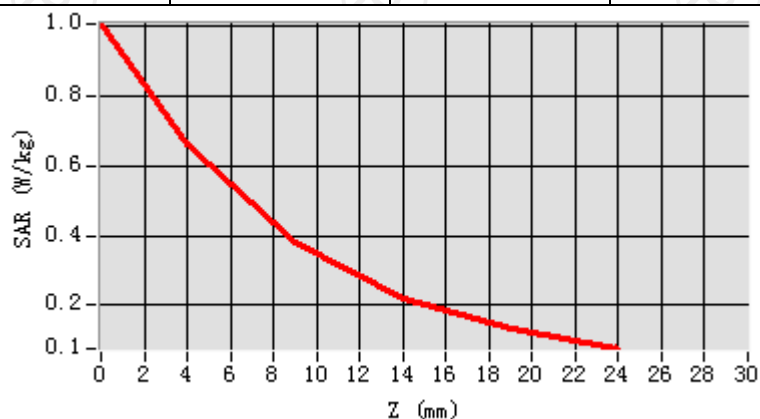
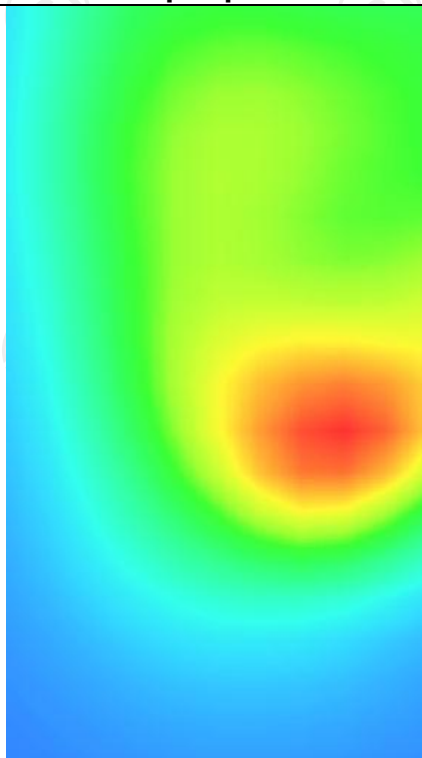


Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.0080	0.6627	0.3834	0.2220	0.1320



Hot spot position



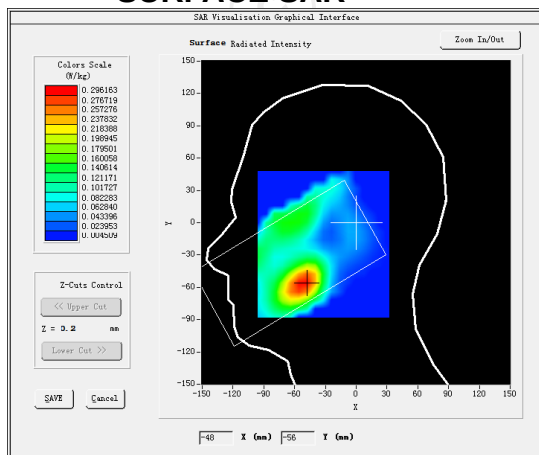
WCDMA Band IV MEASUREMENT 1

Lower Band SAR (Channel 1312):

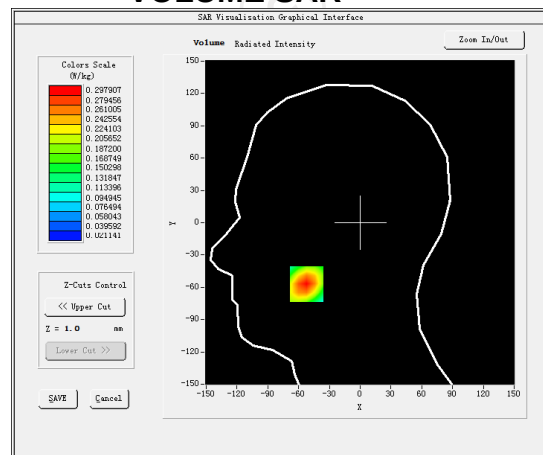
Date: 08/24/2018

Frequency (MHz)	1712.400000
Relative permittivity (real part)	39.112354
Relative permittivity (imaginary part)	12.607241
Conductivity (S/m)	1.342388
Variation (%)	-0.070000
Crest Factor	1.0
Probe Conversion factor	4.85
E-Field Probe:	SSE5 (SN 07/15 EP248)
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>Right head</u>
Device Position	<u>Cheek</u>
Band	<u>BAND1 WCDMA1700</u>

SURFACE SAR



VOLUME SAR



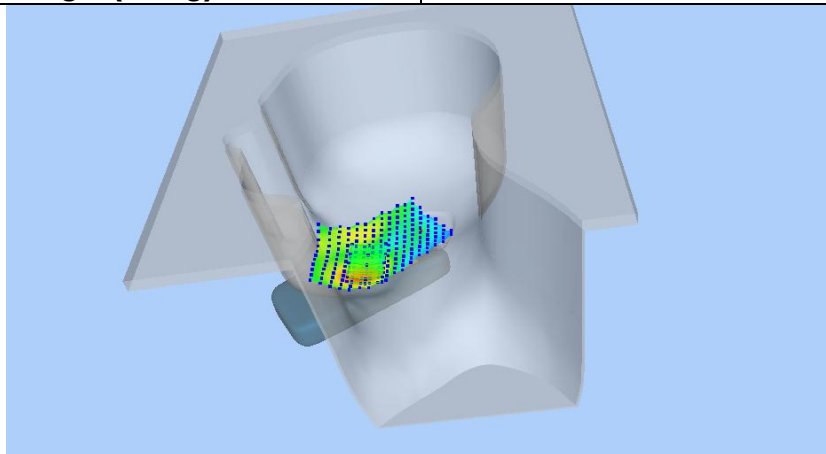
Maximum location: X=-52.00, Y=-57.00 SAR Peak: 0.41 W/kg

SAR 10g (W/Kg)

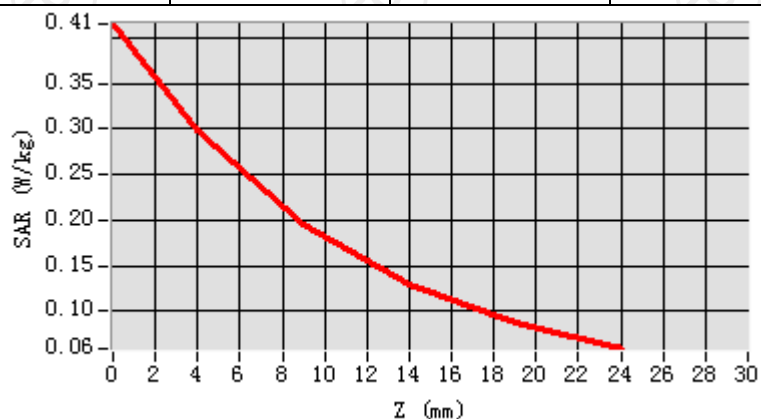
0.151803

SAR 1g (W/Kg)

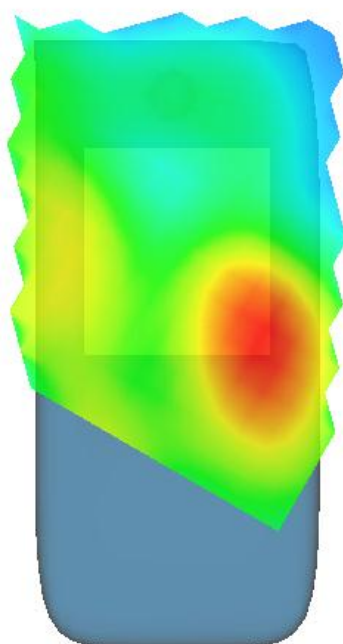
0.244923



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4149	0.2979	0.1957	0.1300	0.0883



Hot spot position



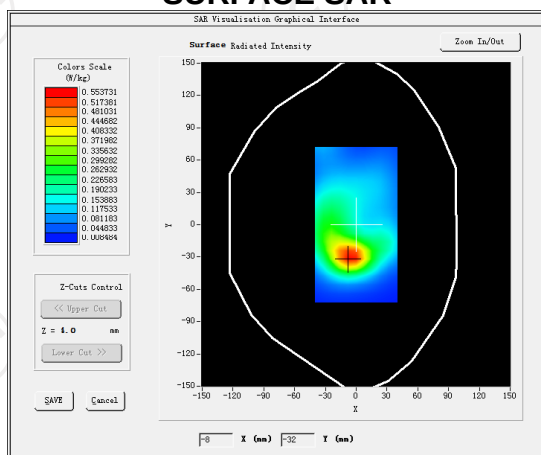
MEASUREMENT 2

Lower Band SAR (Channel 1312):

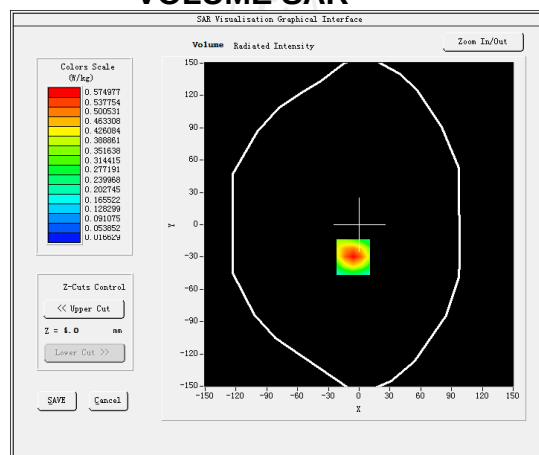
Date: 08/24/2018

Frequency (MHz)	1712.400000
Relative permittivity (real part)	53.342521
Relative permittivity (imaginary part)	14.225400
Conductivity (S/m)	1.492530
Variation (%)	0.620000
Crest Factor	1.0
Probe Conversion factor	5.01
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(10mm)</u>
Band	<u>BAND1 WCDMA1700</u>

SURFACE SAR



VOLUME SAR



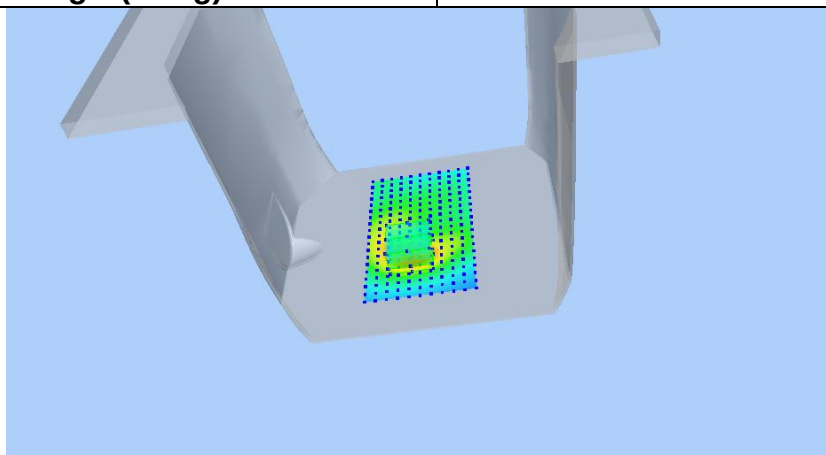
Maximum location: X=-6.00, Y=-30.00 SAR Peak: 0.94 W/kg

SAR 10g (W/Kg)

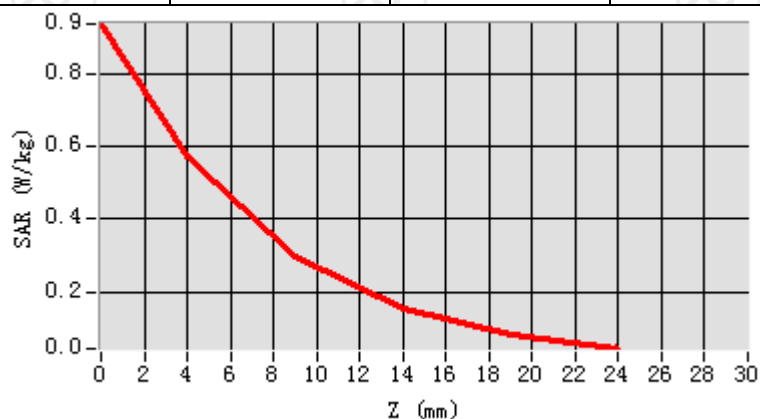
0.280742

SAR 1g (W/Kg)

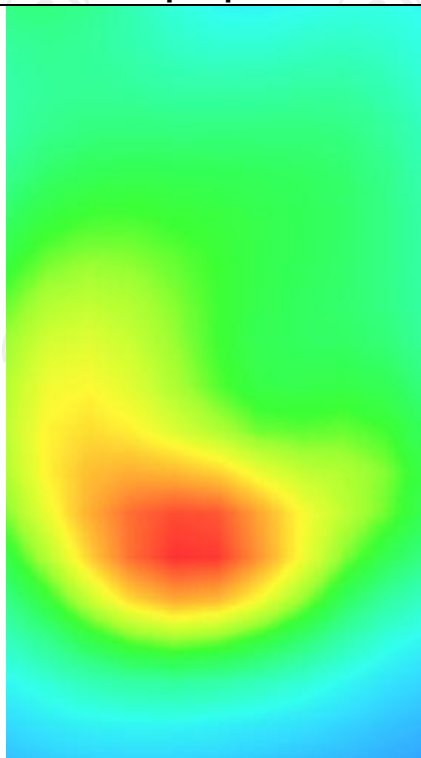
0.539180



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.9408	0.5750	0.2981	0.1530	0.0816



Hot spot position



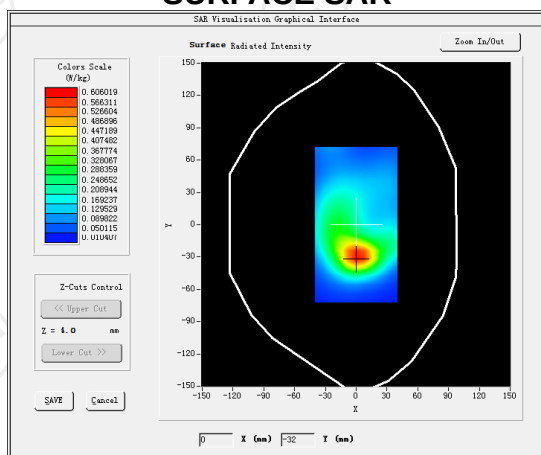
MEASUREMENT 3

Lower Band SAR (Channel 1312):

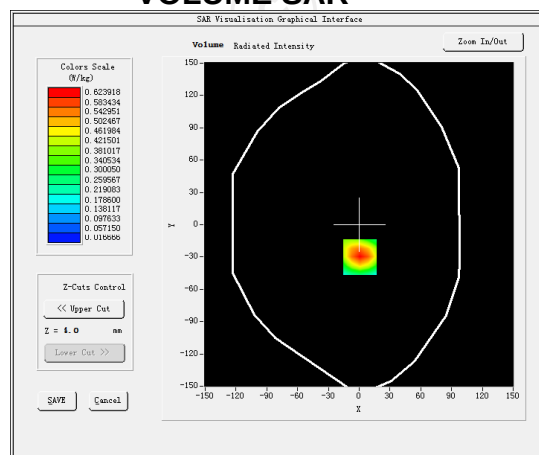
Date: 08/24/2018

Frequency (MHz)	1712.400000
Relative permittivity (real part)	53.342521
Relative permittivity (imaginary part)	14.225400
Conductivity (S/m)	1.492530
Variation (%)	-0.530000
Crest Factor	1.0
Probe Conversion factor	5.01
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 bottom(10mm)
Band	BAND1 WCDMA1700(hotspot)

