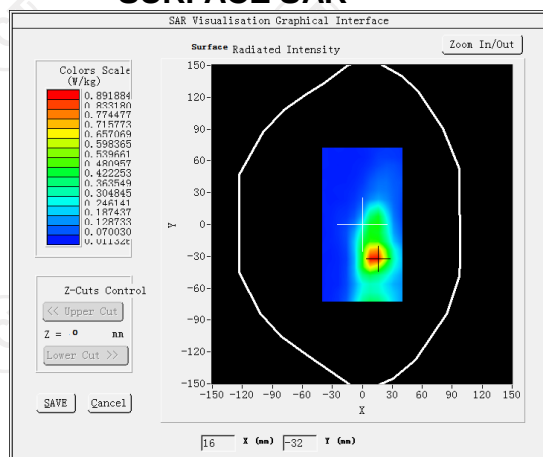
MEASUREMENT 1

Middle Band SAR (Channel 40620):

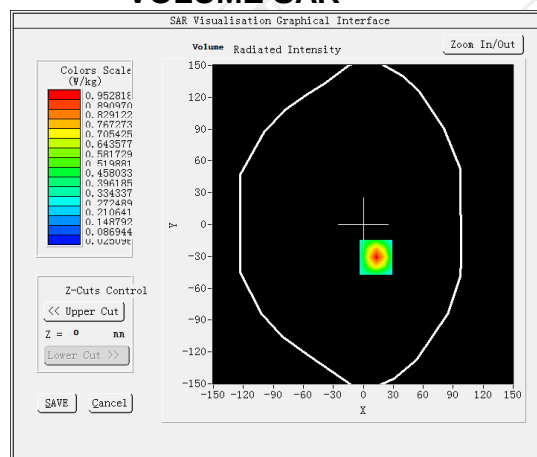
Date: 03/25/2024

Frequency (MHz)	2593.000000
Relative permittivity (real part)	42.126667
Relative permittivity (imaginary part)	23.264000
Conductivity (S/m)	0.914404
Variation (%)	-3.230000
Crest Factor	1.0
Probe Conversion factor	4.36
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	Validation plane
Device Position	Body back(0mm)
Band	<u>LTE band 41(1 RB#0)</u>

SURFACE SAR

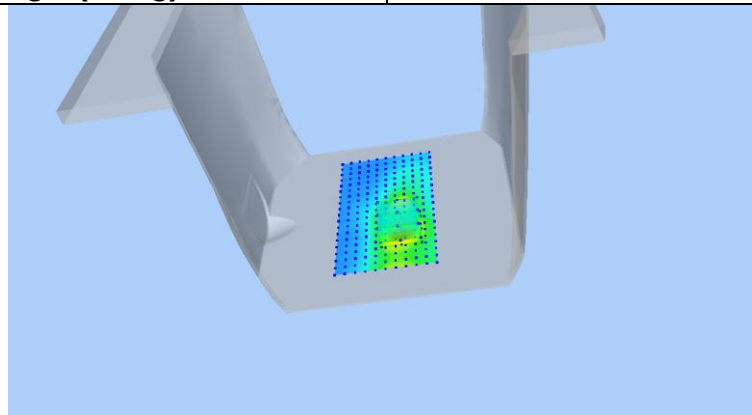


VOLUME SAR

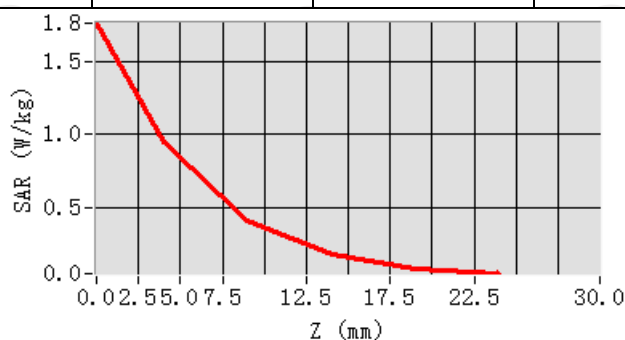


Maximum location: X=13.00, Y=-31.00 SAR Peak: 1.77 W/kg

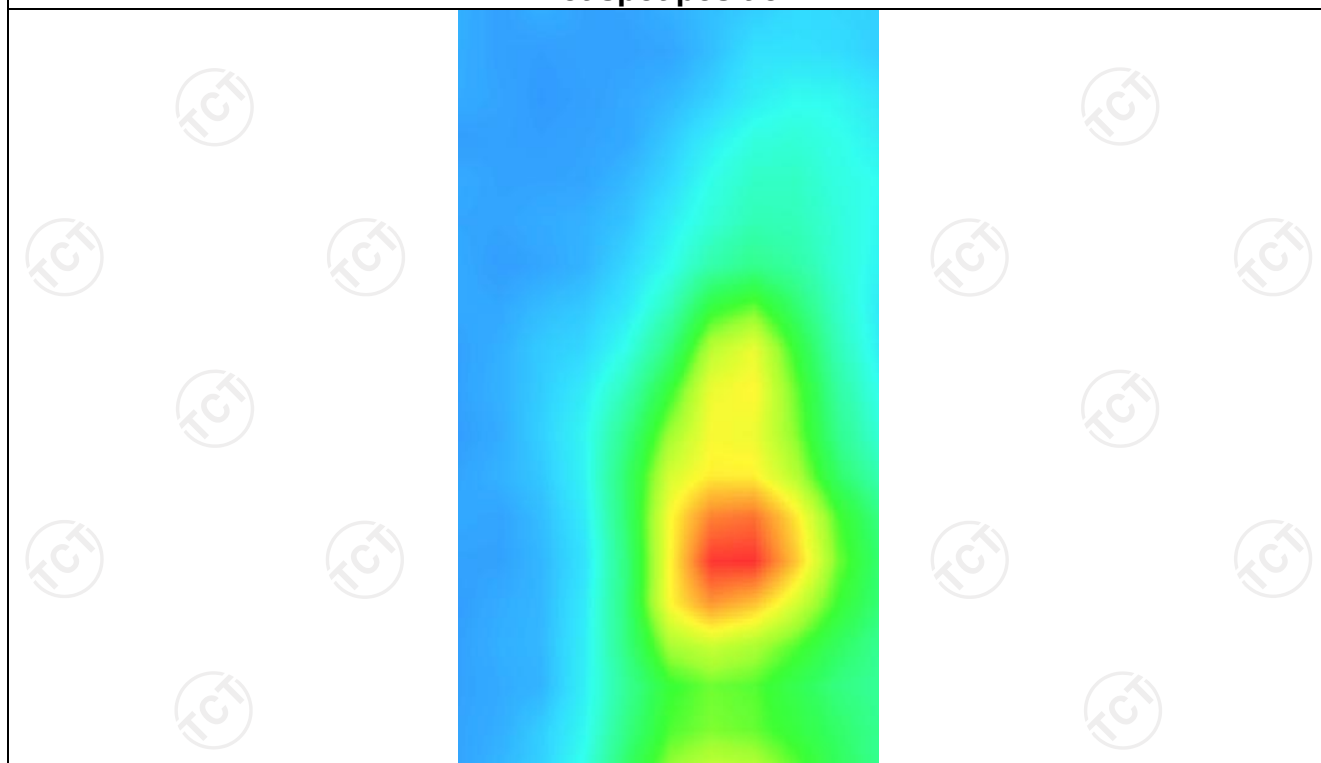
SAR 10g (W/Kg)	0.400449
SAR 1g (W/Kg)	0.882374



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.7659	0.9528	0.4062	0.1703	0.0817



Hot spot position



MEASUREMENT 2

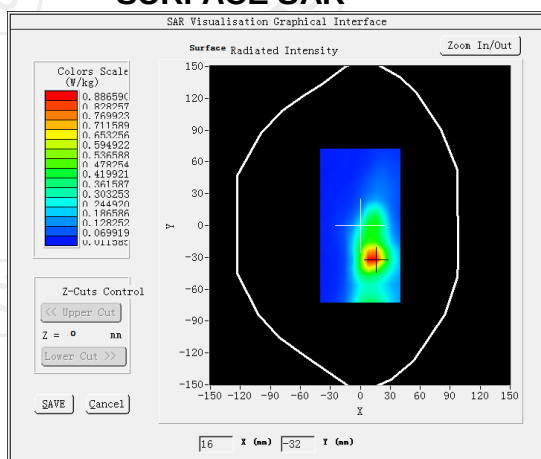
Middle Band SAR (Channel 40620):

Date: 03/25/2024

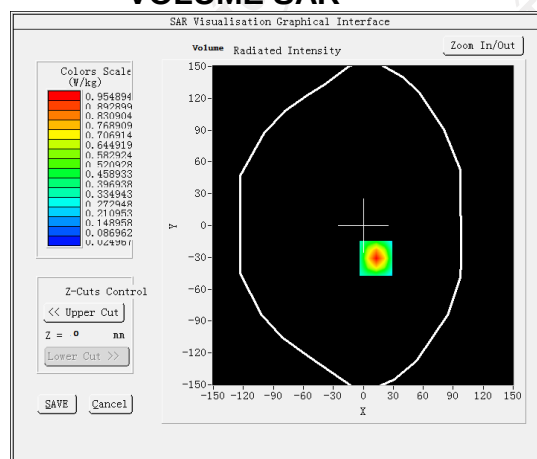
Frequency (MHz)	2593.000000
Relative permittivity (real part)	42.126667
Relative permittivity (imaginary part)	23.264000
Conductivity (S/m)	0.914404
Variation (%)	-1.440000
Crest Factor	1.0
Probe Conversion factor	4.36
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	<u>Body back(hotspot 0mm)</u>
Band	<u>LTE band 41(1 RB#0)</u>

SURFACE SAR

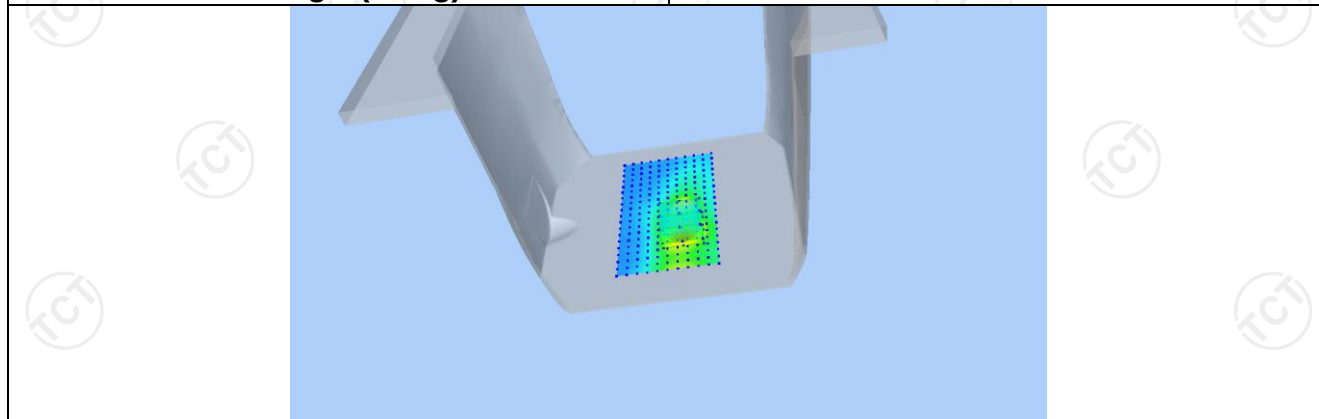


VOLUME SAR

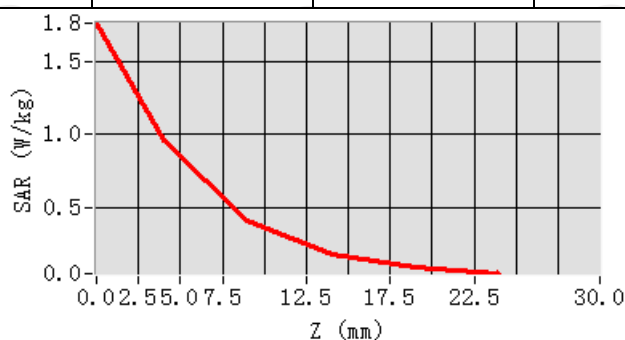


Maximum location: X=13.00, Y=-31.00 SAR Peak: 1.76 W/kg

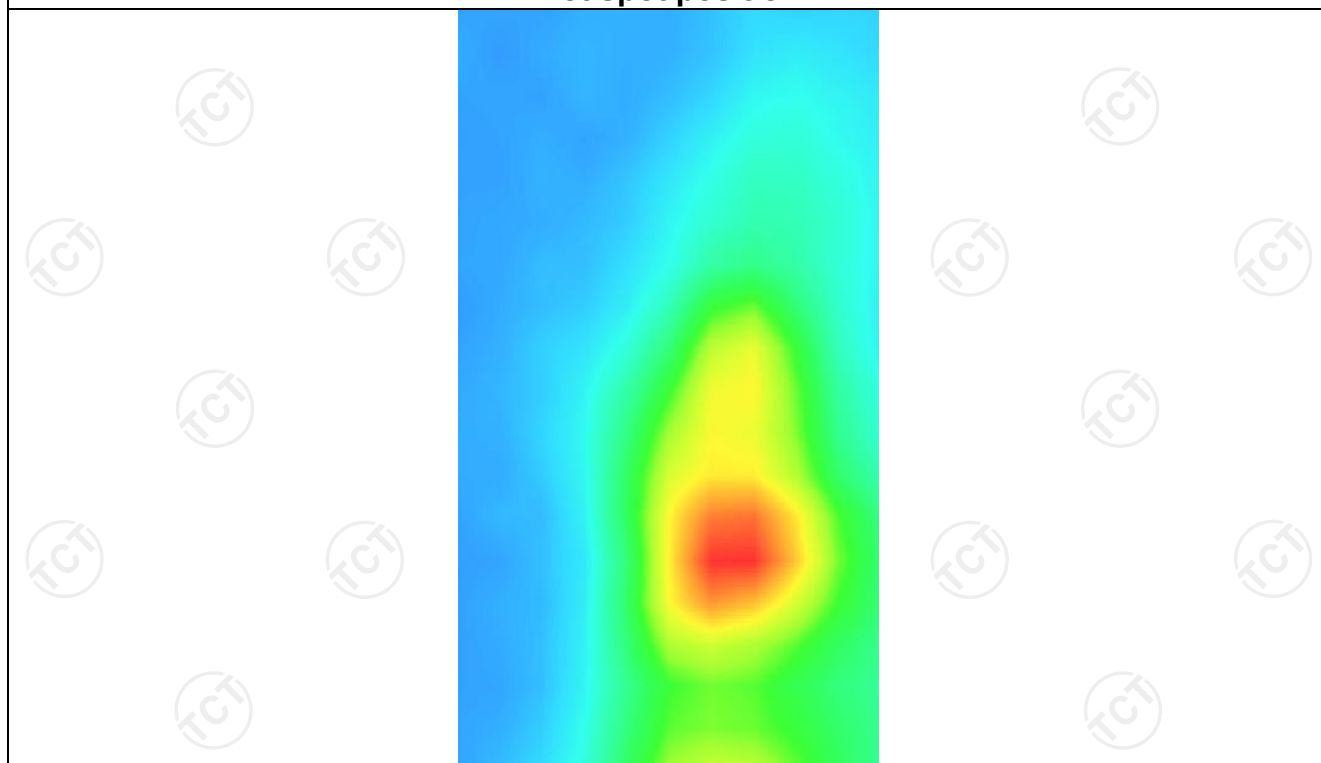
SAR 10g (W/Kg)	0.402367
SAR 1g (W/Kg)	0.884102