SURFACE SAR



VOLUME SAR



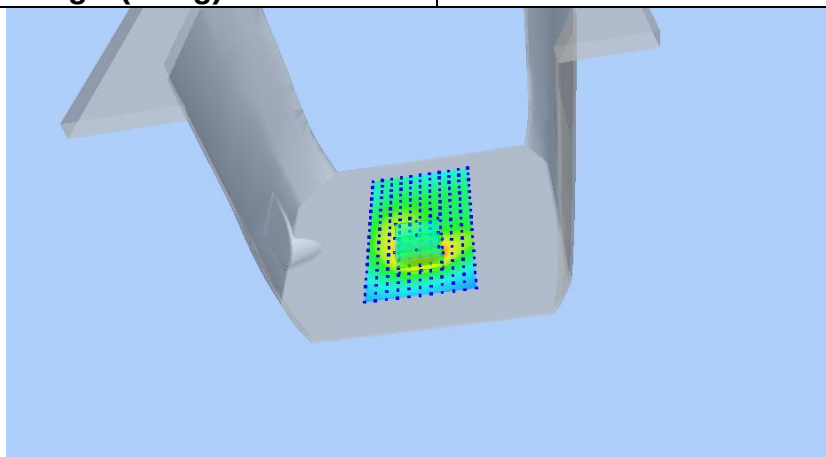
Maximum location: X=1.00, Y=-30.00 SAR Peak: 1.03 W/kg

SAR 10g (W/Kg)

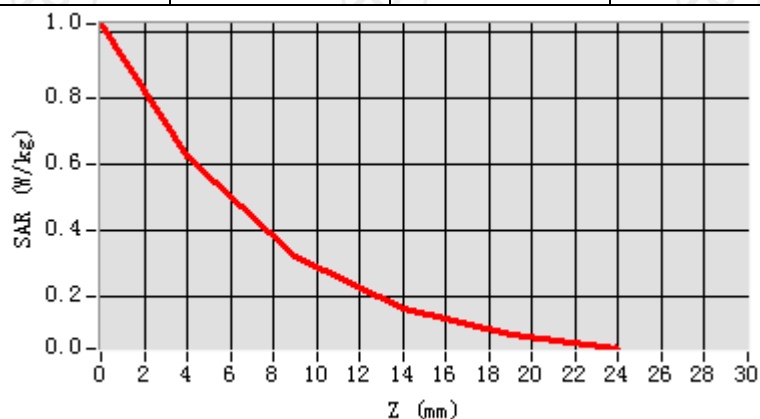
0.304030

SAR 1g (W/Kg)

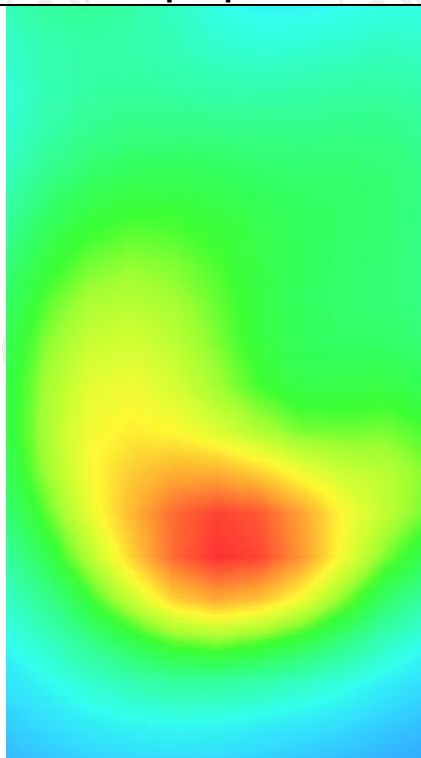
0.581063



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.0267	0.6239	0.3205	0.1628	0.0858



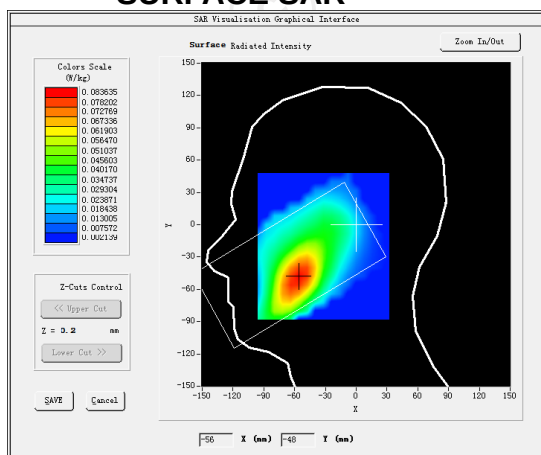
Hot spot position



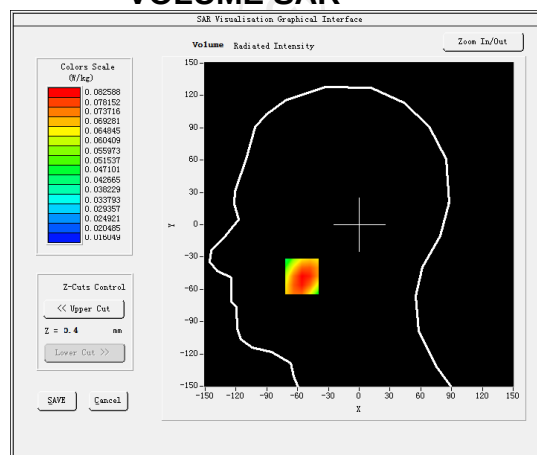
WCDMA Band V MEASUREMENT 1

Lower Band SAR (Channel 4132):		Date: 08/15/2018
Frequency (MHz)	826.400000	
Relative permittivity (real part)	41.432883	
Relative permittivity (imaginary part)	18.129634	
Conductivity (S/m)	0.857241	
Variation (%)	-1.040000	
Crest Factor:	1.0	
Probe Conversion factor	5.50	
E-Field Probe:	SSE5 (SN 07/15 EP248)	
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	Right head	
Device Position	Cheek	
Band	BAND5 WCDMA850	

SURFACE SAR



VOLUME SAR



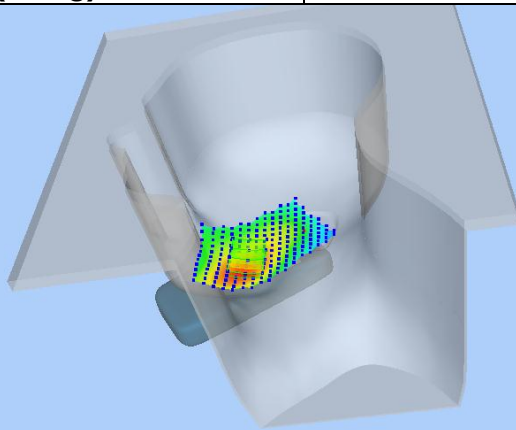
Maximum location: X=-56.00, Y=-48.00 SAR Peak: 0.10 W/kg

SAR 10g (W/Kg)

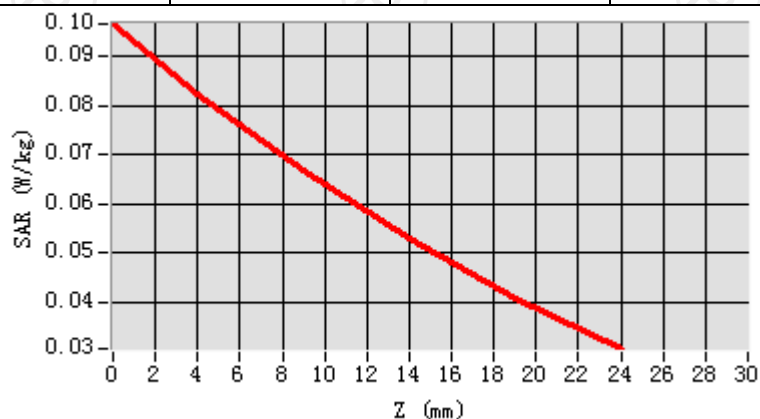
0.059169

SAR 1g (W/Kg)

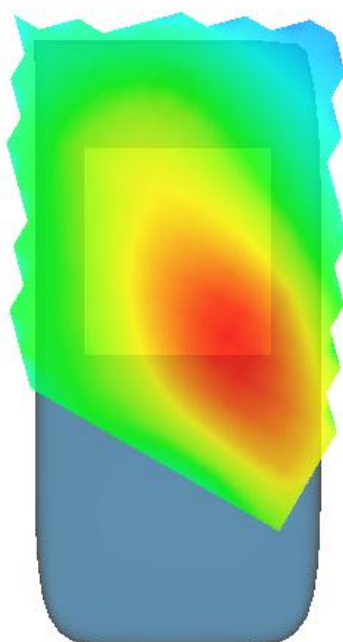
0.080108



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.0967	0.0826	0.0668	0.0529	0.0408



Hot spot position



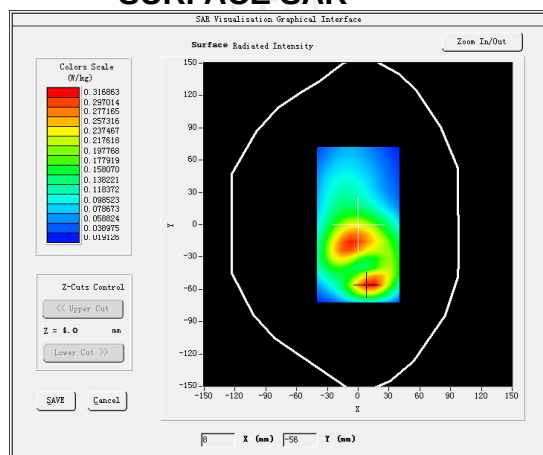
MEASUREMENT 2

Lower Band SAR (Channel 4132):

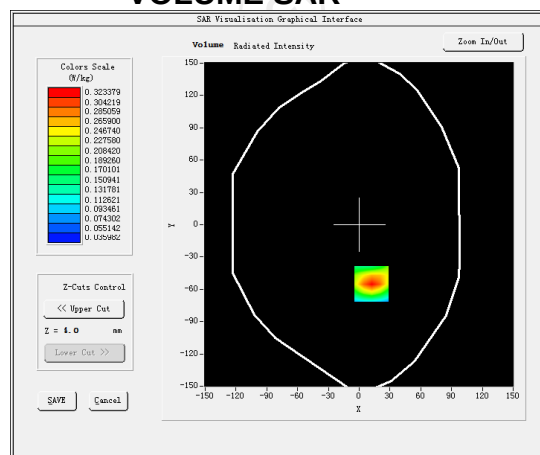
Date: 08/15/2018

Frequency (MHz)	826.400000
Relative permittivity (real part)	55.262457
Relative permittivity (imaginary part)	18.128360
Conductivity (S/m)	0.932668
Variation (%)	-1.160000
Crest Factor:	1.0
Probe Conversion factor	5.65
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(10mm)</u>
Band	<u>BAND5 WCDMA850</u>

SURFACE SAR



VOLUME SAR



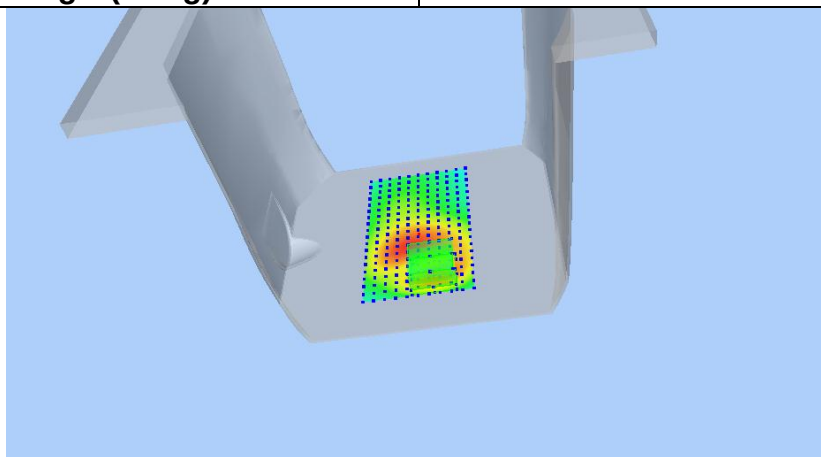
Maximum location: X=11.00, Y=-50.00 SAR Peak: 0.23 W/kg

SAR 10g (W/Kg)

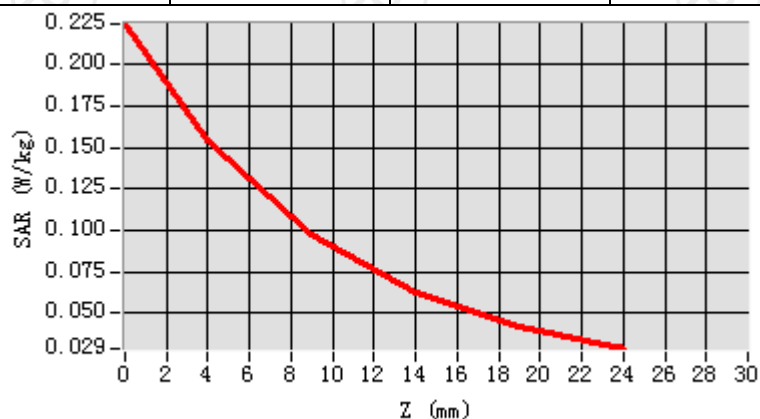
0.089898

SAR 1g (W/Kg)

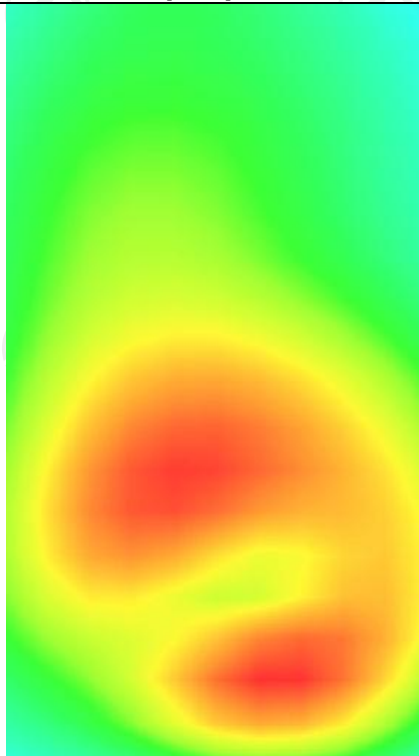
0.147819



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2246	0.1549	0.0969	0.0622	0.0419



Hot spot position



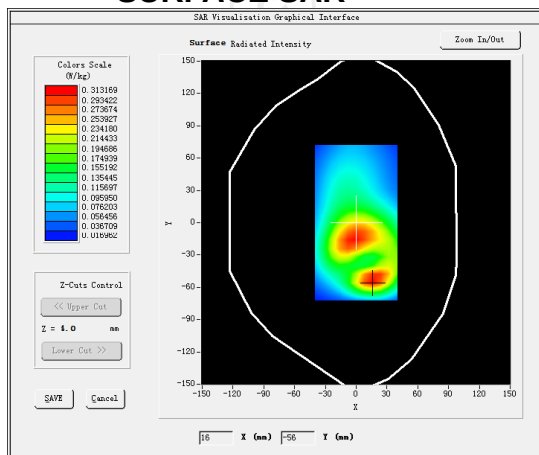
MEASUREMENT 3

Lower Band SAR (Channel 4132):