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.7640	0.9549	0.4092	0.1722	0.0824



Hot spot position



WLAN 2.4G

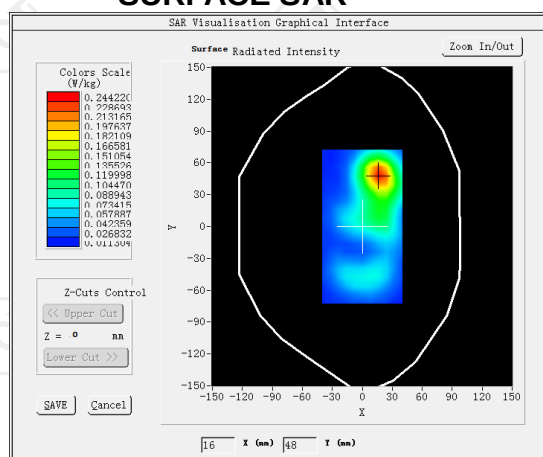
MEASUREMENT 1

Middle Band SAR (Channel 6):

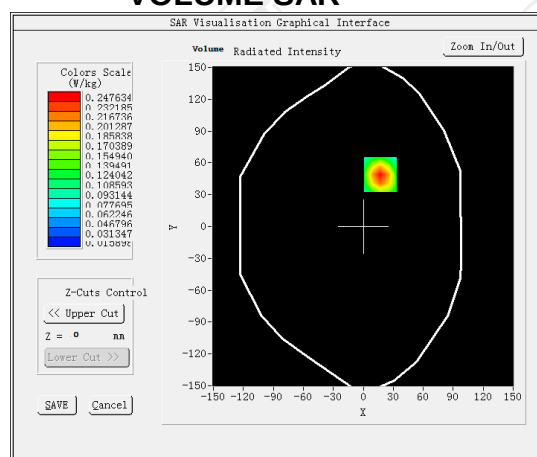
Date: 03/20/2024

Frequency (MHz)	2437.000000
Relative permittivity (real part)	37.821613
Relative permittivity (imaginary part)	13.546980
Conductivity (S/m)	1.834111
Variation (%)	1.510000
Crest Factor	1.0
Probe Conversion factor	2.31
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	Validation plane
Device Position	Body back(0mm)
Band	IEEE 802.11n ISM

SURFACE SAR

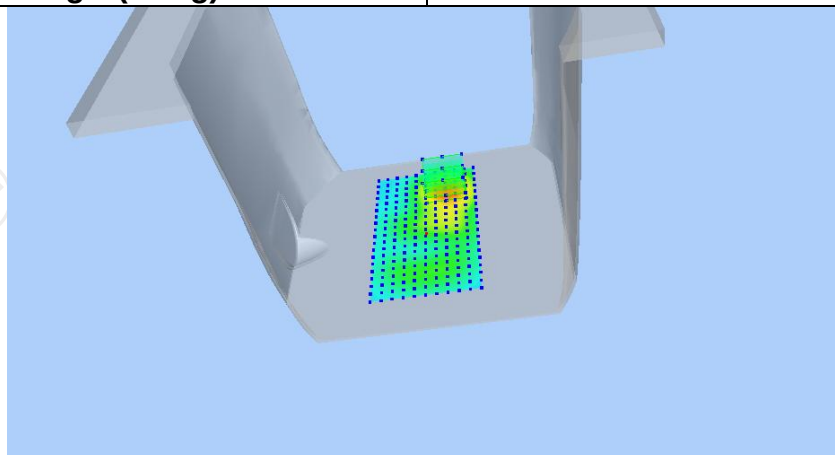


VOLUME SAR

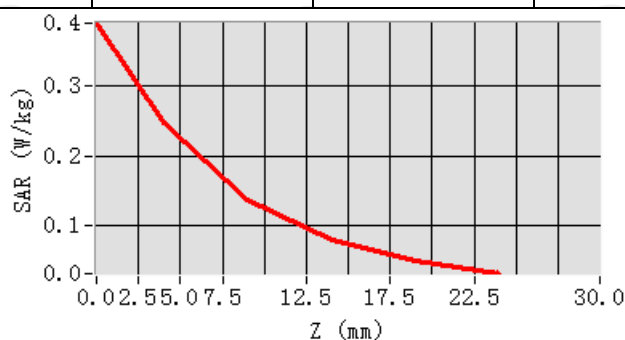


Maximum location: X=17.00, Y=49.00 SAR Peak: 0.39 W/kg

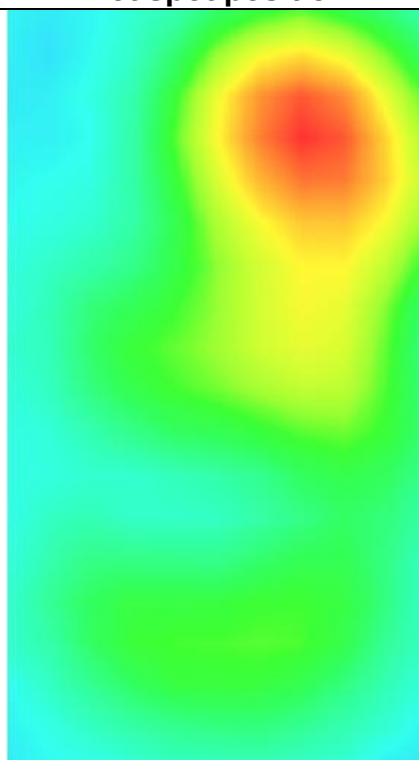
SAR 10g (W/Kg)	0.127915
SAR 1g (W/Kg)	0.200318



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.3901	0.2476	0.1376	0.0785	0.0484



Hot spot position



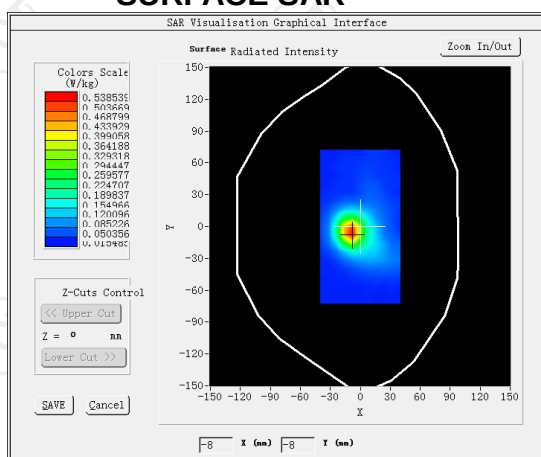
MEASUREMENT 2

Middle Band SAR (Channel 6):

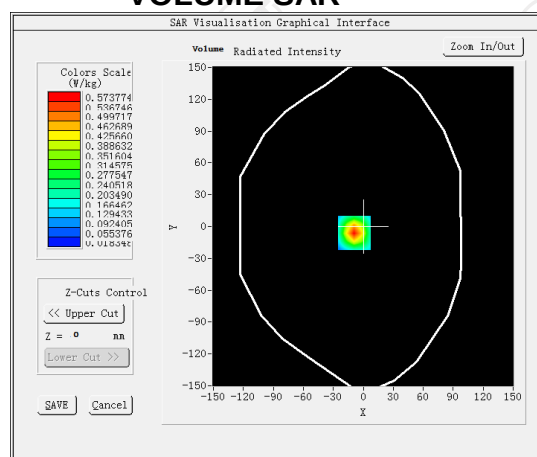
Date: 03/20/2024

Frequency (MHz)	2437.000000
Relative permittivity (real part)	37.821613
Relative permittivity (imaginary part)	13.546980
Conductivity (S/m)	1.834111
Variation (%)	2.610000
Crest Factor	1.0
Probe Conversion factor	2.31
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=12mm dy=12mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=5mm dy=5mm</u> <u>dz=5mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	Validation plane
Device Position	Body back(hotspot 0mm)
Band	IEEE 802.11n ISM

SURFACE SAR

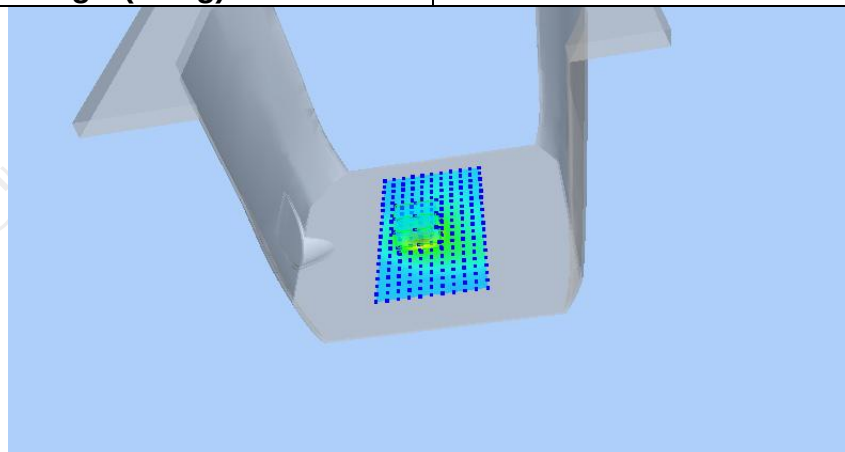


VOLUME SAR

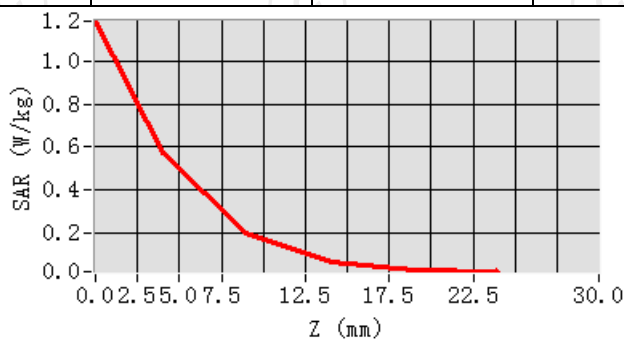


Maximum location: X=-14.00, Y=55.00 SAR Peak: 0.37 W/kg

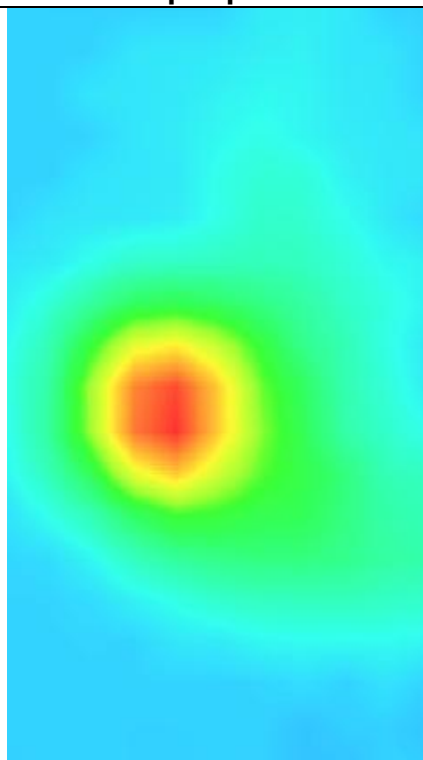
SAR 10g (W/Kg)	0.106420
SAR 1g (W/Kg)	0.200190



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.1857	0.5738	0.2014	0.0679	0.0308



Hot spot position



WLAN 5.2G

MEASUREMENT 1

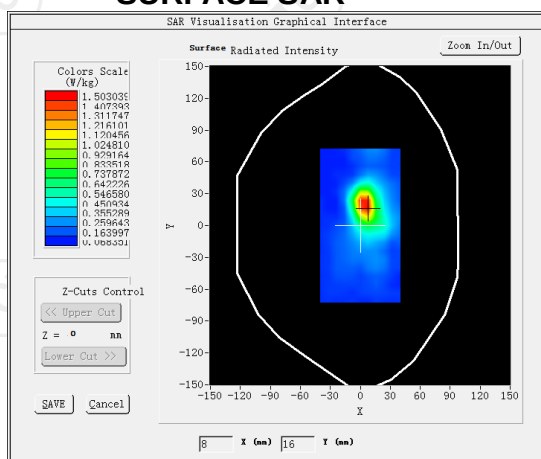
SAR (Channel 48):

Date: 03/29/2024

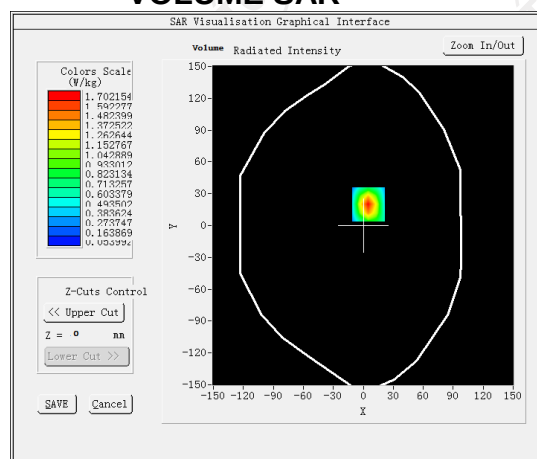
Frequency (MHz)	5240.000000
Relative permittivity (real part)	36.068832
Relative permittivity (imaginary part)	13.679428
Conductivity (S/m)	4.420788
Variation (%)	2.110000
Crest Factor	1.0
Probe Conversion factor	2.01
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=10mm dy=10mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=4mm dy=4mm</u> <u>dz=2mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body Back(0mm)
Band	IEEE 802.11n ISM

SURFACE SAR

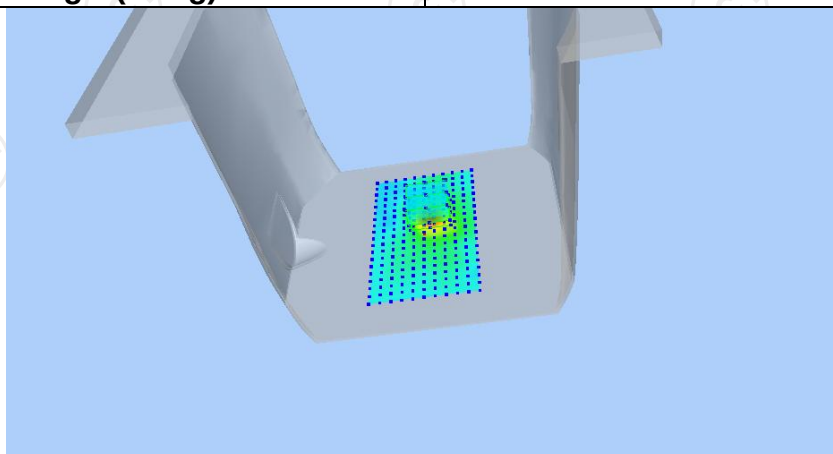


VOLUME SAR

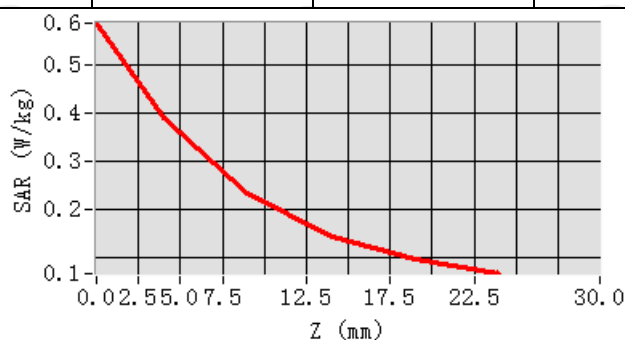


Maximum location: X=5.00, Y=20.00 SAR Peak: 0.59 W/kg

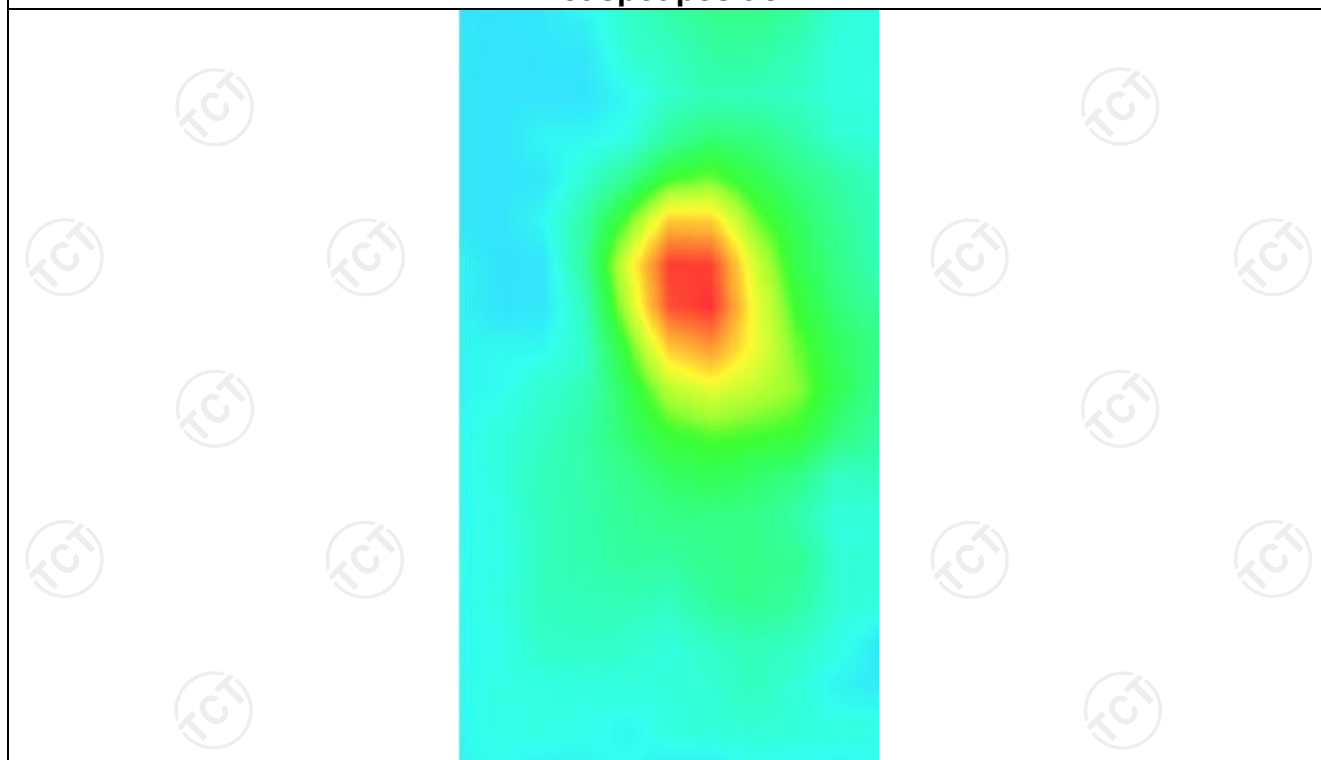
SAR 10g (W/Kg)	0.178750
SAR 1g (W/Kg)	0.308045



Z (mm)	0.00	2.00	7.00	12.00	17.00
SAR (W/Kg)	0.5848	0.3886	0.2319	0.1437	0.0963



Hot spot position



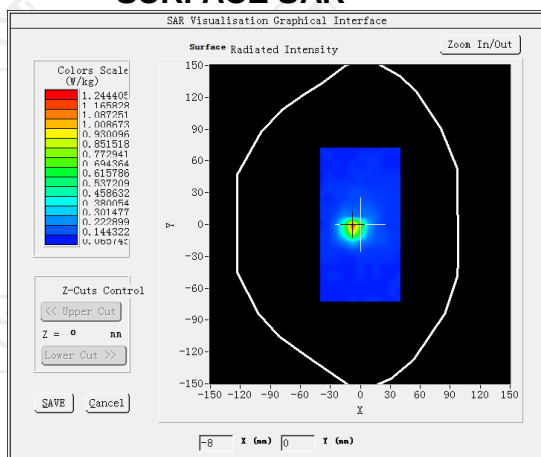
MEASUREMENT 2

SAR (Channel 48):

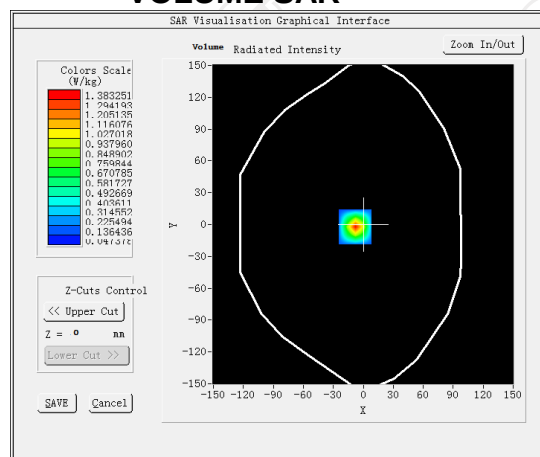
Date: 03/29/2024

Frequency (MHz)	5240.000000
Relative permittivity (real part)	36.068832
Relative permittivity (imaginary part)	13.679428
Conductivity (S/m)	4.420788
Variation (%)	0.950000
Crest Factor	1.0
Probe Conversion factor	2.01
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=10mm dy=10mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=4mm dy=4mm</u> <u>dz=2mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	Validation plane
Device Position	Body back(hotspot 0mm)
Band	IEEE 802.11n ISM

SURFACE SAR

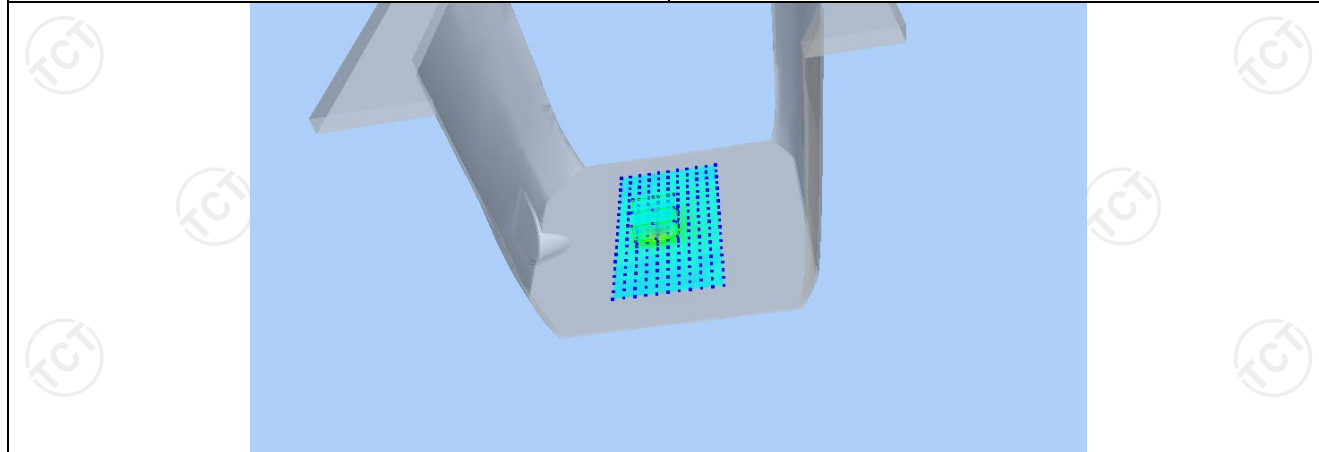


VOLUME SAR

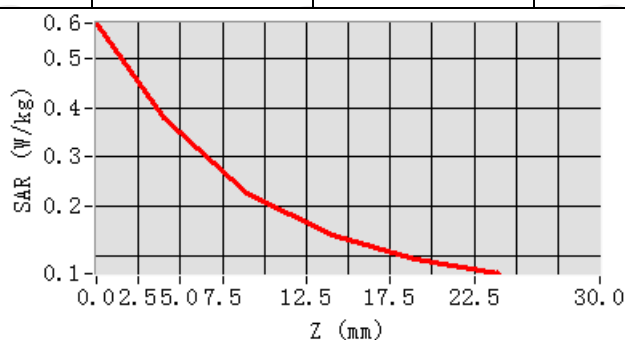


Maximum location: X=-8.00, Y=-2.00 SAR Peak: 0.58W/kg

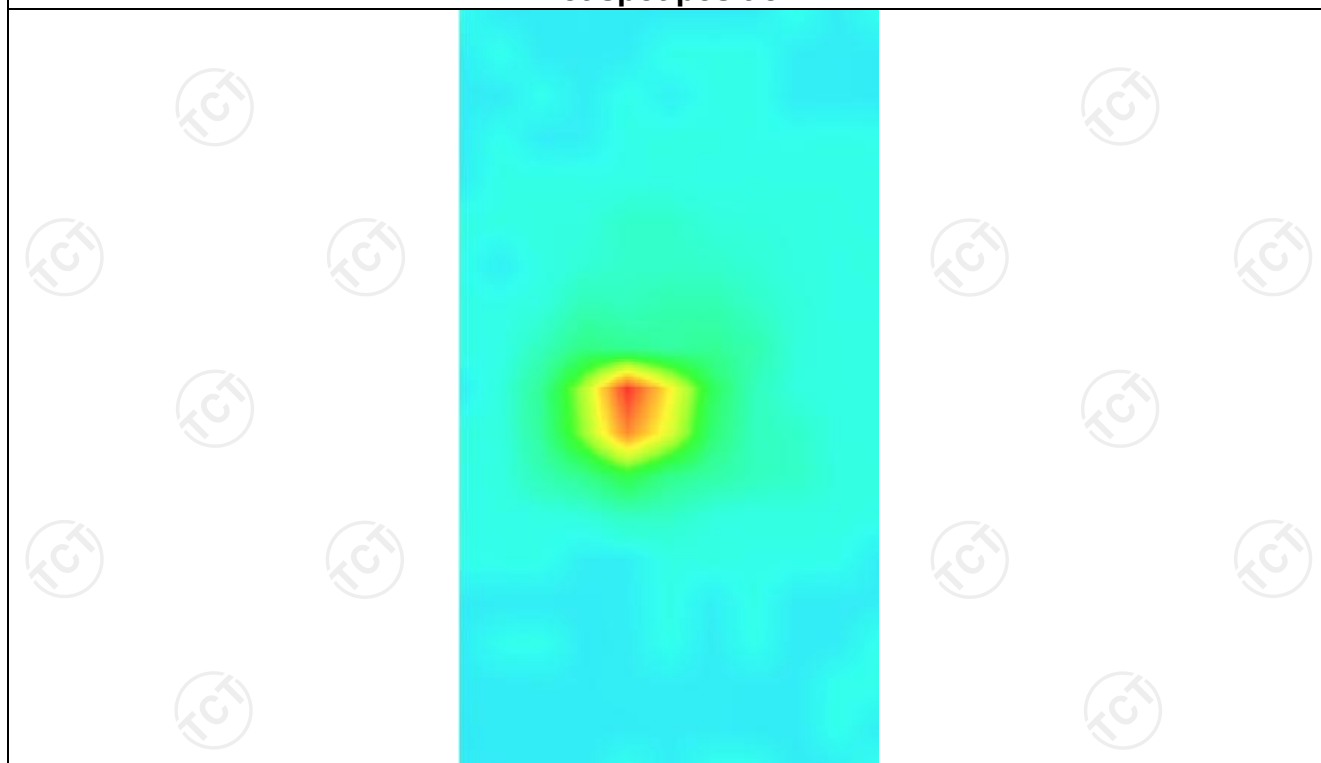
SAR 10g (W/Kg)	0.224653
SAR 1g (W/Kg)	0.287245