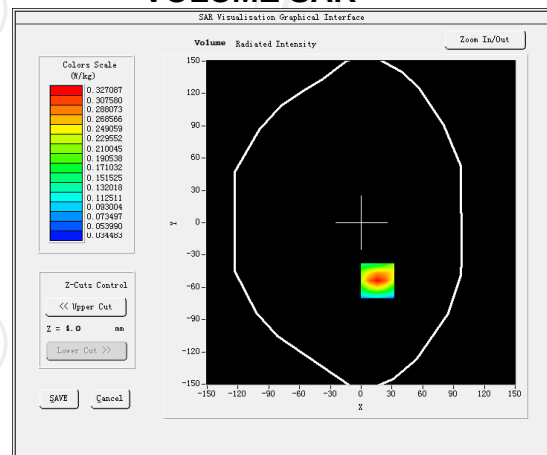
Date: 08/15/2018

Frequency (MHz)	826.400000
Relative permittivity (real part)	55.262457
Relative permittivity (imaginary part)	18.128360
Conductivity (S/m)	0.932668
Variation (%)	-2.410000
Crest Factor:	1.0
Probe Conversion factor	5.65
E-Field Probe:	SSE5 (SN 07/15 EP248)
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,</u> <u>h= 5.00 mm</u>
Phantom	<u>Validation plane</u>
Device Position	<u>Body back(10mm)</u>
Band	<u>BAND5 WCDMA850(hotspot)</u>

SURFACE SAR



VOLUME SAR



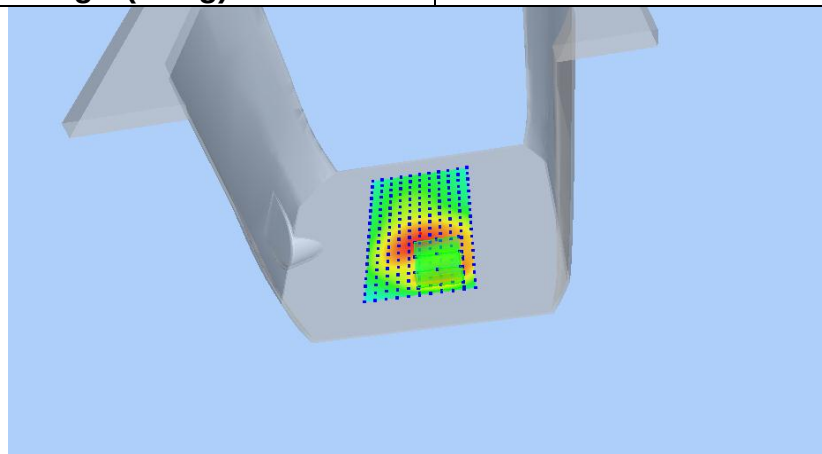
Maximum location: X=19.00, Y=-58.00 SAR Peak: 0.23 W/kg

SAR 10g (W/Kg)

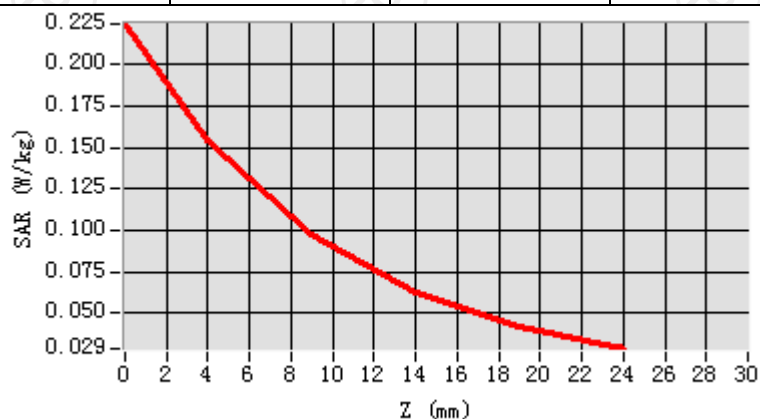
0.092273

SAR 1g (W/Kg)

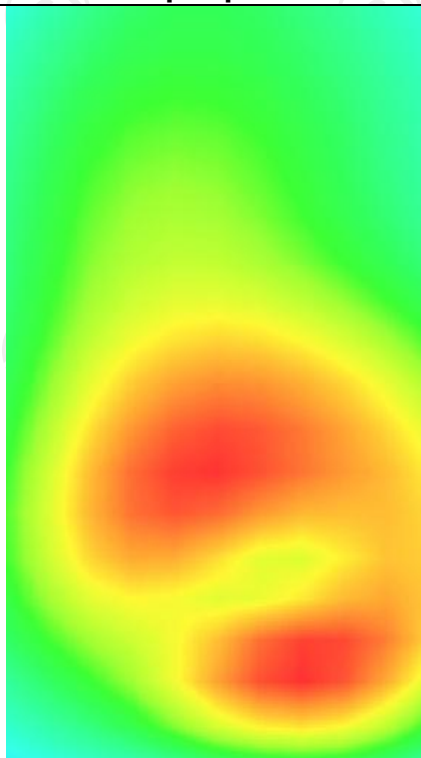
0.159034



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2253	0.1557	0.0975	0.0631	0.0430



Hot spot position



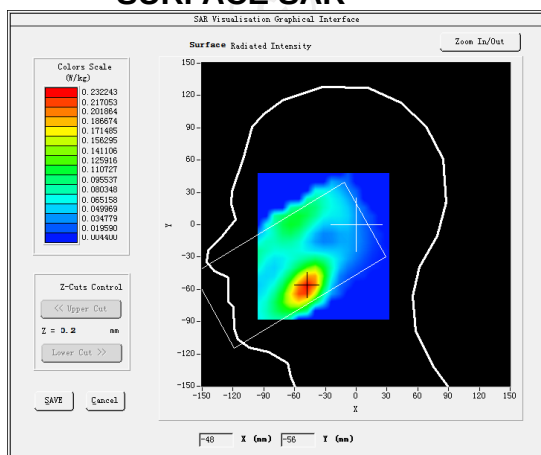
LTE Band 2

MEASUREMENT 1

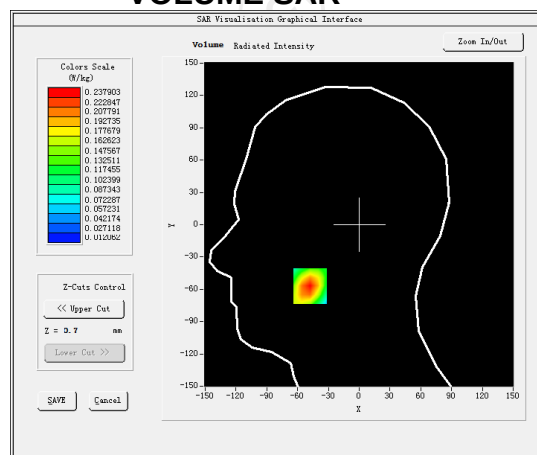
Lower Band SAR (Channel 18607): Date: 08/21/2018

Frequency (MHz)	1850.700000
Relative permittivity (real part)	39.113793
Relative permittivity (imaginary part)	12.607061
Conductivity (S/m)	1.337526
Variation (%)	0.980000
Crest Factor	1.0
Probe Conversion factor	4.85
E-Field Probe:	SSE5 (SN 07/15 EP248)
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	Right head
Device Position	Cheek
Band	LTE band 2 (1 RB#0)

SURFACE SAR



VOLUME SAR



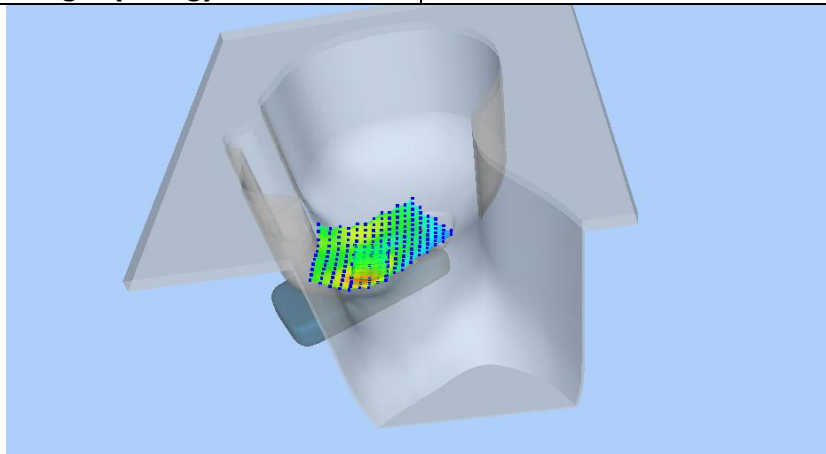
Maximum location: X=-48.00, Y=-57.00 SAR Peak: 0.35 W/kg

SAR 10g (W/Kg)

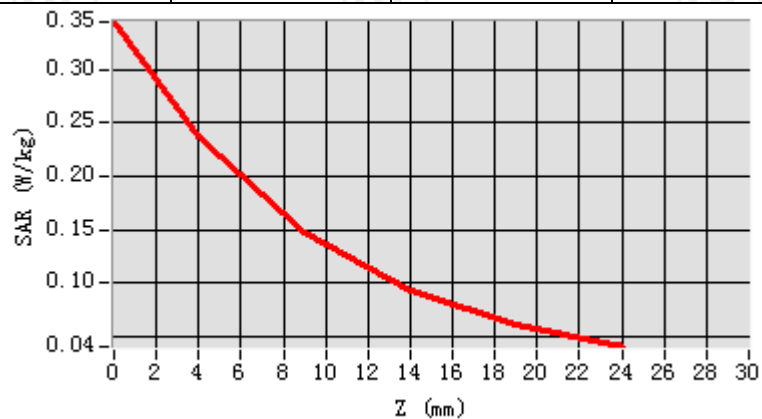
0.129978

SAR 1g (W/Kg)

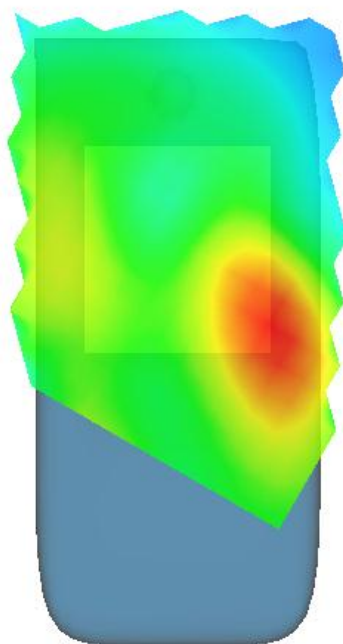
0.223144



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.3451	0.2379	0.1480	0.0935	0.0613



Hot spot position



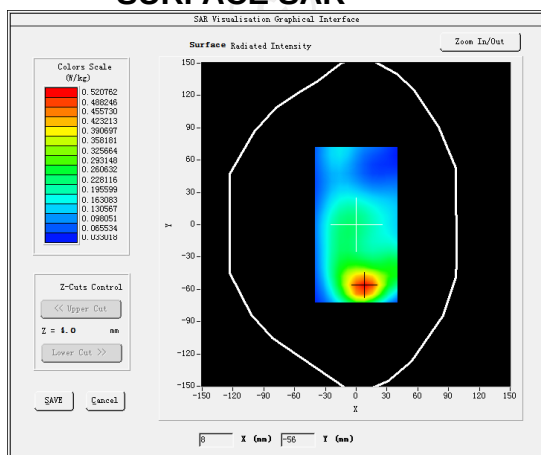
MEASUREMENT 2

Lower Band SAR (Channel 18607):

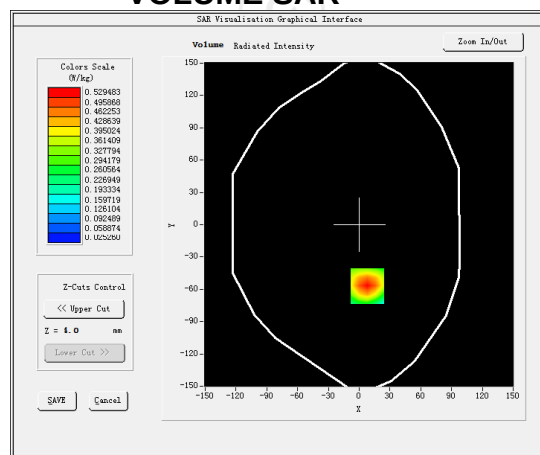
Date: 08/21/2018

Frequency (MHz)	1850.700000
Relative permittivity (real part)	53.342133
Relative permittivity (imaginary part)	14.329440
Conductivity (S/m)	1.491983
Variation (%)	-0.120000
Crest Factor	1.0
Probe Conversion factor	5.01
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 2 (1 RB#0)

SURFACE SAR



VOLUME SAR



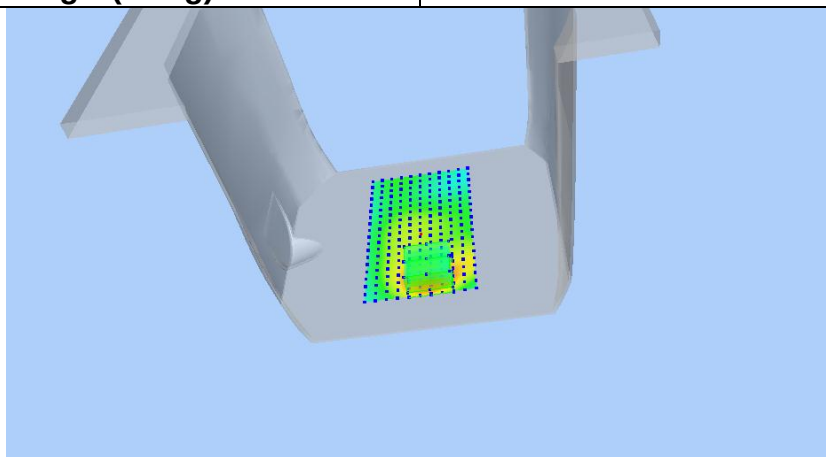
Maximum location: X=8.00, Y=-57.00 SAR Peak: 0.79 W/kg

SAR 10g (W/Kg)

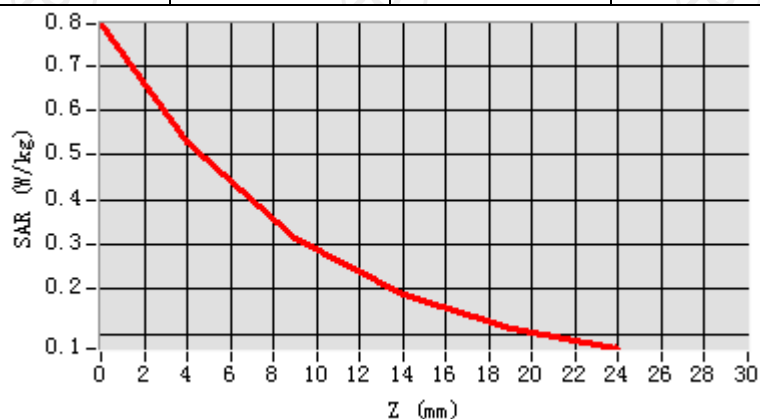
0.285447

SAR 1g (W/Kg)

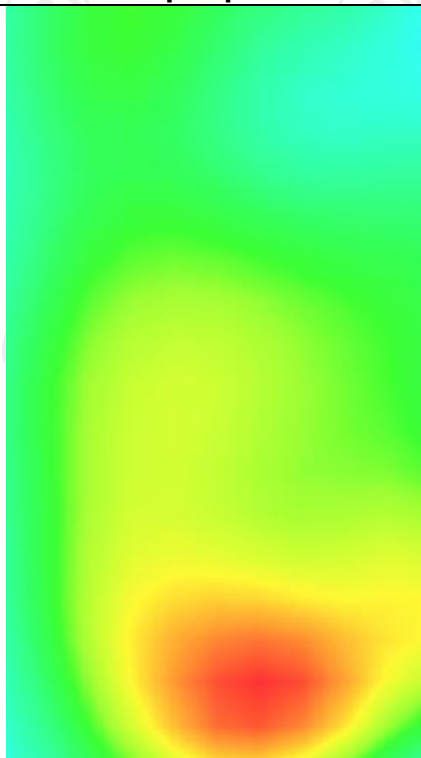
0.497064



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.7921	0.5295	0.3141	0.1871	0.1145



Hot spot position



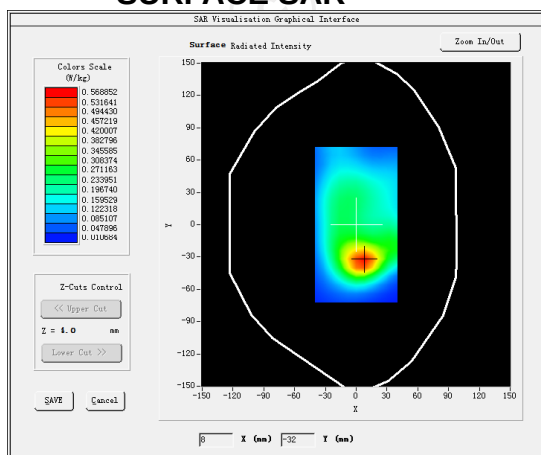
MEASUREMENT 3

Lower Band SAR (Channel 18607):

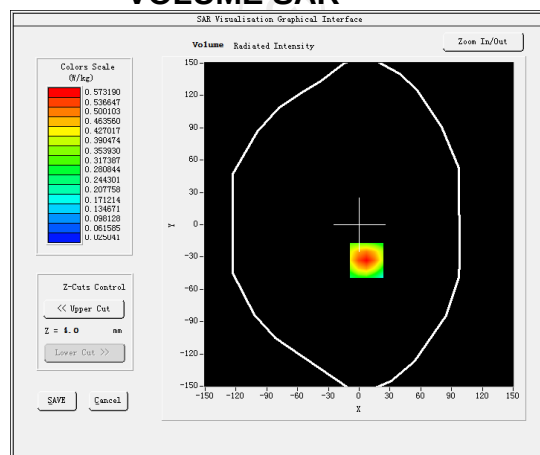
Date: 08/21/2018

Frequency (MHz)	1850.700000
Relative permittivity (real part)	53.342133
Relative permittivity (imaginary part)	14.329440
Conductivity (S/m)	1.491983
Variation (%)	-1.030000
Crest Factor	1.0
Probe Conversion factor	5.01
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(hotspot 10mm)</u>
Band	<u>LTE band 2 (1 RB#0)</u>

SURFACE SAR



VOLUME SAR



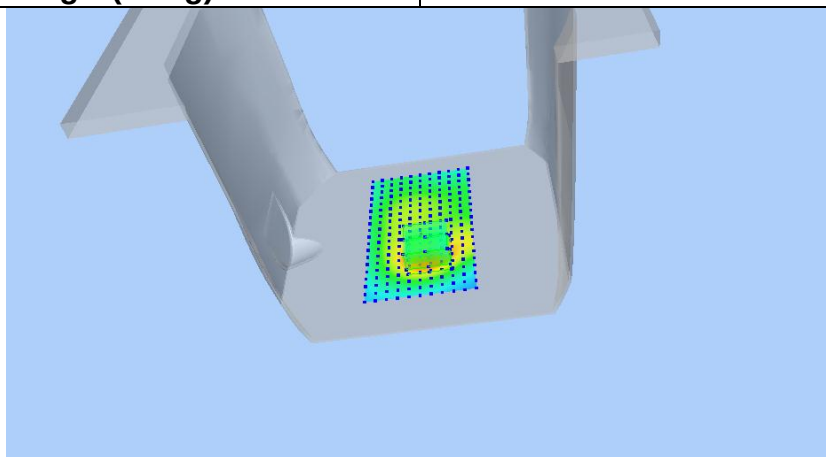
Maximum location: X=7.00, Y=-33.00 SAR Peak: 0.87 W/kg

SAR 10g (W/Kg)

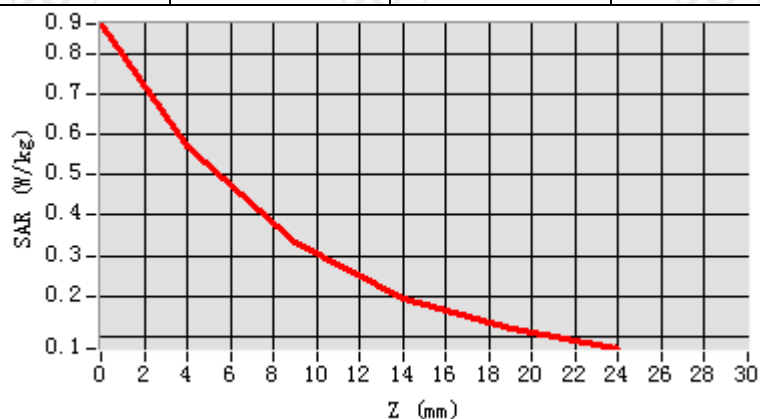
0.306230

SAR 1g (W/Kg)

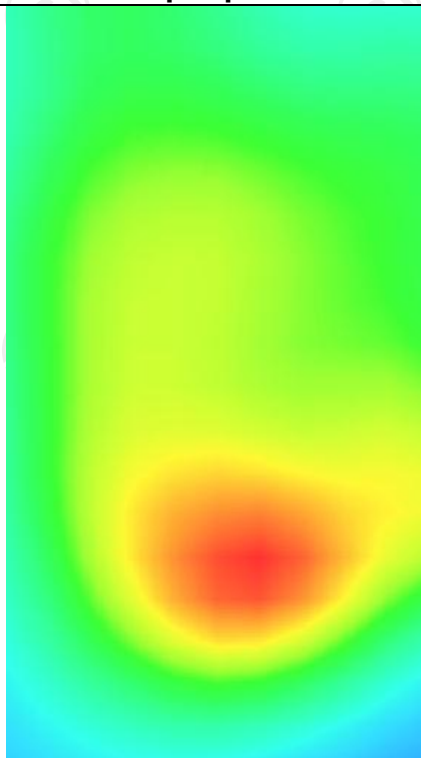
0.538711



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.8741	0.5732	0.3314	0.1930	0.1167



Hot spot position



LTE Band 4

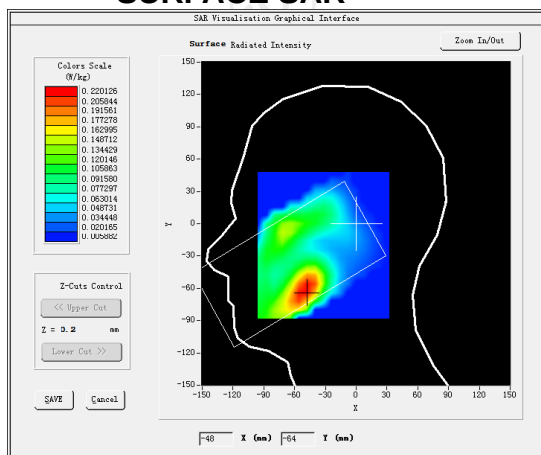
MEASUREMENT 1

Middle Band SAR (Channel 20175):

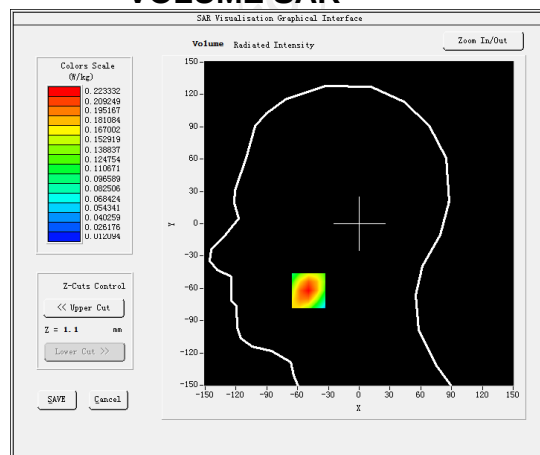
Date: 08/24/2018

Frequency (MHz)	1732.500000
Relative permittivity (real part)	39.101249
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	1.350792
Variation (%)	-1.460000
Crest Factor	1.0
Probe Conversion factor	4.38
E-Field Probe:	SSE5 (SN 07/15 EP248)
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>Left head</u>
Device Position	<u>Cheek</u>
Band	<u>LTE band 4(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



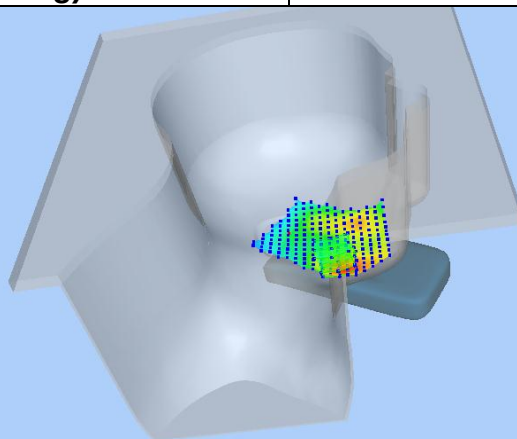
Maximum location: X=-49.00, Y=-62.00 SAR Peak: 0.32 W/kg

SAR 10g (W/Kg)

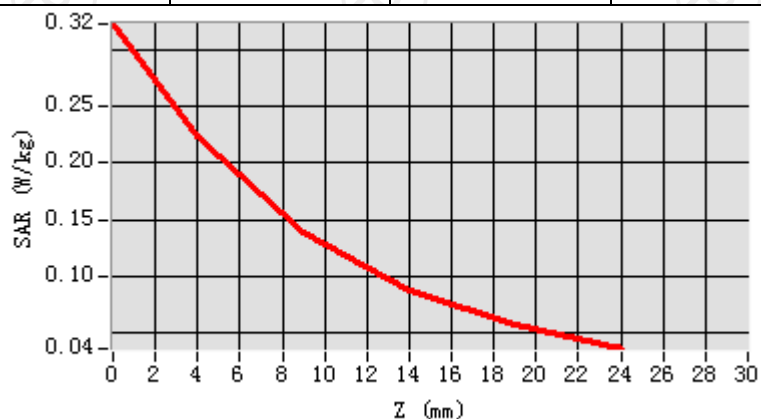
0.095058

SAR 1g (W/Kg)

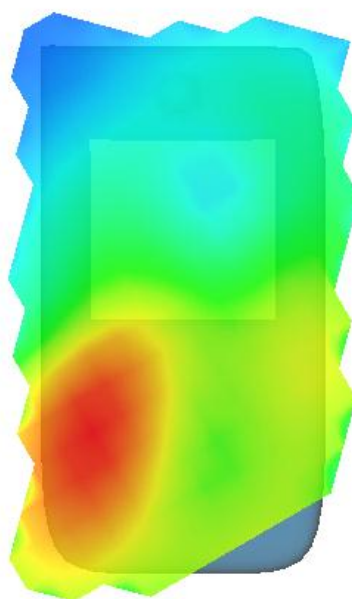
0.150398



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.3222	0.2233	0.1397	0.0882	0.0572



Hot spot position



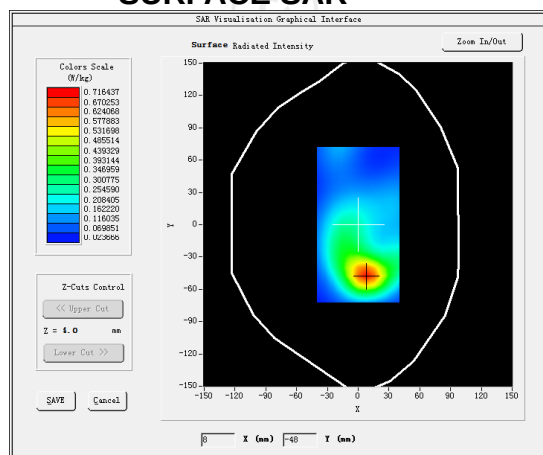
MEASUREMENT 2

Middle Band SAR (Channel 20175):

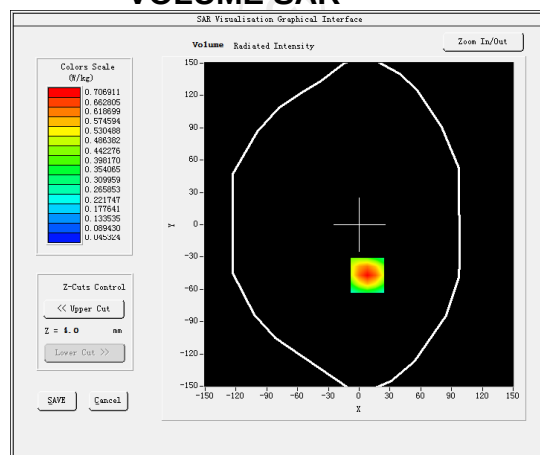
Date: 08/24/2018

Frequency (MHz)	1732.500000
Relative permittivity (real part)	53.321249
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	1.502592
Variation (%)	-0.350000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 4(1 RB#0)

SURFACE SAR



VOLUME SAR



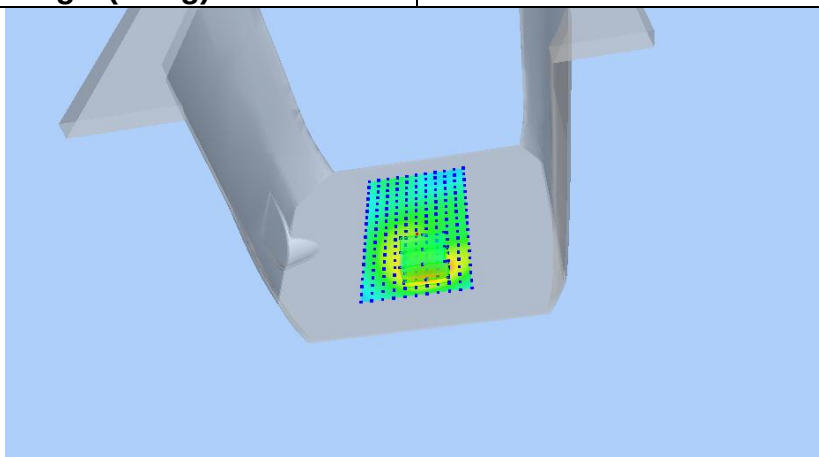
Maximum location: X=8.00, Y=-47.00 SAR Peak: 1.01 W/kg