Z (mm)	0.00	2.00	7.00	12.00	17.00
SAR (W/Kg)	0.5699	0.3804	0.2283	0.1419	0.0950



Hot spot position



WLAN 5.3G

MEASUREMENT 1

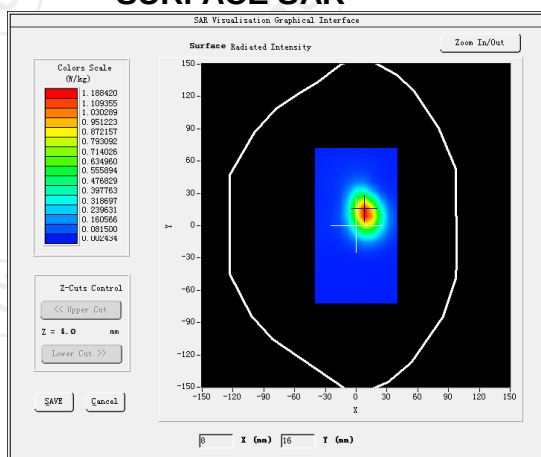
SAR (Channel 52):

Date: 04/04/2024

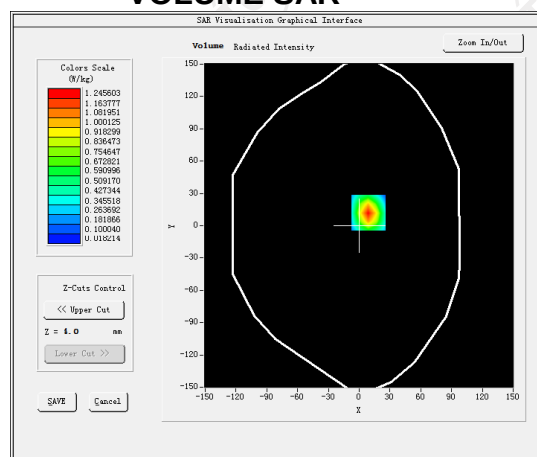
Frequency (MHz)	5260.000000
Relative permittivity (real part)	36.068832
Relative permittivity (imaginary part)	13.680430
Conductivity (S/m)	4.690788
Variation (%)	1.050000
Crest Factor	1.0
Probe Conversion factor	1.94
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=10mm dy=10mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=4mm dy=4mm</u> <u>dz=2mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body Back(0mm)
Band	IEEE 802.11a ISM

SURFACE SAR

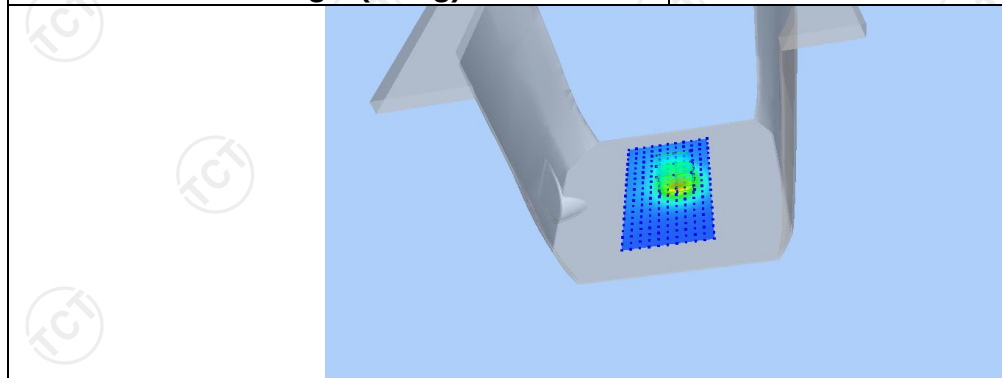


VOLUME SAR

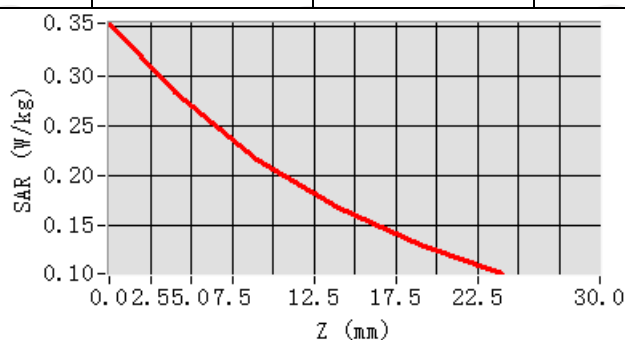


Maximum location: X=18.00, Y=35.00 SAR Peak: 0.55 W/kg

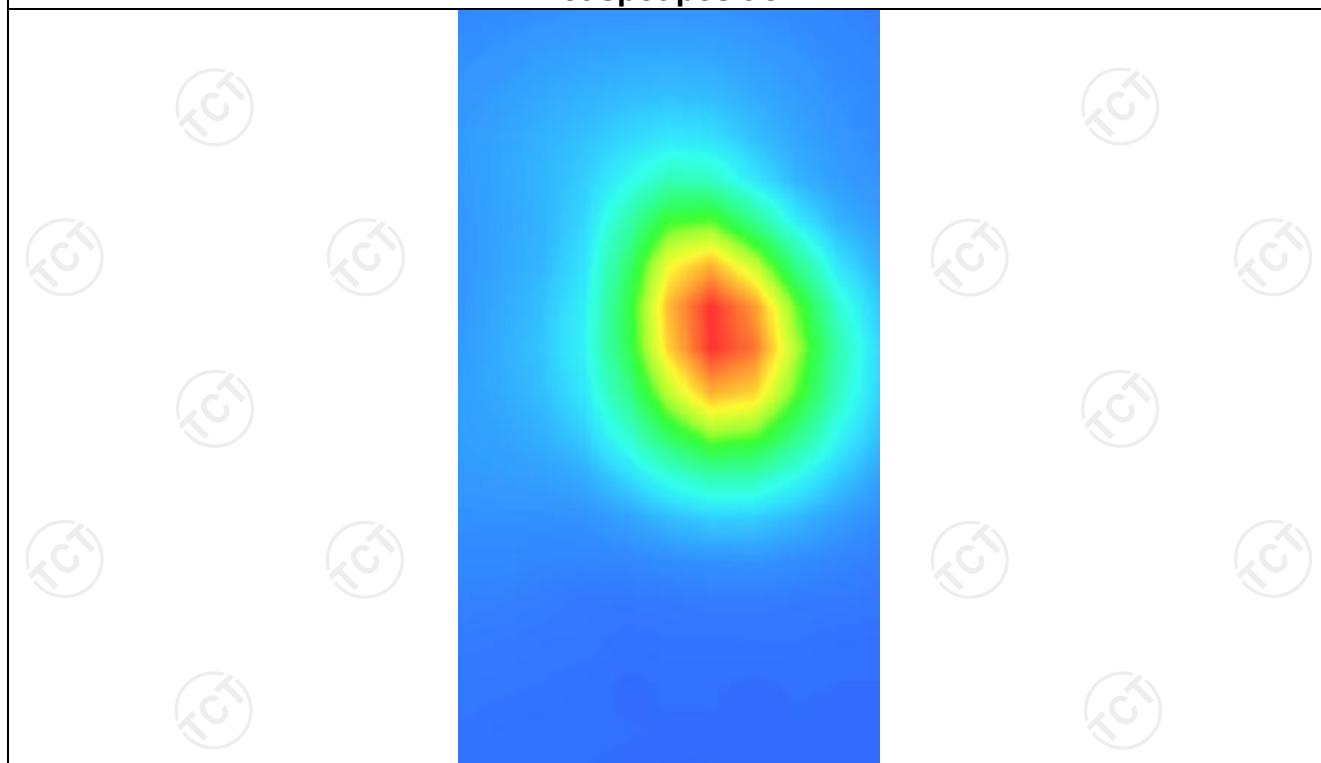
SAR 10g (W/Kg)	0.147515
SAR 1g (W/Kg)	0.241370



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.5470	0.4469	0.3447	0.2643	0.2010



Hot spot position



MEASUREMENT 2

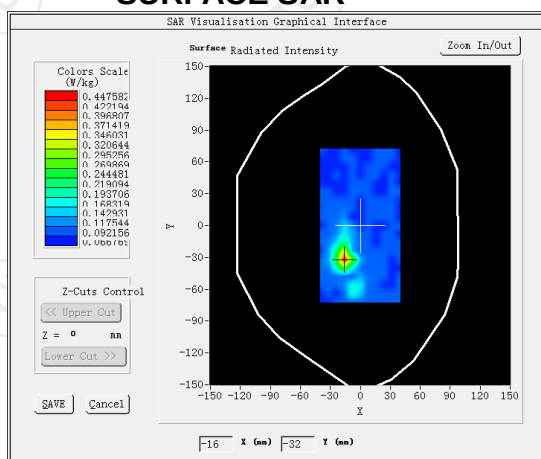
SAR (Channel 52):

Date: 04/04/2024

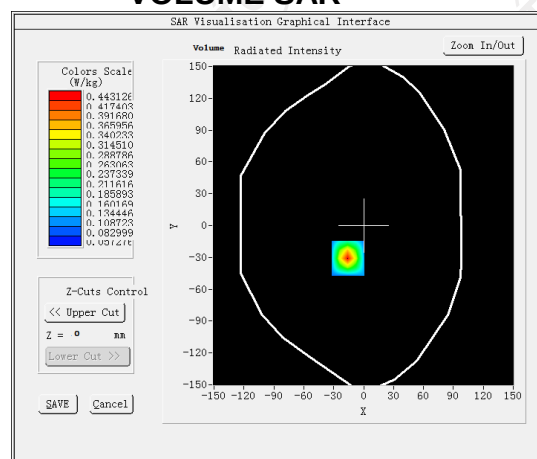
Frequency (MHz)	5260.000000
Relative permittivity (real part)	36.068832
Relative permittivity (imaginary part)	13.680430
Conductivity (S/m)	4.690788
Variation (%)	-3.460000
Crest Factor	1.0
Probe Conversion factor	1.94
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=10mm dy=10mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=4mm dy=4mm</u> <u>dz=2mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	<u>Validation plane</u>
Device Position	<u>Body back(hotspot 0mm)</u>
Band	<u>IEEE 802.11a ISM</u>

SURFACE SAR

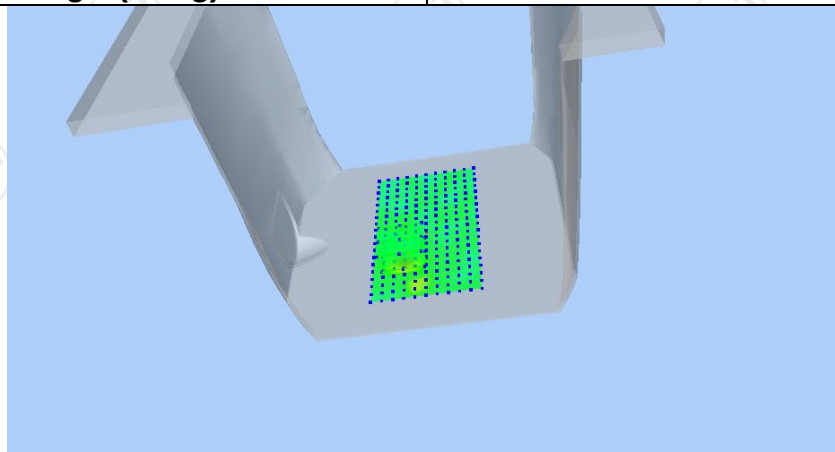


VOLUME SAR

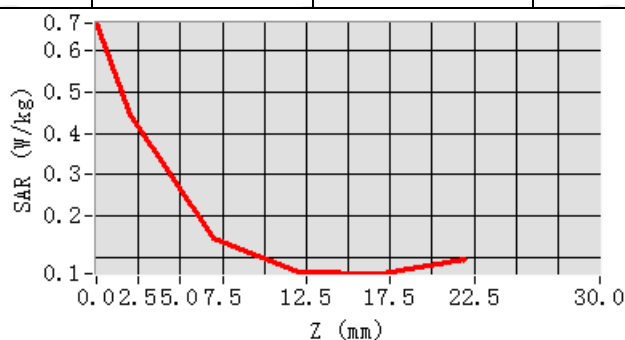


Maximum location: X=-16.00, Y=-31.00 SAR Peak: 0.67 W/kg

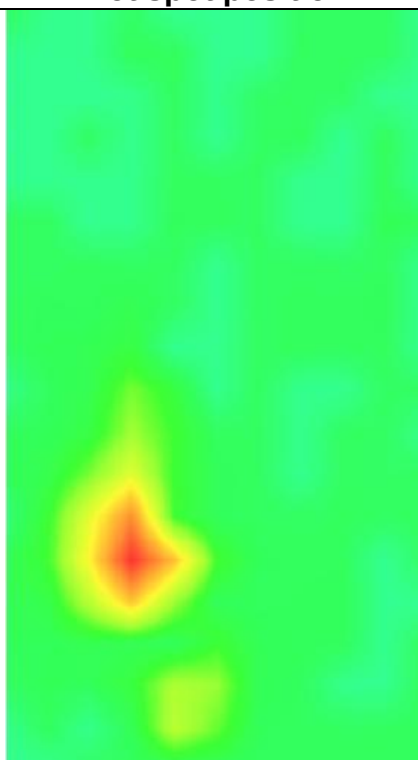
SAR 10g (W/Kg)	0.245644
SAR 1g (W/Kg)	0.336139