SAR 10g (W/Kg)

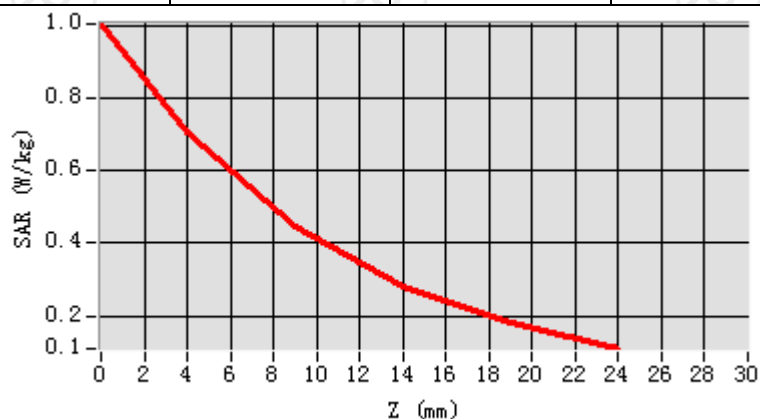
0.390679

SAR 1g (W/Kg)

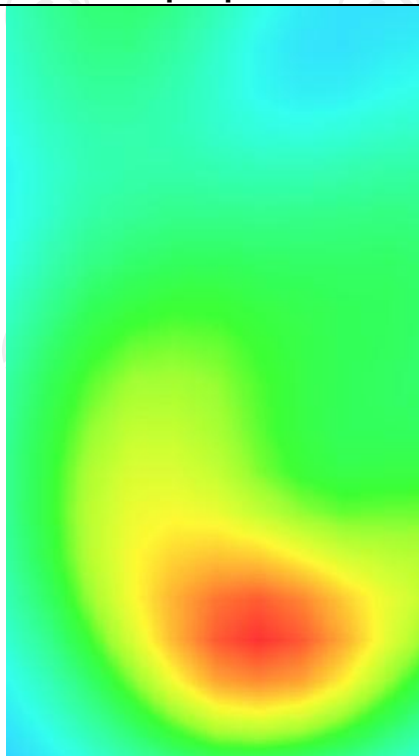
0.663149



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.0070	0.7069	0.4472	0.2821	0.1790



Hot spot position



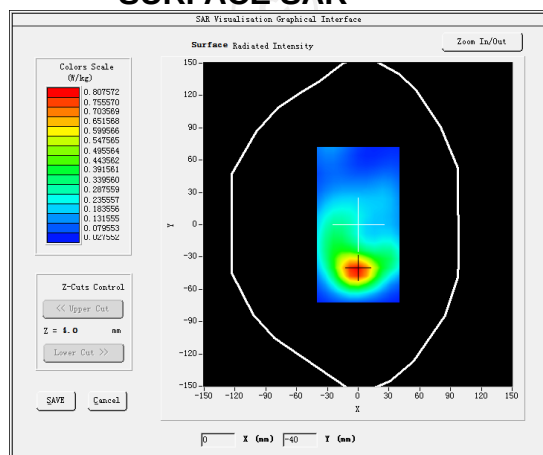
MEASUREMENT 3

Middle Band SAR (Channel 20175):

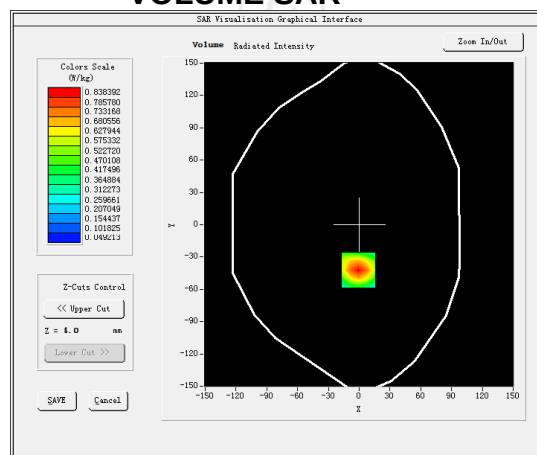
Date: 08/24/2018

Frequency (MHz)	1732.500000
Relative permittivity (real part)	53.321249
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	1.502592
Variation (%)	-0.290000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(hotspot 10mm)</u>
Band	<u>LTE band 4(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



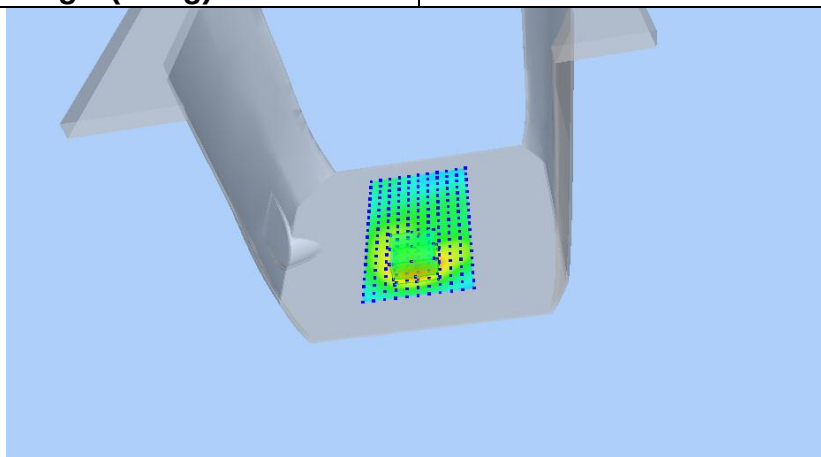
Maximum location: X=-1.00, Y=-42.00 SAR Peak: 1.22 W/kg

SAR 10g (W/Kg)

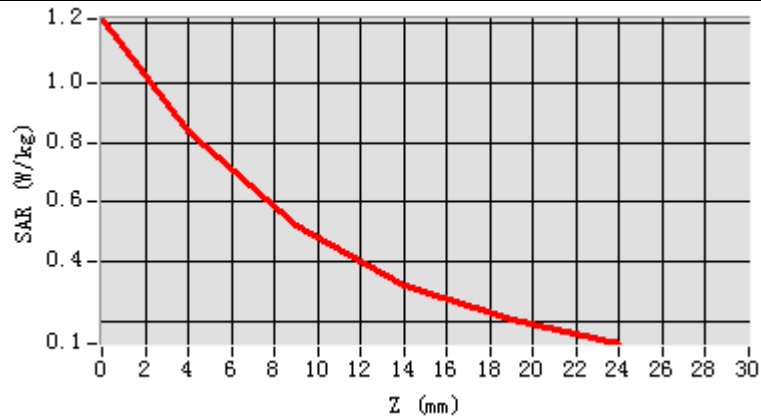
0.413559

SAR 1g (W/Kg)

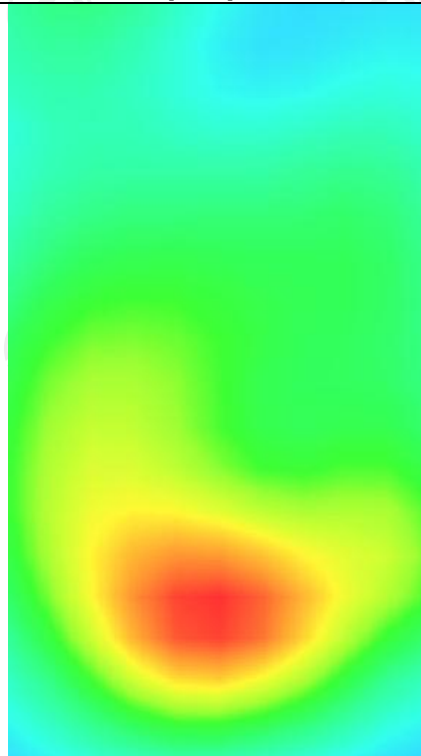
0.723801



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.2164	0.8384	0.5183	0.3210	0.2019



Hot spot position



LTE Band 5

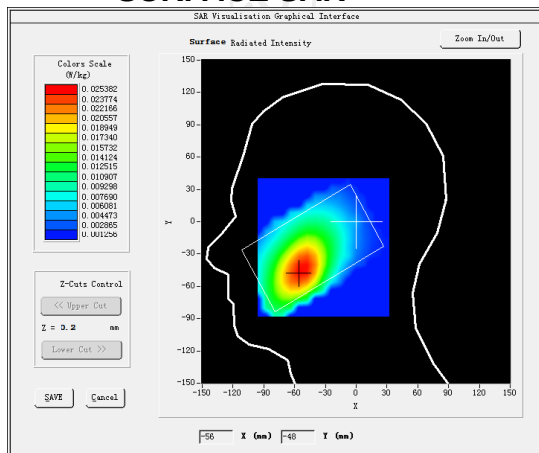
MEASUREMENT 1

Higher Band SAR (Channel 20600):

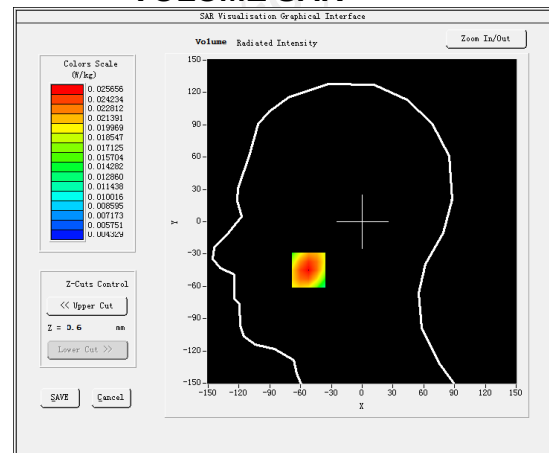
Date: 08/15/2018

Frequency (MHz)	846.500000
Relative permittivity (real part)	40.392517
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	0.881392
Variation (%)	-1.250000
Crest Factor	1.0
Probe Conversion factor	4.38
E-Field Probe:	SSE5 (SN 07/15 EP248)
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>Left head</u>
Device Position	<u>Cheek</u>
Band	<u>LTE band 5(1 RB#0)</u>

SURFACE SAR

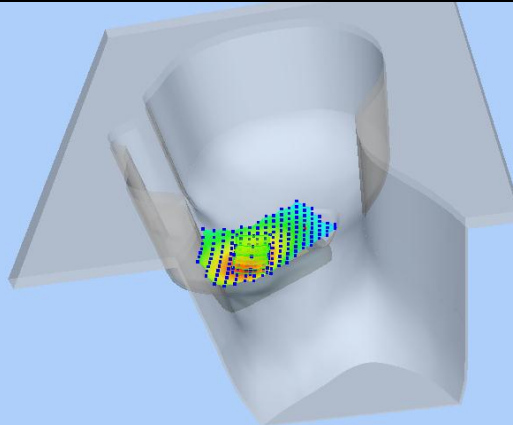


VOLUME SAR

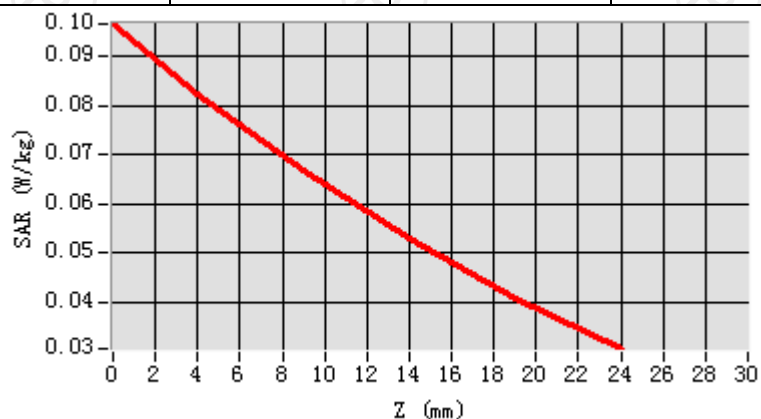


Maximum location: X=-52.00, Y=-45.00 SAR Peak: 0.10 W/kg

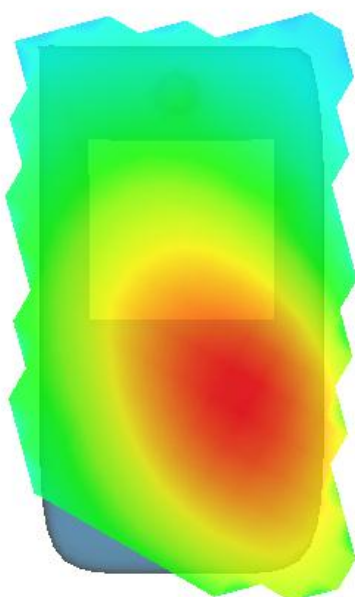
SAR 10g (W/Kg)	0.031965
SAR 1g (W/Kg)	0.062092



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.0980	0.0817	0.0659	0.0518	0.0406



Hot spot position



MEASUREMENT 2

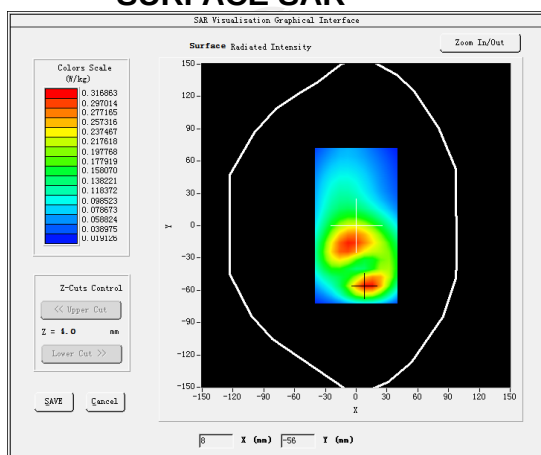
Higher Band SAR (Channel 20600):

Date: 08/15/2018

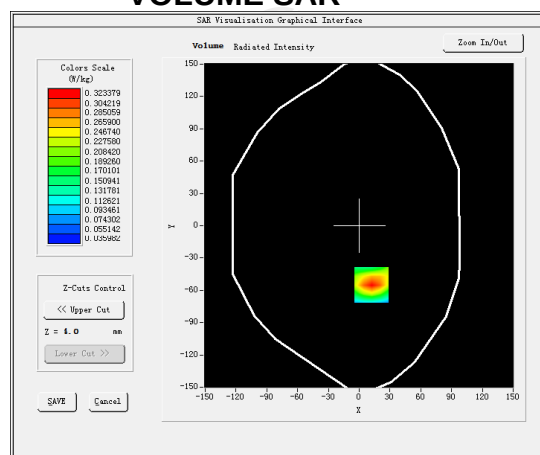
Frequency (MHz)	844.000000
Relative permittivity (real part)	53.214937
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	0.973512
Variation (%)	-1.540000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
Area Scan	<u>dx=8mm dy=8mm, h= 5.00 mm</u>
ZoomScan	<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 back(10mm)</u>
Band	<u>LTE band 5(1 RB#0)</u>

SURFACE SAR

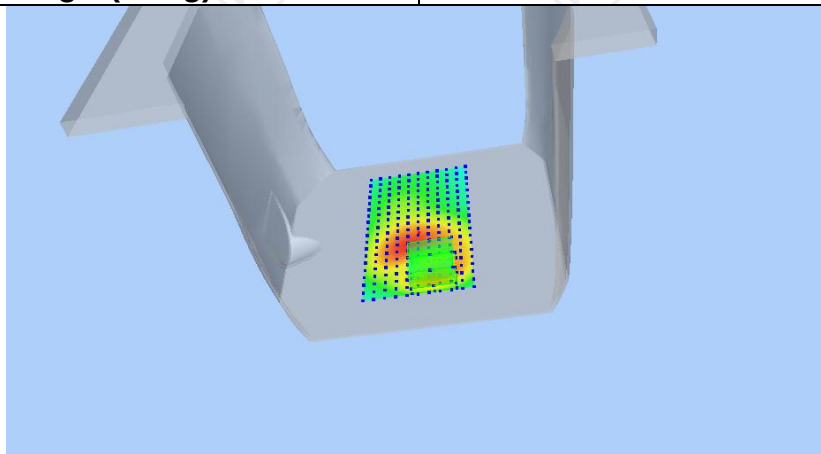


VOLUME SAR

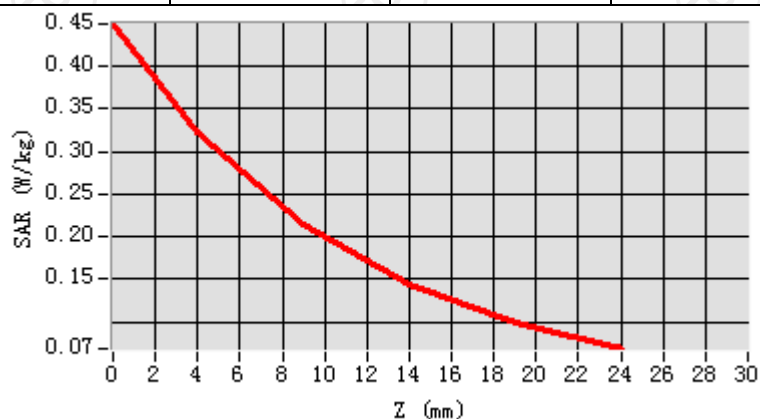


Maximum location: X=12.00, Y=-55.00 SAR Peak: 0.45 W/kg

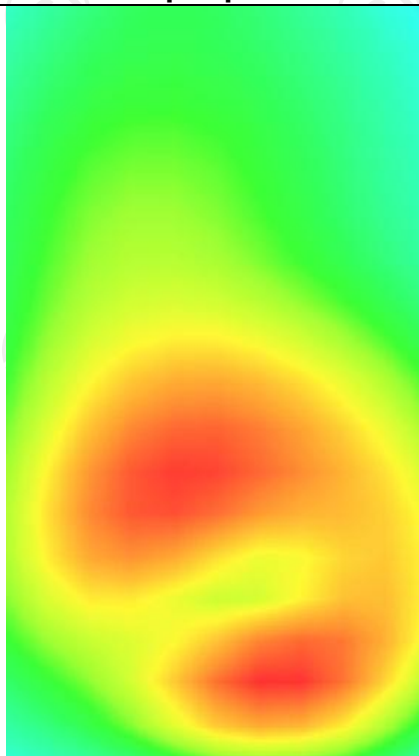
SAR 10g (W/Kg)	0.182644
SAR 1g (W/Kg)	0.303078



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4495	0.3234	0.2137	0.1437	0.0997



Hot spot position



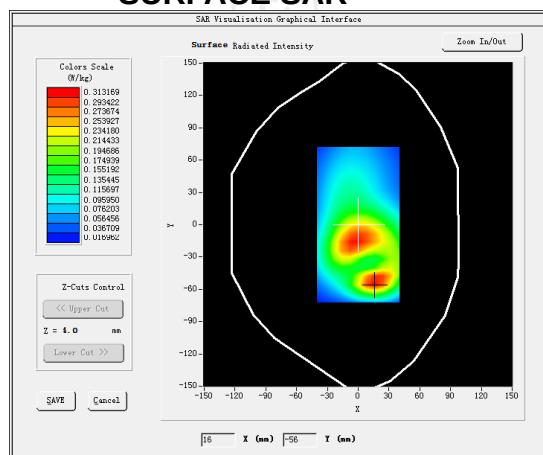
MEASUREMENT 3

Higher Band SAR (Channel 20600):

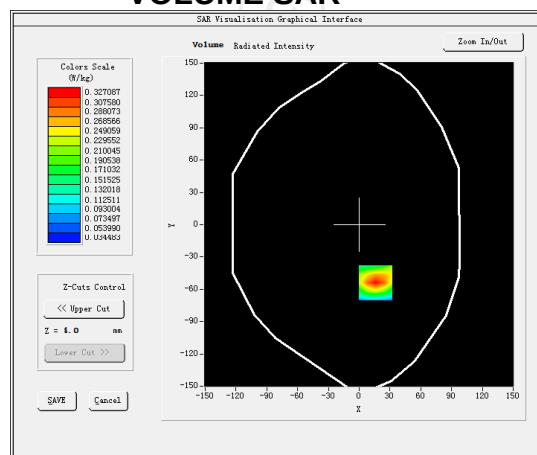
Date: 08/15/2018

Frequency (MHz)	844.000000
Relative permittivity (real part)	53.214937
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	0.973512
Variation (%)	-1.090000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(10mm)</u>
Band	<u>LTE band 5(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



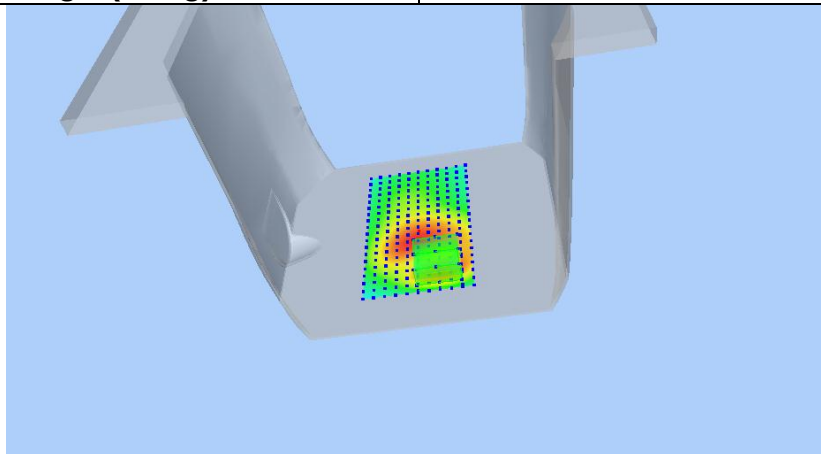
Maximum location: X=-23.00, Y=-41.00 SAR Peak: 0.23 W/kg

SAR 10g (W/Kg)

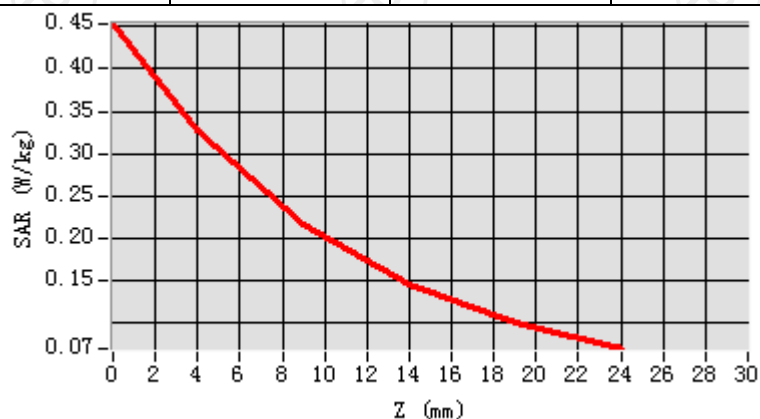
0.184888

SAR 1g (W/Kg)

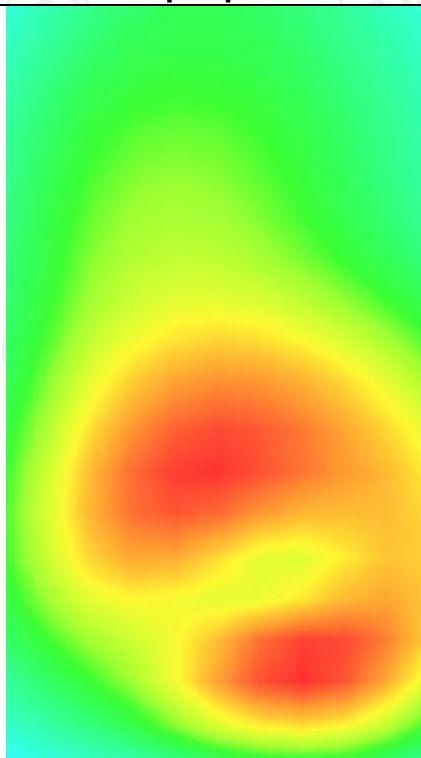
0.307301



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4530	0.3271	0.2171	0.1465	0.1019

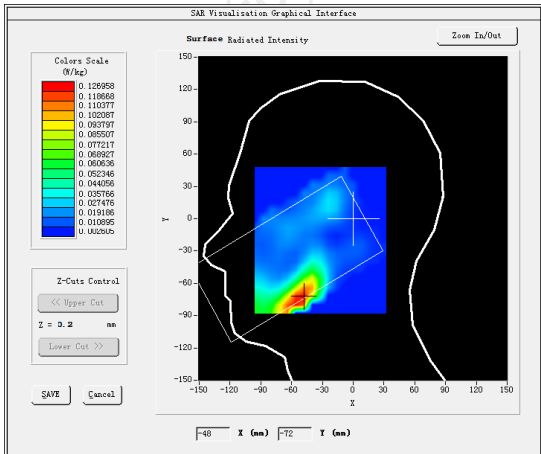
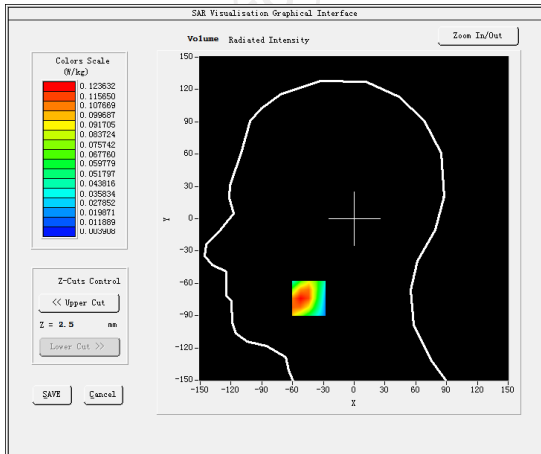


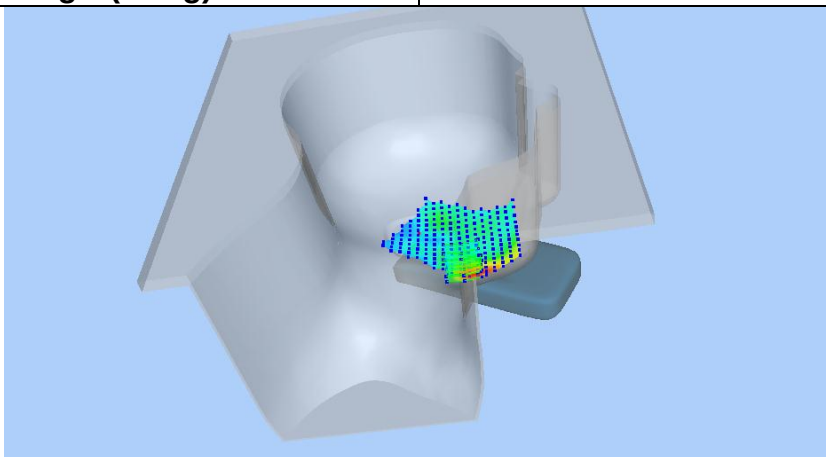
Hot spot position



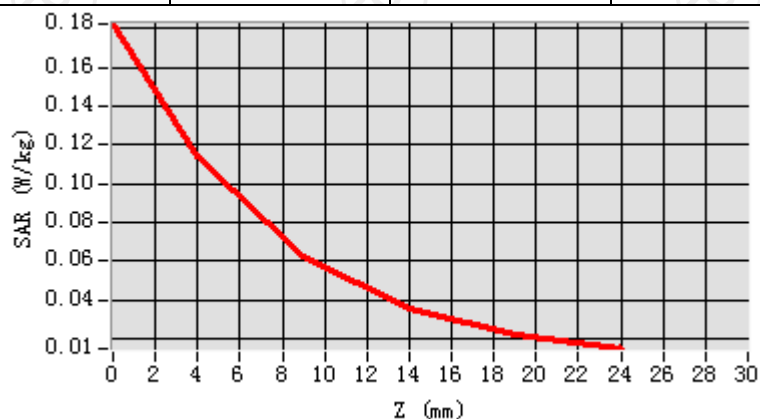
LTE Band 7

MEASUREMENT 1

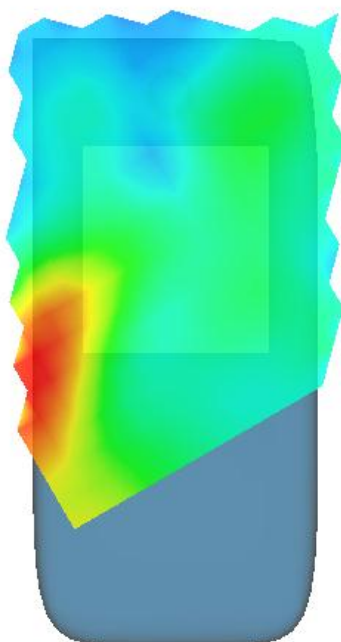
Higher Band SAR (Channel 21350):		Date: 08/30/2018
Frequency (MHz)	2560.000000	
Relative permittivity (real part)	38.892754	
Relative permittivity (imaginary part)	12.468850	
Conductivity (S/m)	1.902731	
Variation (%)	1.750000	
Crest Factor	1.0	
Probe Conversion factor	4.38	
E-Field Probe:	SSE5 (SN 07/15 EP248)	
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>Left head</u>	
Device Position	<u>Cheek</u>	
Band	<u>LTE band 7(1 RB#0)</u>	
SURFACE SAR	VOLUME SAR	
		
Maximum location: X=-44.00, Y=-74.00 SAR Peak: 0.20 W/kg		
SAR 10g (W/Kg)	0.063364	
SAR 1g (W/Kg)	0.118417	



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1824	0.1140	0.0622	0.0353	0.0222



Hot spot position



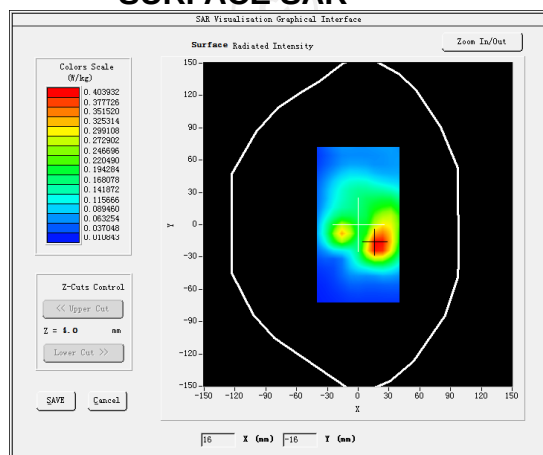
MEASUREMENT 2

Higher Band SAR (Channel 21350):