Z (mm)	0.00	2.00	7.00	12.00	17.00
SAR (W/Kg)	0.6652	0.4431	0.1477	0.0636	0.0615

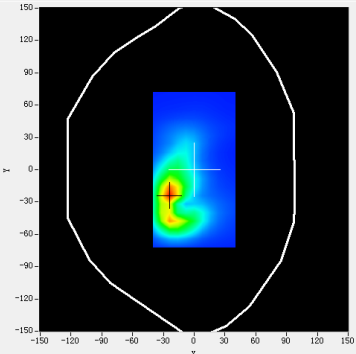
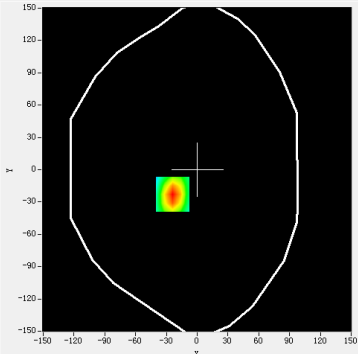


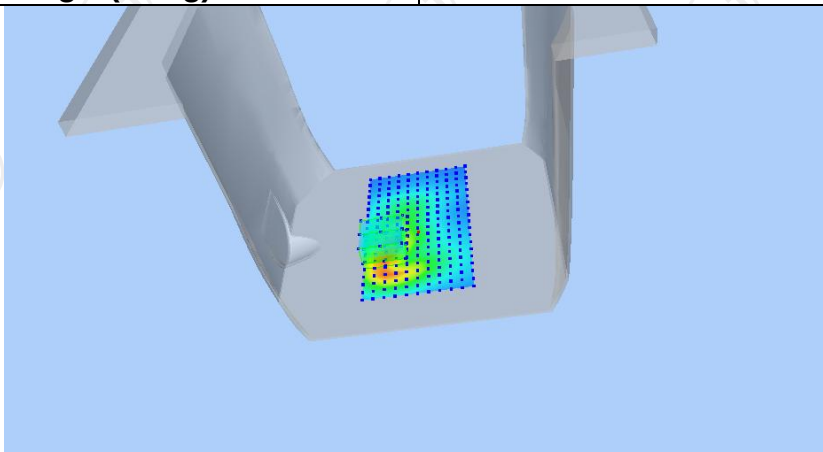
Hot spot position



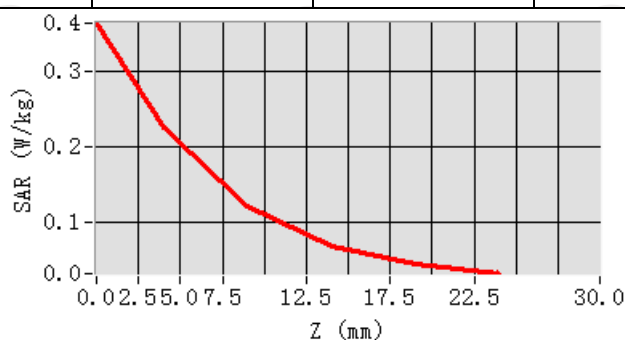
WLAN 5.6G

MEASUREMENT 1

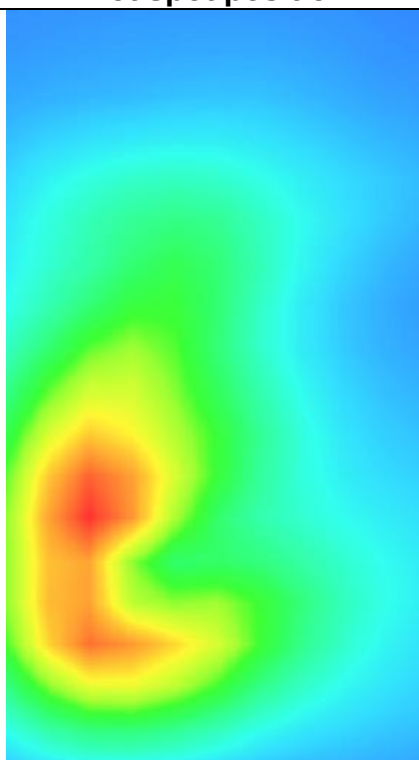
SAR (Channel 122):		Date: 04/10/2024
Frequency (MHz)	5610.000000	
Relative permittivity (real part)	35.599999	
Relative permittivity (imaginary part)	13.329440	
Conductivity (S/m)	4.970354	
Variation (%)	0.970000	
Crest Factor	1.0	
Probe Conversion factor	2.12	
E-Field Probe:	SSE2 (SN 25/22 EPG0375)	
Area Scan	<u>dx=10mm dy=10mm, h= 5.00 mm</u>	
ZoomScan	<u>5x5x7,dx=4mm dy=4mm</u> <u>dz=2mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>	
Phantom	Validation plane	
Device Position	Body back(0mm)	
Band	<u>IEEE 802.11ac ISM</u>	
SURFACE SAR	VOLUME SAR	
SAR Visualization Graphical Interface Surface Radiated Intensity Colors Scale (W/kg) 0.596522 0.557069 0.517616 0.478163 0.438709 0.399256 0.359803 0.320350 0.280896 0.241443 0.201990 0.162537 0.123083 0.083630 0.044177 0.004723 Z-Cuts Control << Upper Cut Z = 5.0 mm Lower Cut >> SAVE Cancel  -24 X (mm) -23 Y (mm) Volume Radiated Intensity Colors Scale (W/kg) 0.596912 0.558057 0.512102 0.473247 0.434391 0.395536 0.357681 0.318825 0.279970 0.240815 0.202059 0.163304 0.124549 0.085794 0.047038 0.008283 Z-Cuts Control << Upper Cut Z = 5.0 mm Lower Cut >> SAVE Cancel  X		
Maximum location: X=-24.00, Y=-23.00 SAR Peak: 0.36 W/kg		
SAR 10g (W/Kg)	0.121226	
SAR 1g (W/Kg)	0.178941	



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.3639	0.2251	0.1218	0.0697	0.0457



Hot spot position



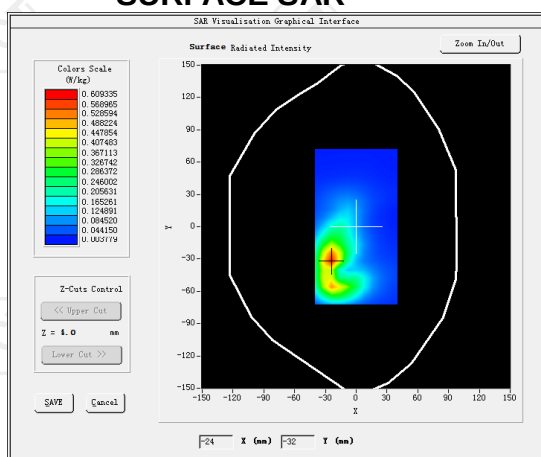
MEASUREMENT 2

SAR (Channel 122):

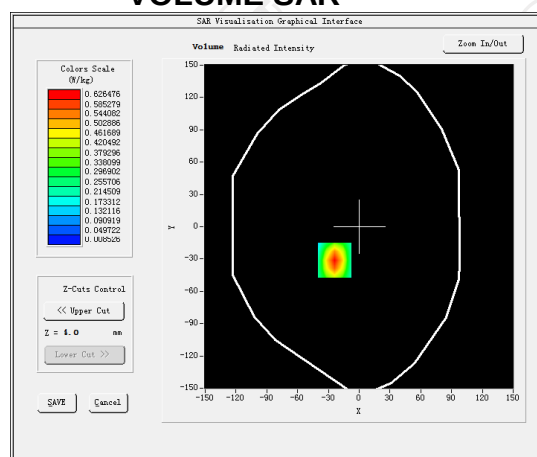
Date: 04/10/2024

Frequency (MHz)	5610.000000
Relative permittivity (real part)	35.599999
Relative permittivity (imaginary part)	13.329440
Conductivity (S/m)	4.970354
Variation (%)	2.450000
Crest Factor	1.0
Probe Conversion factor	2.12
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=10mm dy=10mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7,dx=4mm dy=4mm</u> <u>dz=2mm,Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>
Phantom	Validation plane
Device Position	Body back(hotspot 0mm)
Band	<u>IEEE 802.11ac ISM</u>

SURFACE SAR

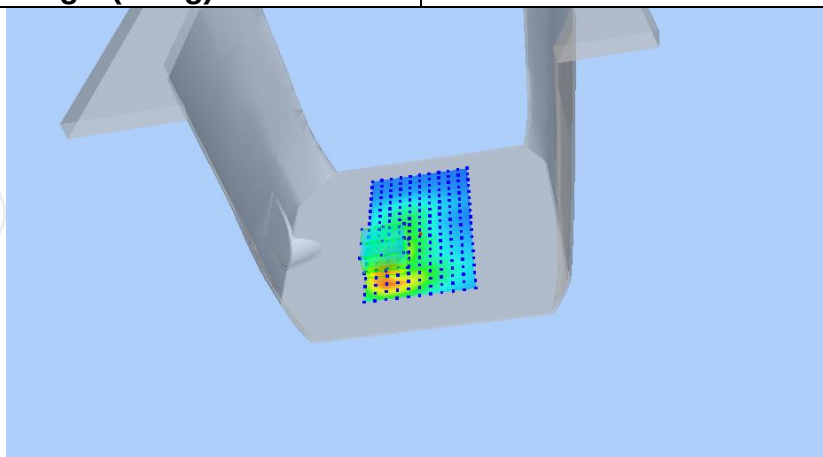


VOLUME SAR

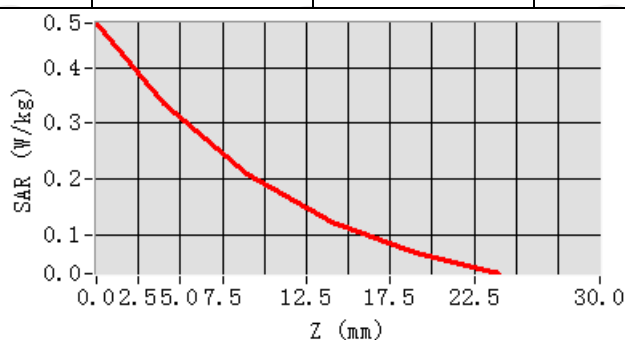


Maximum location: X=-24.00, Y=-31.00 SAR Peak: 0.48 W/kg

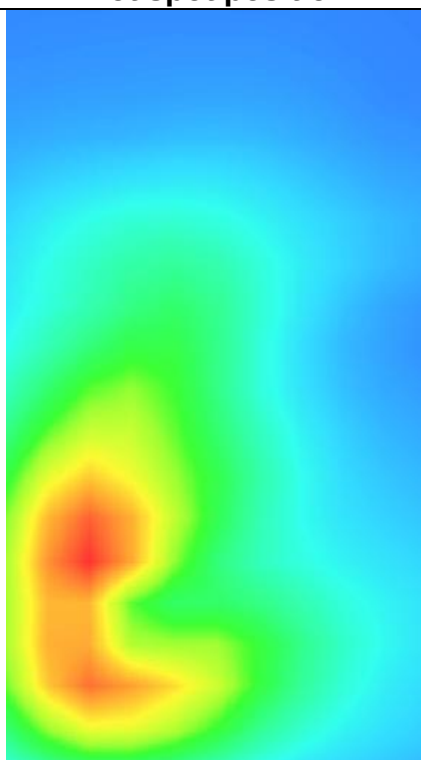
SAR 10g (W/Kg)	0.203380
SAR 1g (W/Kg)	0.235486



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4808	0.3371	0.2078	0.1214	0.0655



Hot spot position



WLAN 5.8G

MEASUREMENT 1

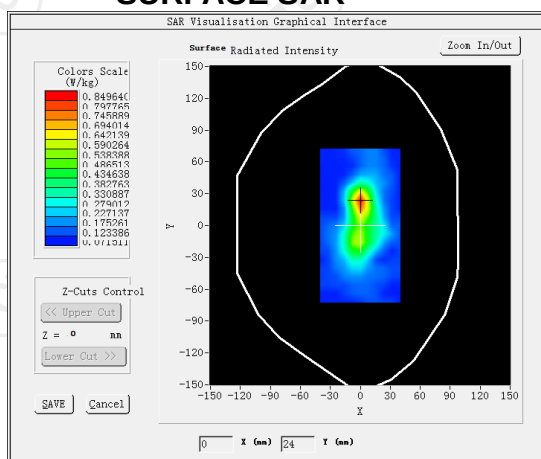
SAR (Channel 159):

Date: 04/17/2024

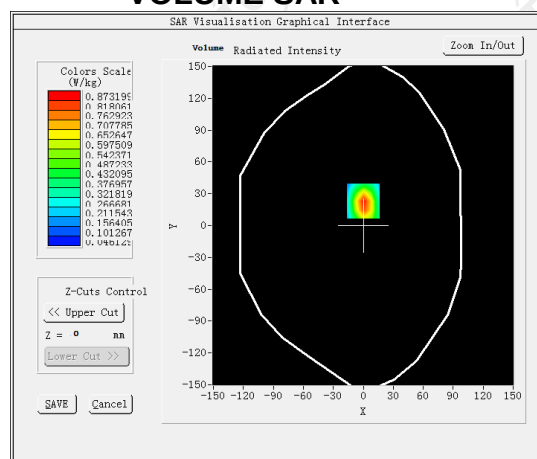
Frequency (MHz)	5795.000000
Relative permittivity (real part)	34.812823
Relative permittivity (imaginary part)	13.671675
Conductivity (S/m)	5.080828
Variation (%)	-1.360000
Crest Factor	1.0
Probe Conversion factor	4.70
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=10mm dy=10mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=4mm dy=4mm</u> <u>dz=2mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back (0mm)
Band	IEEE 802.11n ISM