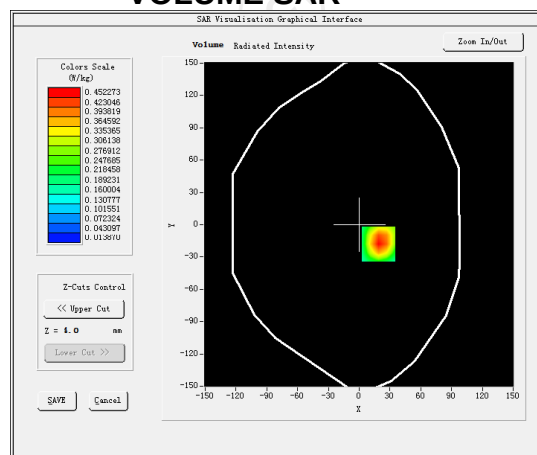
Date: 08/30/2018

Frequency (MHz)	2560.000000
Relative permittivity (real part)	52.131509
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	2.128245
Variation (%)	0.770000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(10mm)</u>
Band	<u>LTE band 7(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



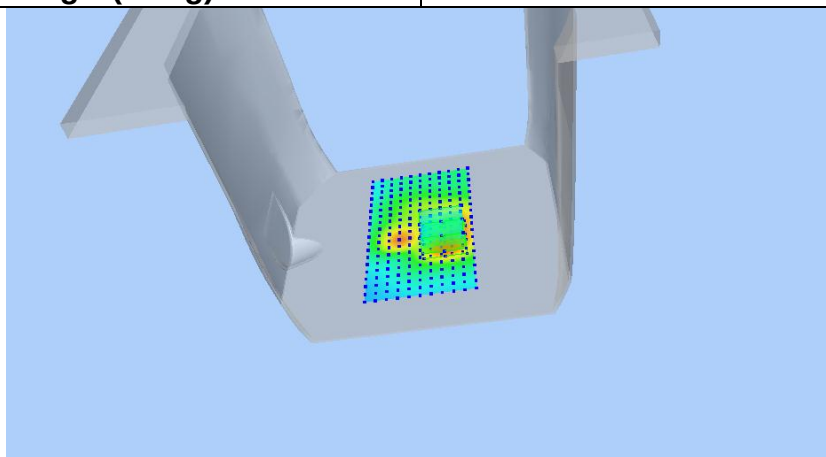
Maximum location: X=19.00, Y=-18.00 SAR Peak: 0.74 W/kg

SAR 10g (W/Kg)

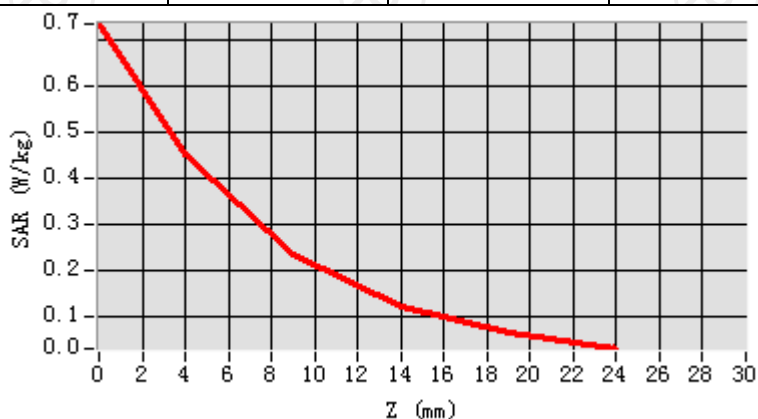
0.221093

SAR 1g (W/Kg)

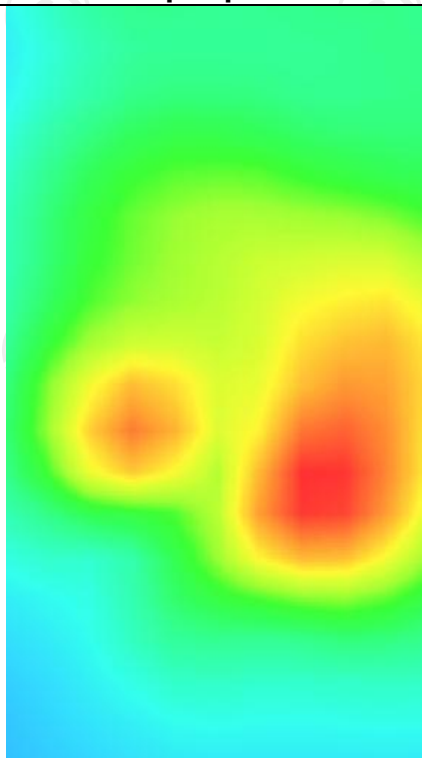
0.425483



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.7333	0.4523	0.2372	0.1224	0.0647



Hot spot position



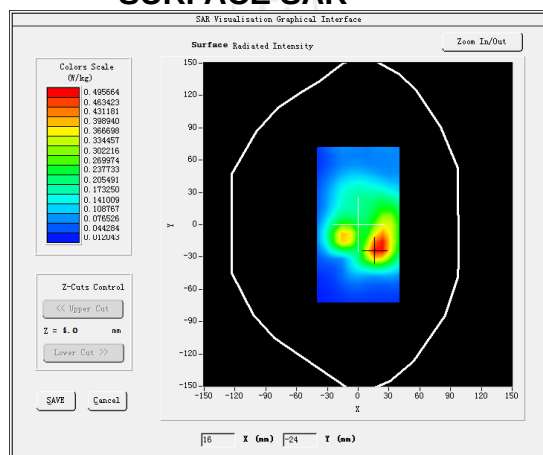
MEASUREMENT 3

Higher Band SAR (Channel 21350):

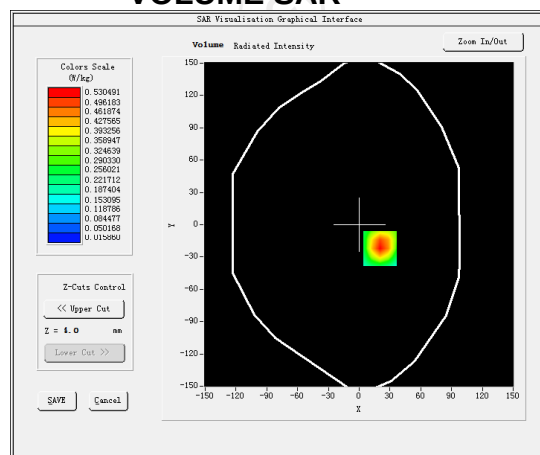
Date: 08/30/2018

Frequency (MHz)	2560.000000
Relative permittivity (real part)	52.131509
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	2.128245
Variation (%)	1.280000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(hotspot 10mm)</u>
Band	<u>LTE band 7(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



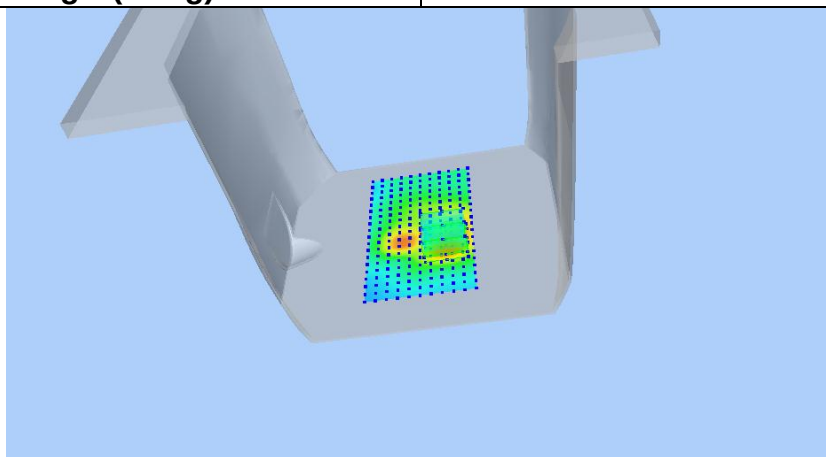
Maximum location: X=20.00, Y=-22.00 SAR Peak: 0.86 W/kg

SAR 10g (W/Kg)

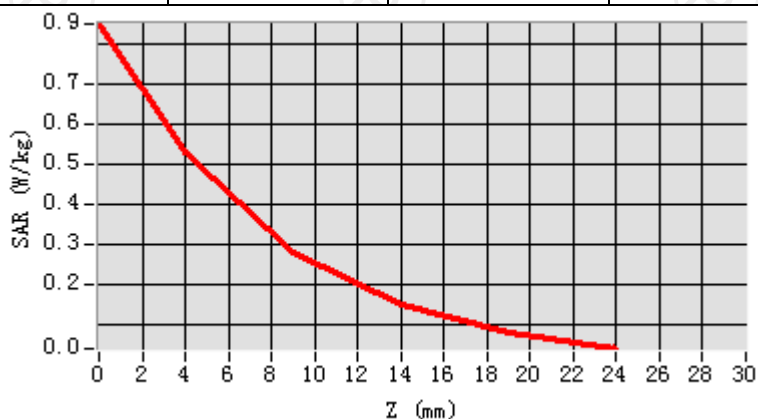
0.257940

SAR 1g (W/Kg)

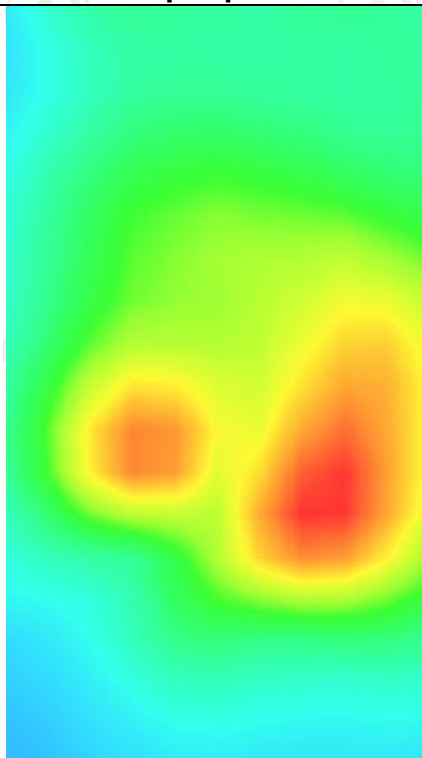
0.498053



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.8523	0.5305	0.2818	0.1473	0.0784



Hot spot position



LTE Band 12

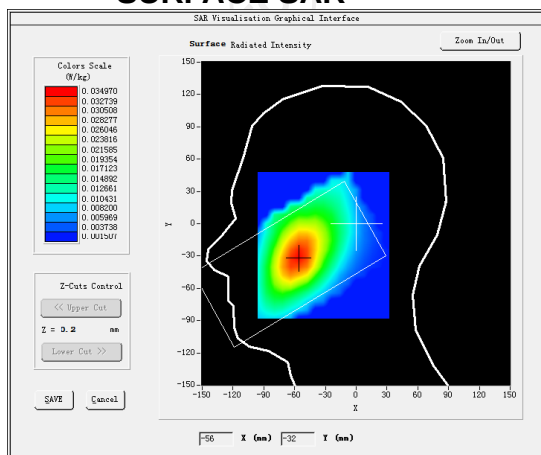
MEASUREMENT 1

Higher Band SAR (Channel 23165):

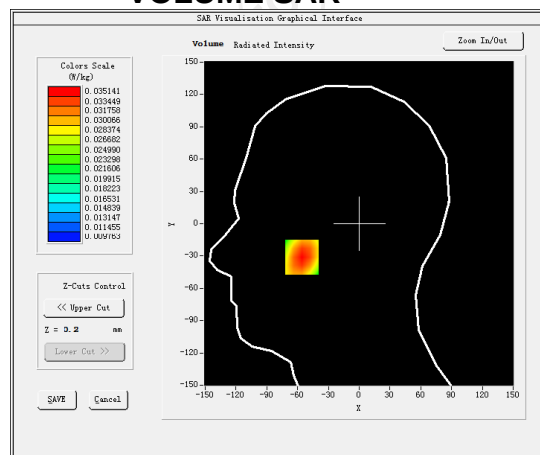
Date: 08/15/2018

Frequency (MHz)	714.500000
Relative permittivity (real part)	40.392517
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	0.881392
Variation (%)	0.570000
Crest Factor	1.0
Probe Conversion factor	4.38
E-Field Probe:	SSE5 (SN 07/15 EP248)
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>Right head</u>
Device Position	<u>Cheek</u>
Band	<u>LTE band 12(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



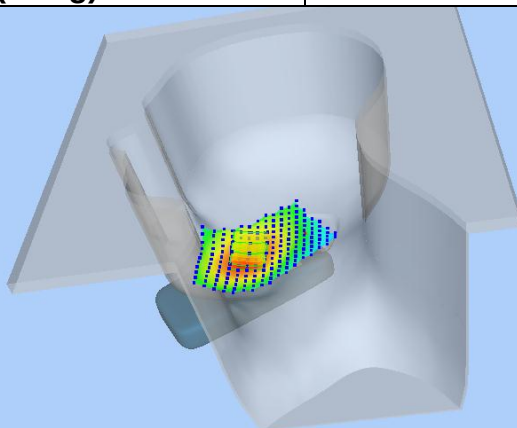
Maximum location: X=-56.00, Y=-31.00 SAR Peak: 0.04 W/kg

SAR 10g (W/Kg)

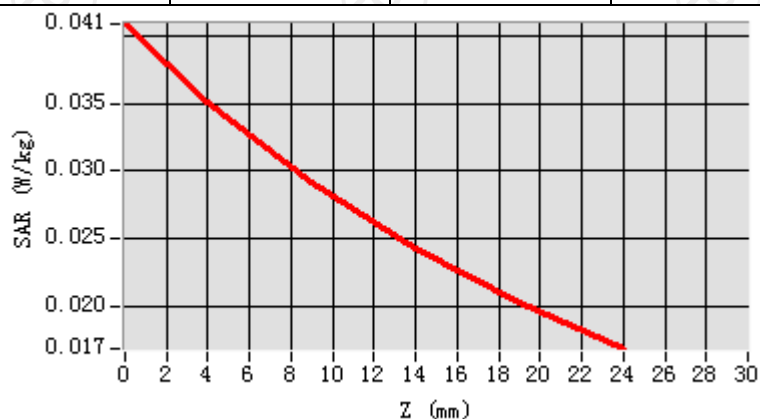
0.027075

SAR 1g (W/Kg)

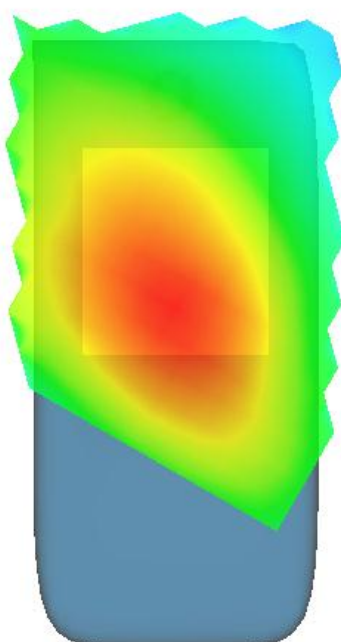
0.034680



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.0408	0.0351	0.0291	0.0243	0.0203