SURFACE SAR

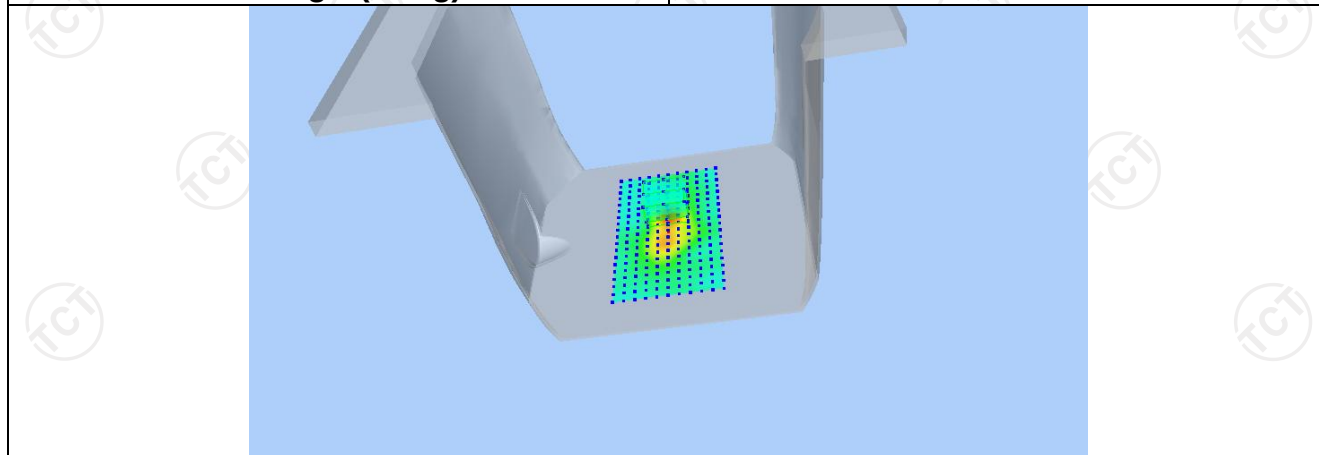


VOLUME SAR

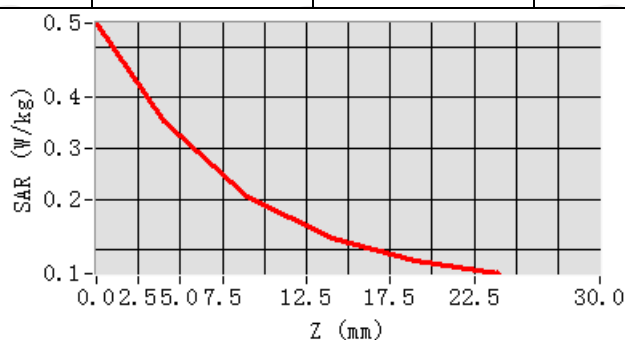


Maximum location: X=0.00, Y=23.00 SAR Peak: 0.55 W/kg

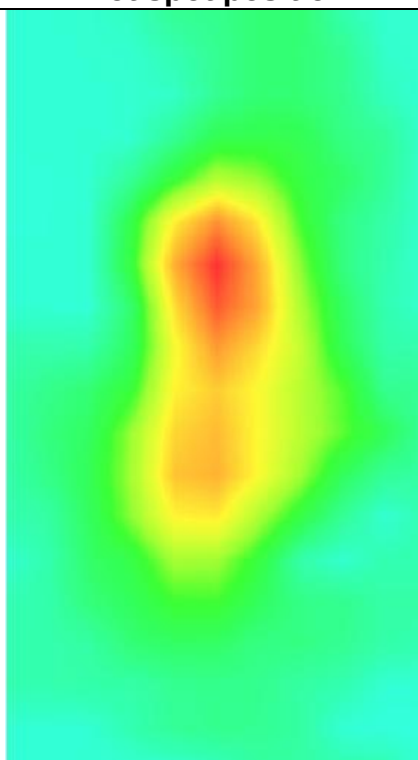
SAR 10g (W/Kg)	0.165261
SAR 1g (W/Kg)	0.294264



Z (mm)	0.00	2.00	7.00	12.00	17.00
SAR (W/Kg)	0.5465	0.3542	0.2038	0.1217	0.0792



Hot spot position



MEASUREMENT 2

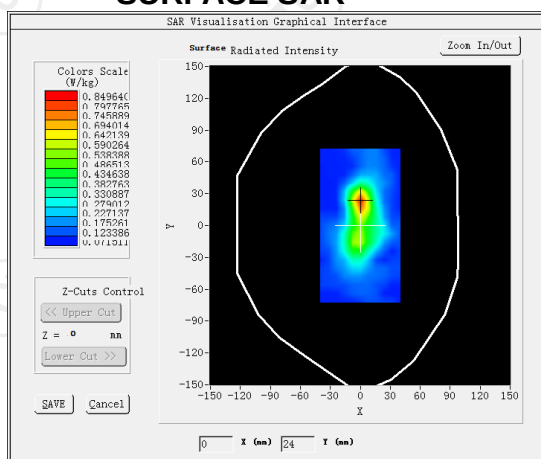
SAR (Channel 159):

Date: 04/17/2024

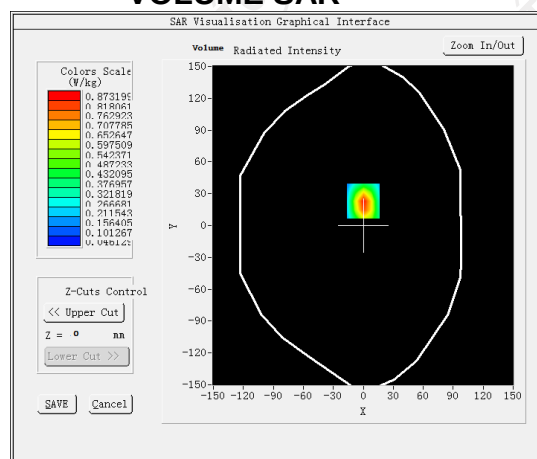
Frequency (MHz)	5795.000000
Relative permittivity (real part)	34.812823
Relative permittivity (imaginary part)	13.671675
Conductivity (S/m)	5.080828
Variation (%)	1.390000
Crest Factor	1.0
Probe Conversion factor	2.12
E-Field Probe:	SSE2 (SN 25/22 EPG0375)
Area Scan	<u>dx=10mm dy=10mm, h= 5.00 mm</u>
ZoomScan	<u>5x5x7, dx=4mm dy=4mm</u> <u>dz=2mm, Complete/ndx=8mm dy=8mm, h=</u> <u>5.00 mm</u>

Phantom	Validation plane
Device Position	Body back(hotspot 0mm)
Band	IEEE 802.11n ISM

SURFACE SAR

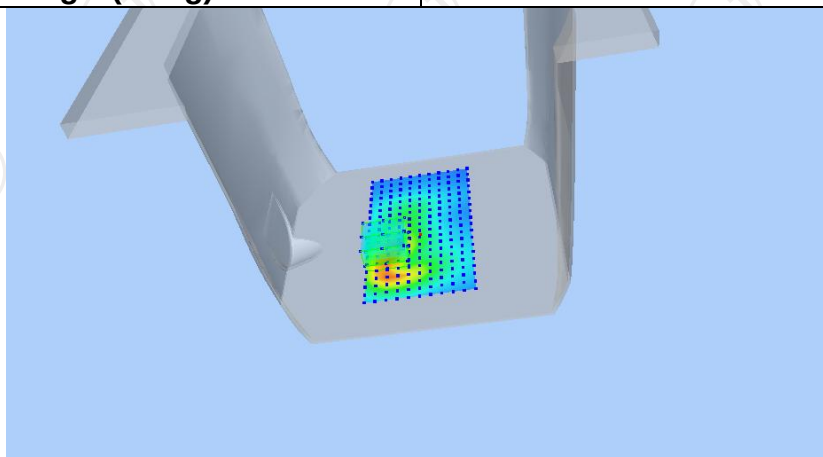


VOLUME SAR

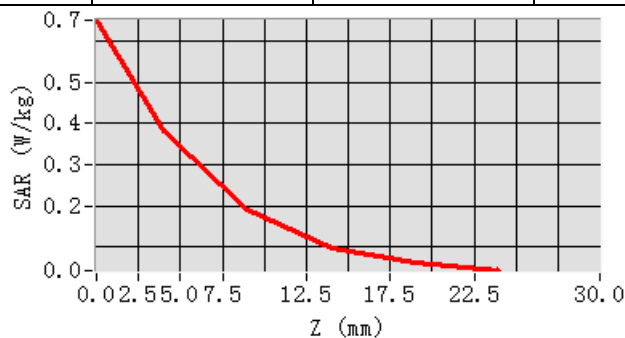


Maximum location: X=0.00, Y=23.00 SAR Peak: 0.66 W/kg

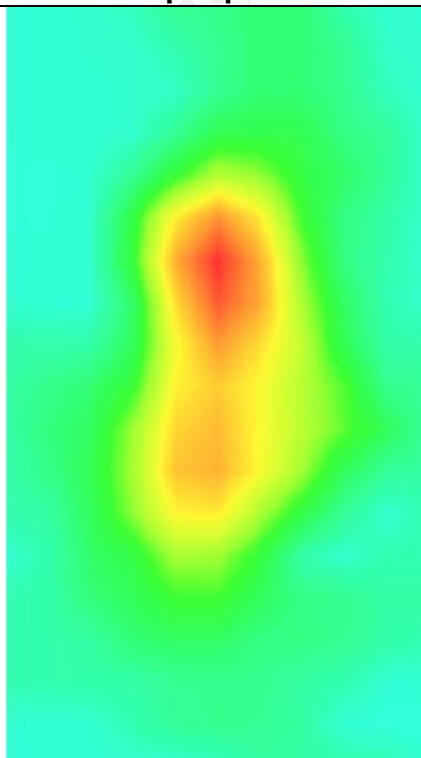
SAR 10g (W/Kg)	0.269196
SAR 1g (W/Kg)	0.364200



Z (mm)	0.00	2.00	7.00	12.00	17.00
SAR (W/Kg)	0.6514	0.3816	0.1899	0.0997	0.0619

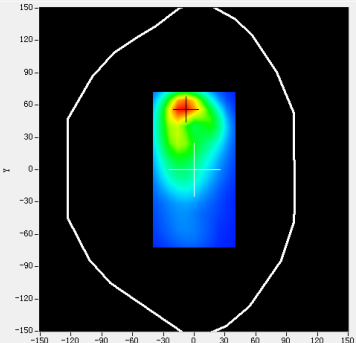
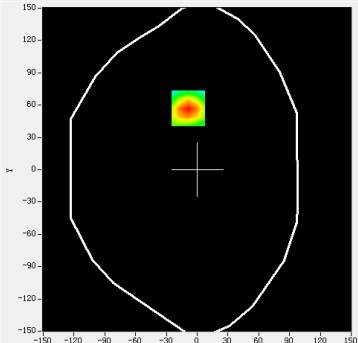
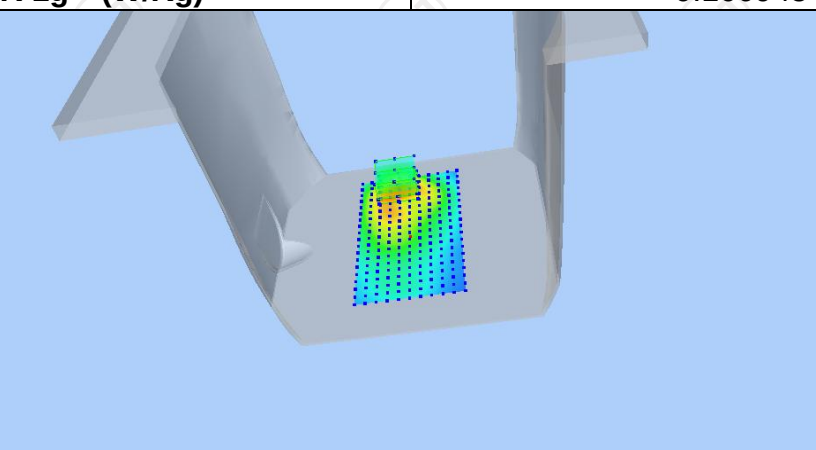
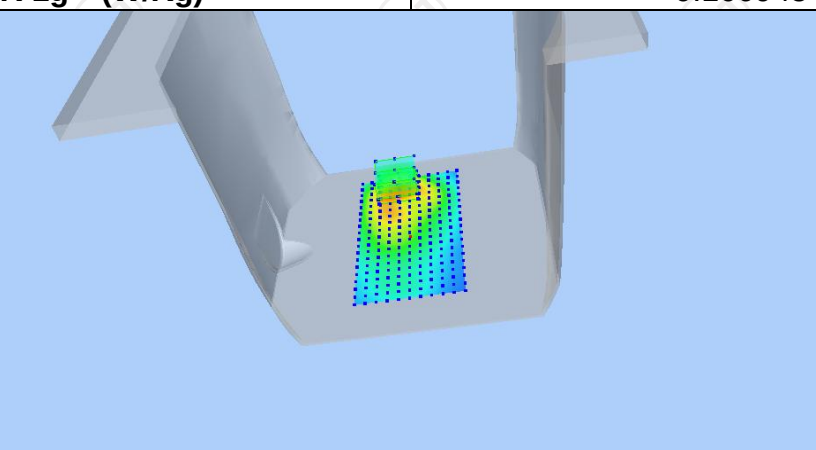
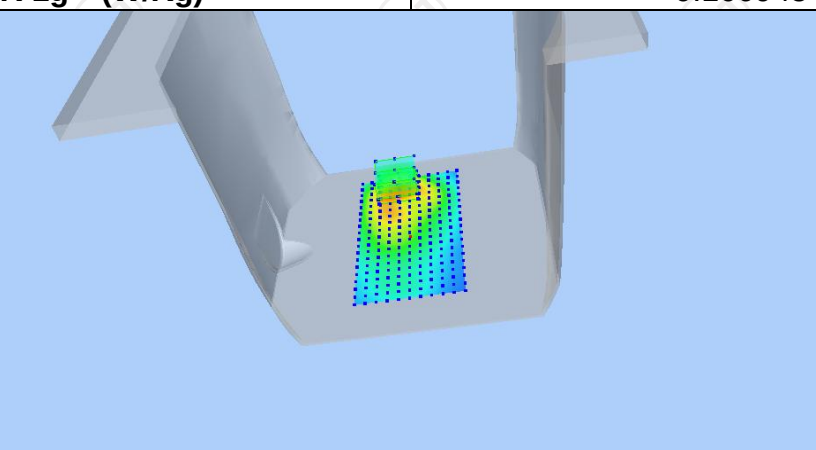


Hot spot position

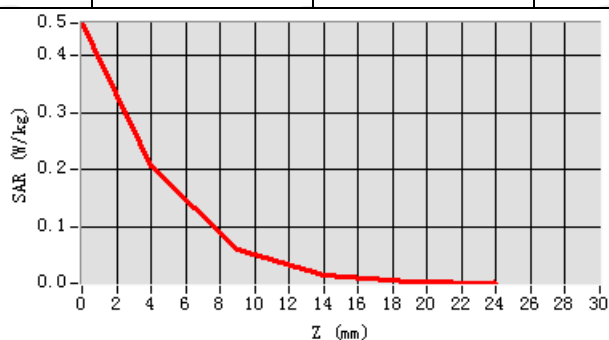


BT

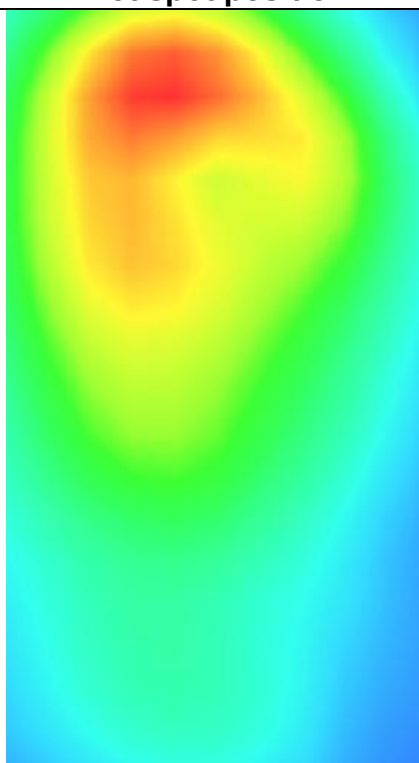
MEASUREMENT 1

High Band SAR (Channel 78):		Date: 03/25/2024												
Frequency (MHz)	2480.000000													
Relative permittivity (real part)	37.821613													
Relative permittivity (imaginary part)	13.546980													
Conductivity (S/m)	1.834111													
Variation (%)	0.610000													
Crest Factor	1.0													
Probe Conversion factor	2.37													
E-Field Probe:	SSE2 (SN 25/22 EPG0375)													
Area Scan	dx=12mm dy=12mm, h= 5.00 mm													
ZoomScan	5x5x7,dx=5mm dy=5mm dz=5mm,Complete/ndx=8mm dy=8mm, h= 5.00 mm													
Phantom	Validation plane													
Device Position	Body back(0mm)													
Band	8DPSK													
SURFACE SAR	VOLUME SAR													
Colors Scale (W/kg) 0.015703 0.761664 0.707625 0.653566 0.599546 0.545507 0.491468 0.437429 0.383390 0.329350 0.275311 0.221272 0.167232 0.113193 0.059154 0.005115 Z-Cuts Control << Upper Cut Z = 0.0 mm Lower Cut >> SAVE Cancel Surface Radiated Intensity Zoom In/Out  -150 X (mm) 150 Y (mm) Colors Scale (W/kg) 0.033251 0.700029 0.728407 0.675995 0.623584 0.571142 0.518721 0.466299 0.413877 0.361455 0.309034 0.256612 0.204190 0.151768 0.099347 0.046925 Z-Cuts Control << Upper Cut Z = 0.0 mm Lower Cut >> SAVE Cancel Volume Radiated Intensity Zoom In/Out  -150 X 150 Y <tr><td colspan="3">Maximum location: X=8.00, Y=-7.00 SAR Peak: 0.16W/kg</td></tr> <tr><td>SAR 10g (W/Kg)</td><td colspan="2">0.053679</td></tr> <tr><td>SAR 1g (W/Kg)</td><td colspan="2">0.100945</td></tr> <tr><td colspan="3"></td></tr>			Maximum location: X=8.00, Y=-7.00 SAR Peak: 0.16W/kg			SAR 10g (W/Kg)	0.053679		SAR 1g (W/Kg)	0.100945				
Maximum location: X=8.00, Y=-7.00 SAR Peak: 0.16W/kg														
SAR 10g (W/Kg)	0.053679													
SAR 1g (W/Kg)	0.100945													
														

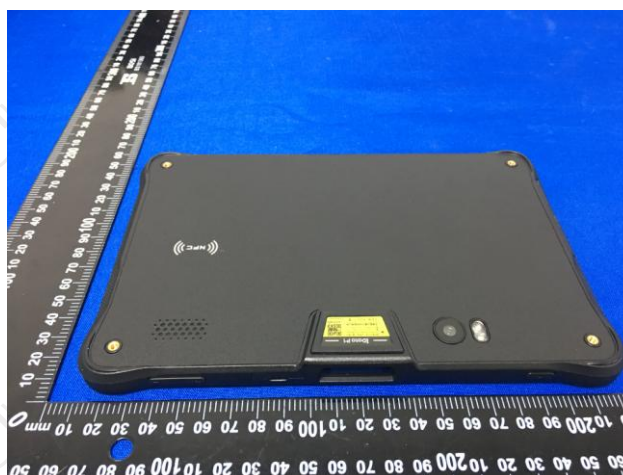
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4557	0.2059	0.0618	0.0155	0.0049



Hot spot position



Appendix A: EUT Photos



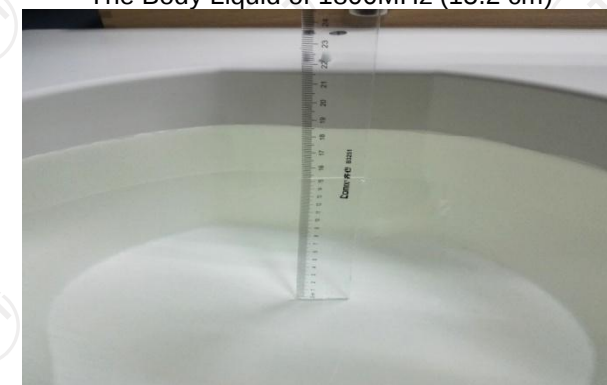
Liquid depth



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)

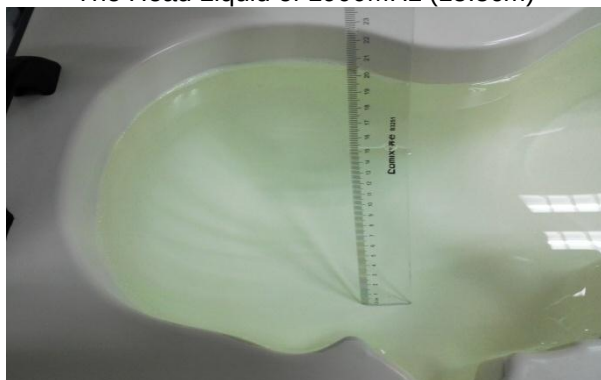
The Body Liquid of 5000-6000MHz (16.5cm)



The Head Liquid of 1900MHz (15.5cm)



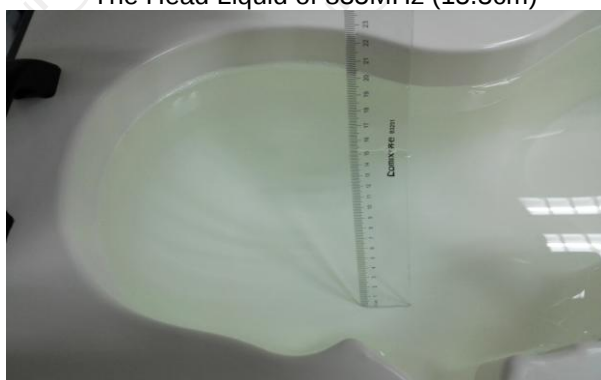
The Head Liquid of 2450MHz (15.6cm)



The Head Liquid of 835MHz (15.3cm)



The Head Liquid of 1800MHz (15.2cm)



The Head Liquid of 2600MHz (15.1cm)



The Body Liquid of 5000-6000MHz (15.8cm)

Appendix B: Test Setup Photos



Body worn – Front (0mm)



Body worn – Back (0mm)



Hotspo Front (0mm)



Hotspo Back (0mm)



Hotspot Right (10mm)



Hotspot Top (10mm)



Hotspot Left(10mm)

Appendix C: Probe Calibration Certificate

COMOSAR E-FIELD Probe



COMOSAR E-Field Probe Calibration Report

Ref : ACR.180.7.22.BES.B

SHENZHEN TONGCE TESTING LAB

2101 & 2201, ZHENCHANG FACTORY RENSHAN INDUSTRIAL
ZONE, FUHAI SUBDISTRICT, BAO'AN DISTRICT SHENZHEN,
GUANGDONG, 518103, PEOPLE'S REPUBLIC OF CHINA

MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 25/22 EPGO375

Calibrated at MVG

Z.I. de la pointe du diable

Technopôle Brest Iroise – 295 avenue Alexis de Rochon

29280 PLOUZANE - FRANCE

Calibration date: 06/29/2023



Accreditations #2-6789

Scope available on www.cofrac.fr

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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).



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

	Name	Function	Date	Signature
Prepared by :	Jérôme Le Gall	Measurement Responsible	6/30/2023	
Checked & approved by:	Jérôme Luc	Technical Manager	6/30/2023	
Authorized by:	Yann Toutain	Laboratory Director	7/05/2023	

	Customer Name
Distribution :	Shenzhen Tongce Testing Lab

Issue	Name	Date	Modifications
A	Jérôme Le Gall	6/30/2023	Initial release

Page: 2/11

Template_ACR.DDD.N.YY.MVGB.ISSUE_COMOSAR Probe vK

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

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**COMOSAR E-FIELD PROBE CALIBRATION REPORT**

Ref: ACR.180.7.22.BES.B

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE2
Serial Number	SN 25/22 EPG0375
Product Condition (new / used)	New
Frequency Range of Probe	0.15 GHz-6GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.197 MΩ Dipole 2: R2=0.230 MΩ Dipole 3: R3=0.208 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	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 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.

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3.3 LOWER DETECTION LIMIT

The lower detection limit was assessed using the same measurement set up as used for the linearity measurement. The required lower detection limit is 10 mW/kg.

3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 to 360 degrees in 15-degree steps. The hemispherical isotropy is determined by inserting the probe in a thin plastic box filled with tissue-equivalent liquid, with the plastic box illuminated with the fields from a half wave dipole. The dipole is rotated about its axis (0°–180°) in 15° increments. At each step the probe is rotated about its axis (0°–360°).

3.1 BOUNDARY EFFECT

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

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

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

where

$SAR_{uncertainty}$	is the uncertainty in percent of the probe boundary effect
d_{be}	is the distance between the surface and the closest <i>zoom-scan</i> 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.

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



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

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 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 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normy dipole 2 ($\mu\text{V}/(\text{V}/\text{m})^2$)	Normz dipole 3 ($\mu\text{V}/(\text{V}/\text{m})^2$)
0.64	0.53	0.44

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
106	108	109

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

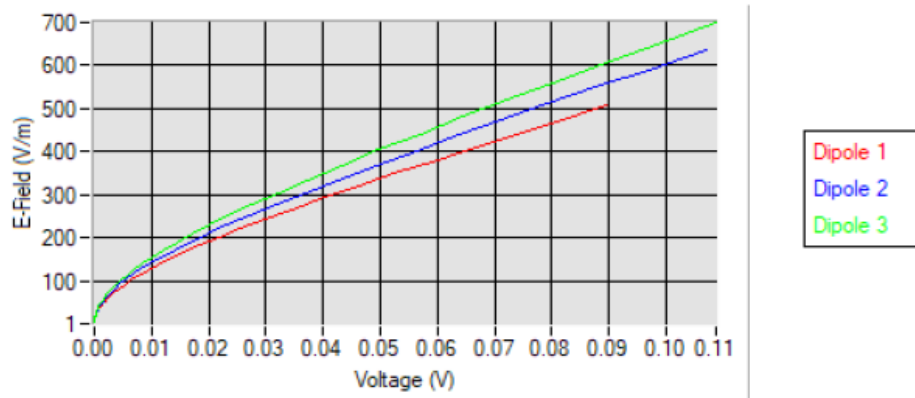
$$E = \sqrt{E_1^2 + E_2^2 + E_3^2}$$



COMOSAR E-FIELD PROBE CALIBRATION REPORT

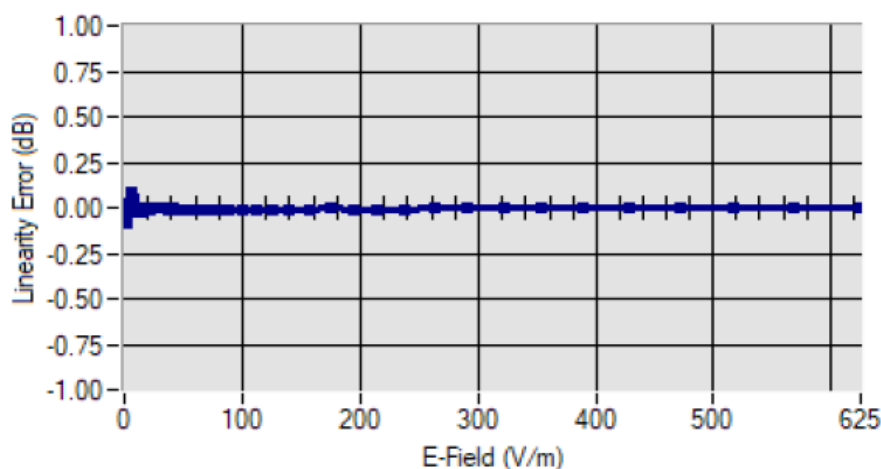
Ref: ACR.180.7.22.BES.B

Calibration curves



5.2 LINEARITY

Linearity



Linearity: +/-1.94% (+/-0.09dB)



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz +/- 100MHz)	ConvF
HL750	750	1.71
BL750	750	1.78
HL900	900	1.91
BL900	900	1.96
HL1800	1800	2.08
BL1800	1800	2.16
HL2000	2000	2.03
BL2000	2000	2.10
HL2450	2450	2.31
BL2450	2450	2.37
HL2600	2600	2.16
BL2600	2600	2.23
HL3500	3500	2.21
BL3500	3500	2.28
HL3700	3700	3.45
BL3700	3700	3.15
HL4600	4600	3.30
BL4600	4600	3.70
HL5200	5200	2.01
BL5200	5200	2.08
HL5600	5600	2.07
BL5600	5600	2.12
HL5800	5800	2.06
BL5800	5800	2.13

LOWER DETECTION LIMIT: 7mW/kg

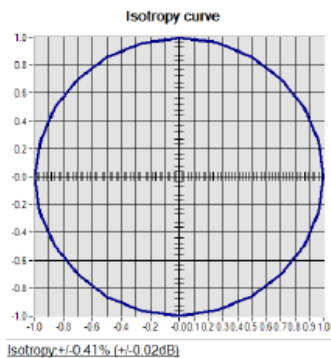


COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

5.4 ISOTROPY

HL1800 MHz





6 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	10/2023	10/2026
Network Analyzer – Calibration kit	HP 85033D	3423A08186	06/2021	06/2027
Multimeter	Keithley 2000	1160271	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	Rohde & Schwarz NRVD	832839-056	11/2023	11/2026
Directional Coupler	Krytar 158020	131467	Characterized prior to test. No cal required.	Characterized prior to test. 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.

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.180.7.22.BES.B

Liquid transition	MVG	SN 32/16 WGLIQ_5G000_1	Validated. No cal required.	Validated. No cal required.
Temperature / Humidity Sensor	Testo 184 H1	44225320	06/2021	06/2024



Dielectric Probe Calibration Report

Ref: ACR.138.4.33.SATU.A

SHENZHEN TONGCE TESTING LAB
2101&2201, ZHENCHANG FACTORY, RENSHAN
INDUSTRIAL ZONE, FUHAI SUBDISTRICT, BAOAN
DISTRICT, SHENZHEN, GUANGDONG, 518103,
PEOPLES REPUBLIC OF 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



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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

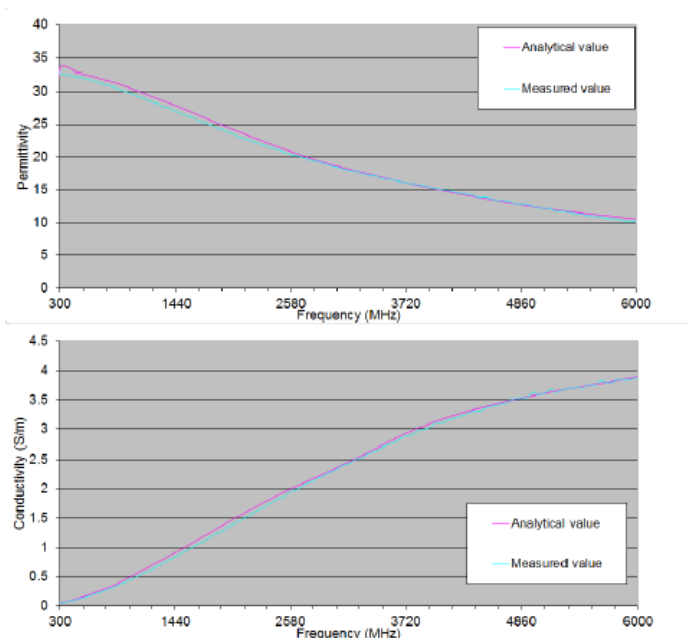
6 CALIBRATION MEASUREMENT RESULTS

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	02/2024	02/2027
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	09/2023	09/2024

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Appendix D: Dipole Calibration Report

SID 750



SAR Reference Dipole Calibration Report

Ref : ACR.156.3.15.SATU.A

SHENZHEN TONGCE TESTING LAB
2101&2201, ZHENCHANG FACTORY, RENSHAN
INDUSTRIAL ZONE, FUHAI SUBDISTRICT, 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

Page: 2/11

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.3.15.SATU.A

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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



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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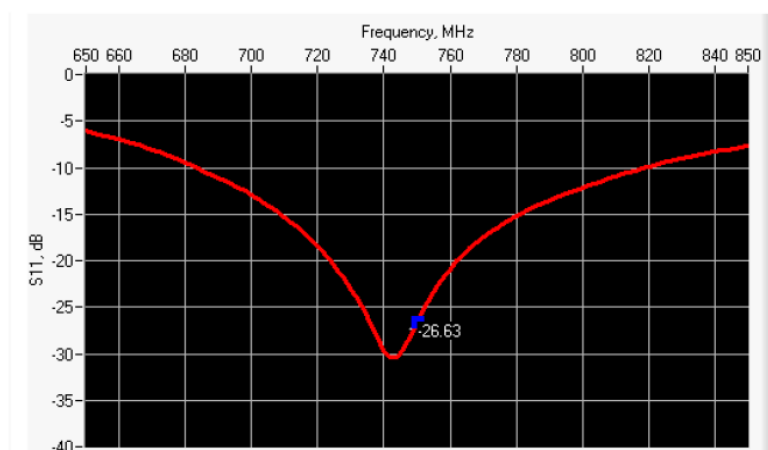
SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.3.15.SATU.A

10 g	20.1 %
------	--------

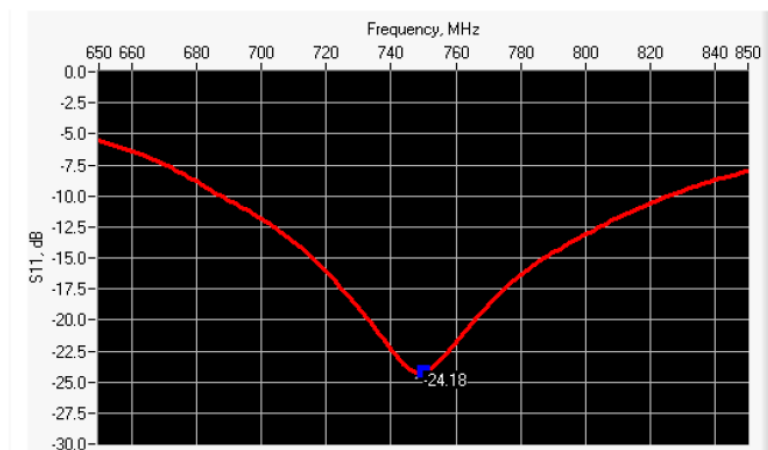
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-26.63	-20	$54.1 \Omega + 1.4 j\Omega$

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-24.18	-20	$52.4 \Omega + 5.8 j\Omega$

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 %	

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Ref: ACR.156.3.15.SATU.A

450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.	PASS	100.0 ±1 %.	PASS	6.35 ±1 %.	PASS
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±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 %.	
3500	37.0 ±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7 ±1 %.		26.4 ±1 %.		3.6 ±1 %.	

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 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 (ϵ_r')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %	PASS	0.89 ±5 %	PASS
835	41.5 ±5 %		0.90 ±5 %	
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	

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Ref: ACR.156.3.15.SATU.A

1800	40.0 ±5 %		1.40 ±5 %	
1900	40.0 ±5 %		1.40 ±5 %	
1950	40.0 ±5 %		1.40 ±5 %	
2000	40.0 ±5 %		1.40 ±5 %	
2100	39.8 ±5 %		1.49 ±5 %	
2300	39.5 ±5 %		1.67 ±5 %	
2450	39.2 ±5 %		1.80 ±5 %	
2600	39.0 ±5 %		1.96 ±5 %	
3000	38.5 ±5 %		2.40 ±5 %	
3500	37.9 ±5 %		2.91 ±5 %	

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 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.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: ϵ_{ps}' : 41.8 σ : 0.90
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49	8.31 (0.73)	5.55	5.71 (0.54)
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	

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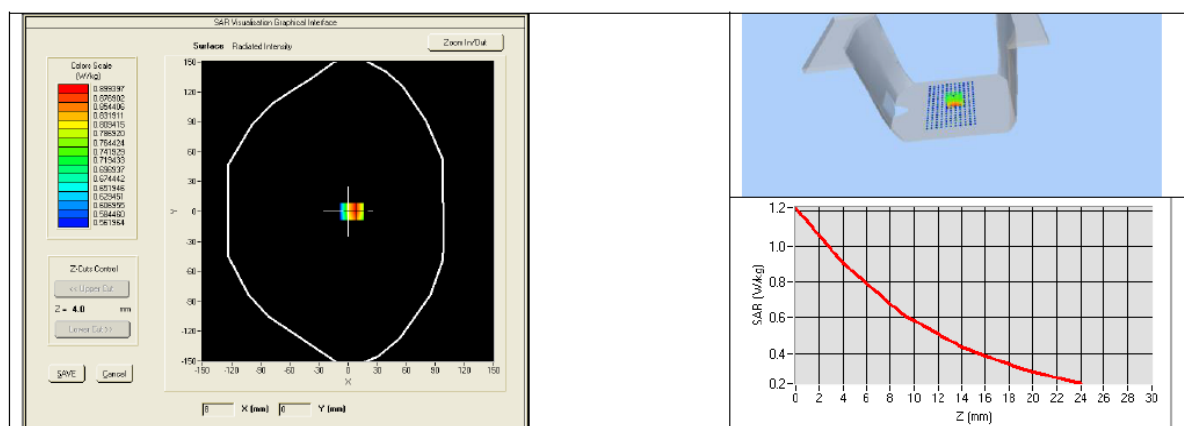
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1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	



7.3 BODY LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ϵ_r')		Conductivity (σ) S/m	
	required	measured	required	measured
150	61.9 $\pm$ 5 %		0.80 $\pm$ 5 %	
300	58.2 $\pm$ 5 %		0.92 $\pm$ 5 %	
450	56.7 $\pm$ 5 %		0.94 $\pm$ 5 %	
750	55.5 $\pm$ 5 %	PASS	0.96 $\pm$ 5 %	PASS
835	55.2 $\pm$ 5 %		0.97 $\pm$ 5 %	
900	55.0 $\pm$ 5 %		1.05 $\pm$ 5 %	
915	55.0 $\pm$ 5 %		1.06 $\pm$ 5 %	
1450	54.0 $\pm$ 5 %		1.30 $\pm$ 5 %	
1610	53.8 $\pm$ 5 %		1.40 $\pm$ 5 %	
1800	53.3 $\pm$ 5 %		1.52 $\pm$ 5 %	
1900	53.3 $\pm$ 5 %		1.52 $\pm$ 5 %	
2000	53.3 $\pm$ 5 %		1.52 $\pm$ 5 %	
2100	53.2 $\pm$ 5 %		1.62 $\pm$ 5 %	
2450	52.7 $\pm$ 5 %		1.95 $\pm$ 5 %	

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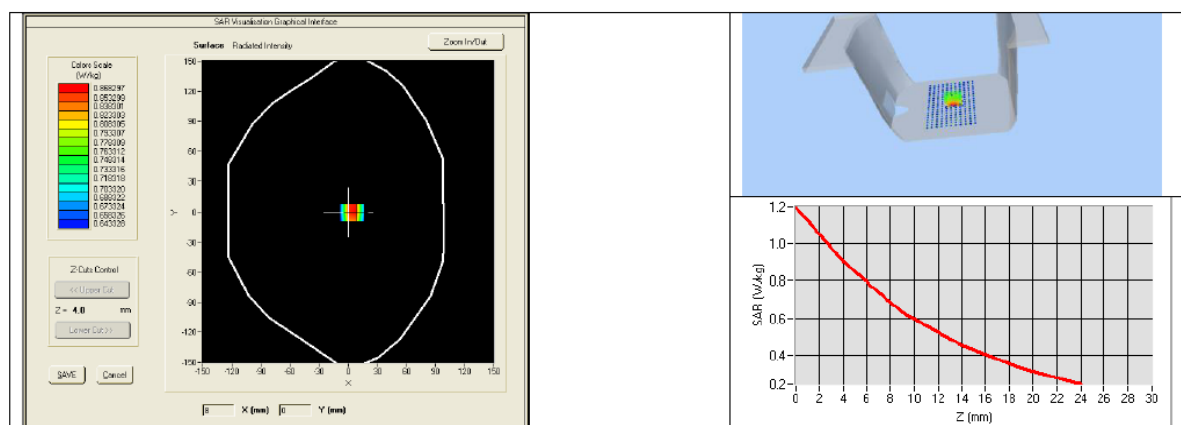
Ref: ACR.156.3.15.SATU.A

2600	52.5 ±5 %		2.16 ±5 %	
3000	52.0 ±5 %		2.73 ±5 %	
3500	51.3 ±5 %		3.31 ±5 %	
5200	49.0 ±10 %		5.30 ±10 %	
5300	48.9 ±10 %		5.42 ±10 %	
5400	48.7 ±10 %		5.53 ±10 %	
5500	48.6 ±10 %		5.65 ±10 %	
5600	48.5 ±10 %		5.77 ±10 %	
5800	48.2 ±10 %		6.00 ±10 %	

7.4 SAR MEASUREMENT RESULT WITH BODY LIQUID

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Body Liquid Values: ϵ_{ps} : 56.3 σ : 0.98
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8mm/dz=5mm
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)	10 g SAR (W/kg/W)
	measured	measured
750	8.46 (0.77)	5.81 (0.45)



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8 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	Manufacturer / Model	Identification No.	Current Calibration Date	Next Calibration Date
SAM 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	Rhode & Schwarz ZVA	SN100132	02/2024	02/2027
Calipers	Carrera	CALIPER-01	02/2024	02/2027
Reference Probe	MVG	EPG122 SN 18/11	02/2024	02/2025
Multimeter	Keithley 2000	1188656	02/2024	02/2027
Signal Generator	Agilent E4438C	MY49070581	02/2024	02/2027
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	02/2024	02/2027
Power Sensor	HP ECP-E26A	US37181460	02/2024	02/2027
Directional Coupler	Narda 4216-20	01386	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Temperature and Humidity Sensor	Control Company	11-661-9	02/2024	02/2027