Hot spot position



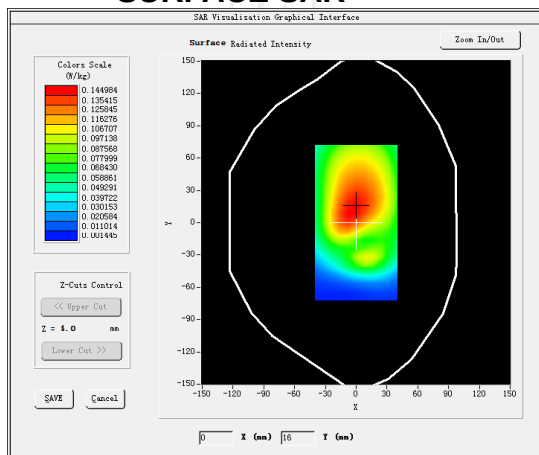
MEASUREMENT 2

Higher Band SAR (Channel 23165):

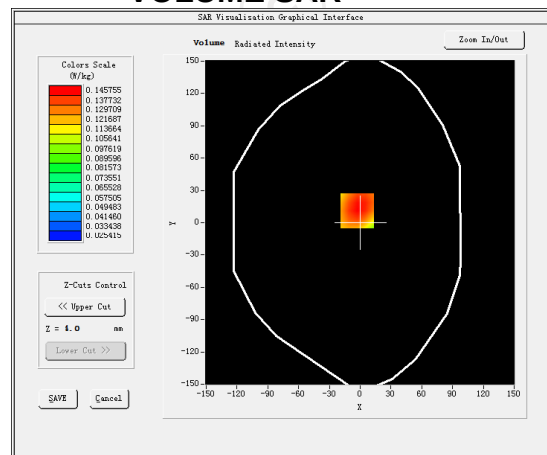
Date: 08/15/2018

Frequency (MHz)	714.500000
Relative permittivity (real part)	40.392517
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	0.881392
Variation (%)	-1.160000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(10mm)</u>
Band	<u>LTE band 12(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



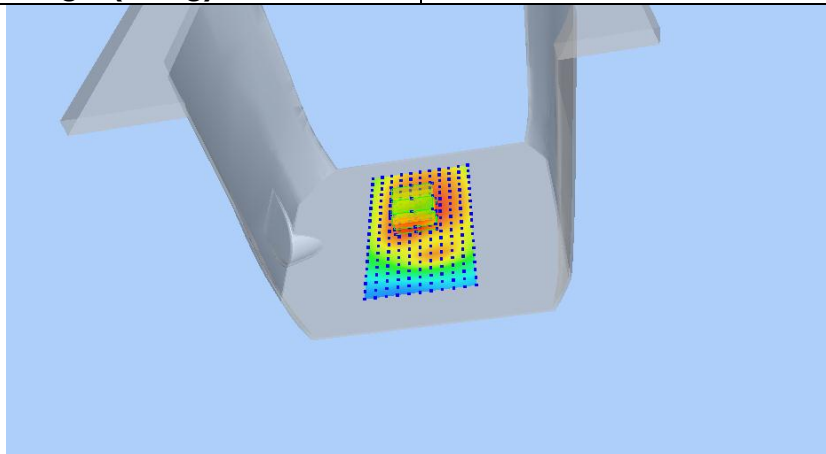
Maximum location: X=-3.00, Y=11.00 SAR Peak: 0.17 W/kg

SAR 10g (W/Kg)

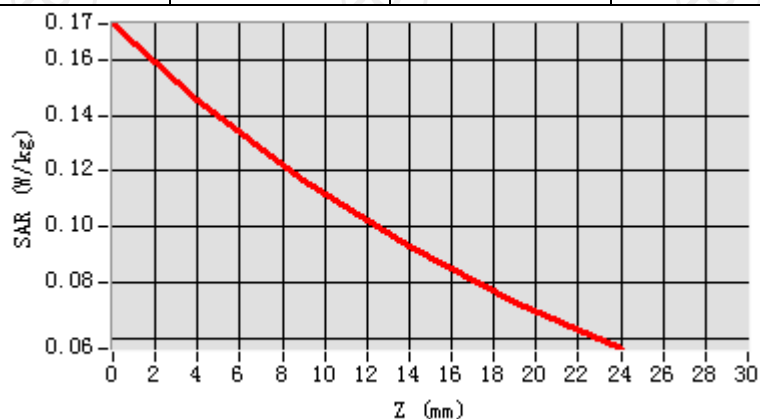
0.108746

SAR 1g (W/Kg)

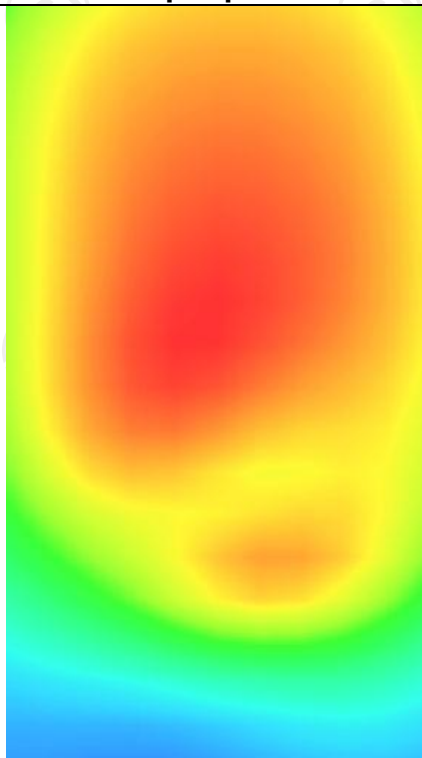
0.141547



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1728	0.1458	0.1169	0.0930	0.0732



Hot spot position



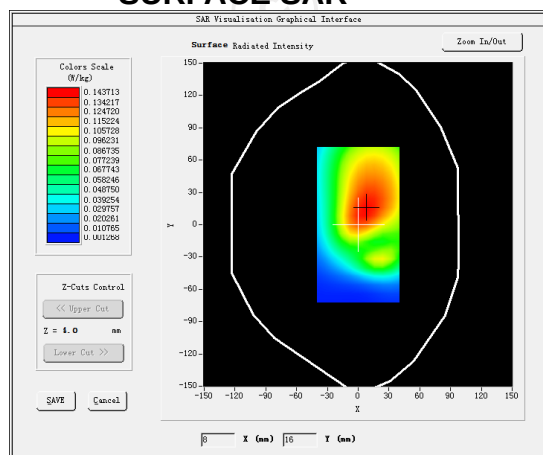
MEASUREMENT 3

Higher Band SAR (Channel 23165):

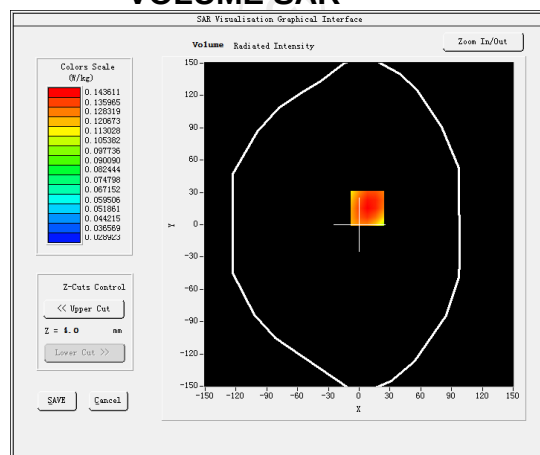
Date: 08/15/2018

Frequency (MHz)	714.500000
Relative permittivity (real part)	40.392517
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	0.881392
Variation (%)	-0.460000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(hotspot 10mm)</u>
Band	<u>LTE band 12(1 RB#0)</u>

SURFACE SAR



VOLUME SAR



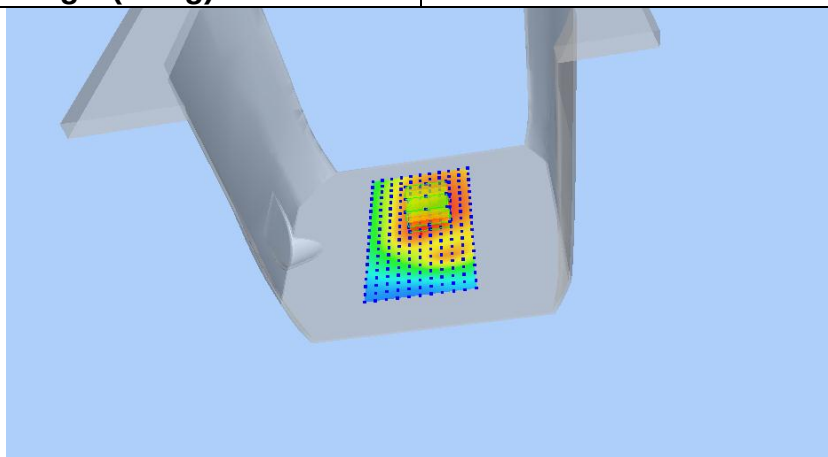
Maximum location: X=8.00, Y=15.00 SAR Peak: 0.17 W/kg

SAR 10g (W/Kg)

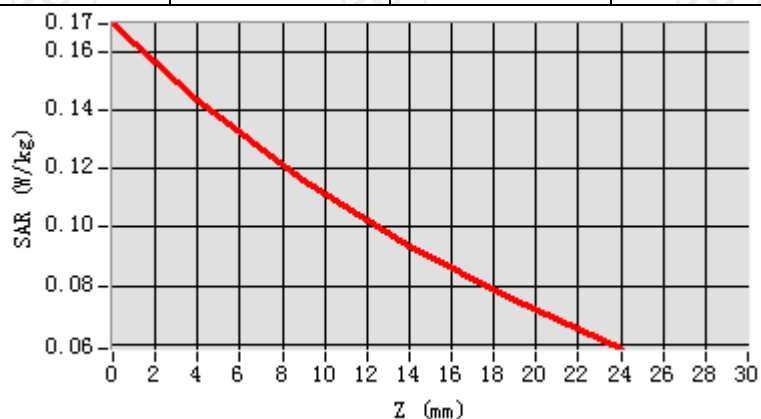
0.108025

SAR 1g (W/Kg)

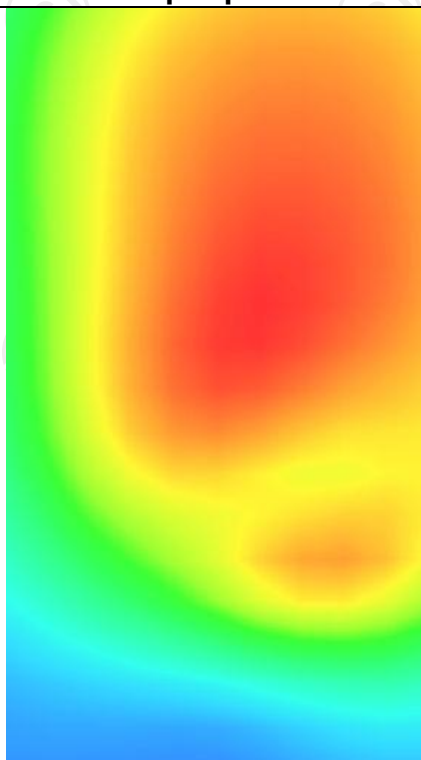
0.139366



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1693	0.1436	0.1162	0.0936	0.0747

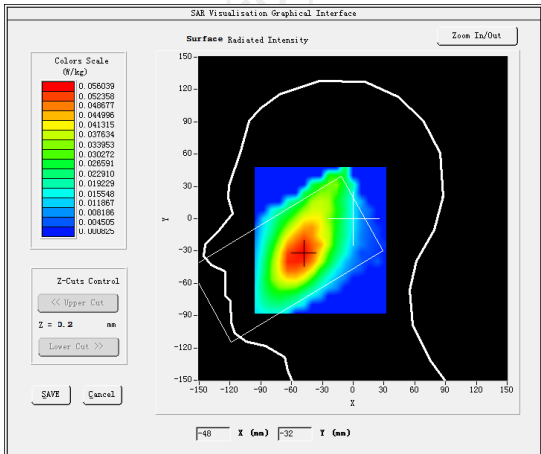
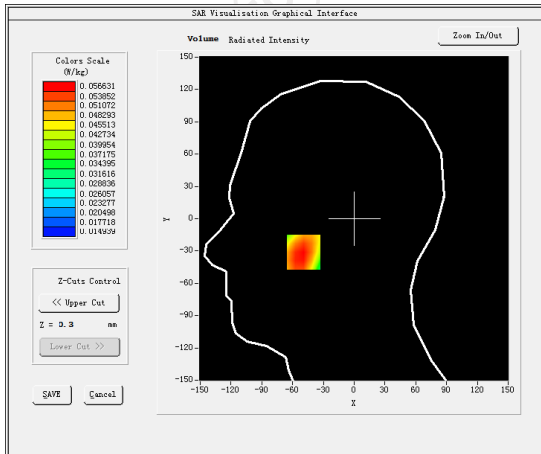


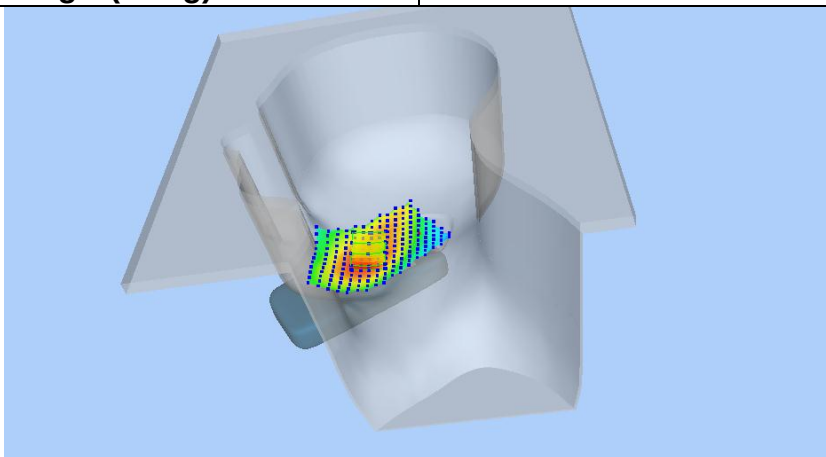
Hot spot position



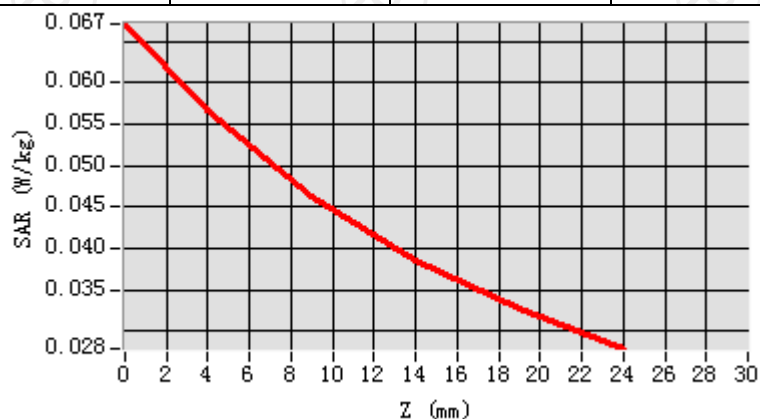
LTE Band 17

MEASUREMENT 1

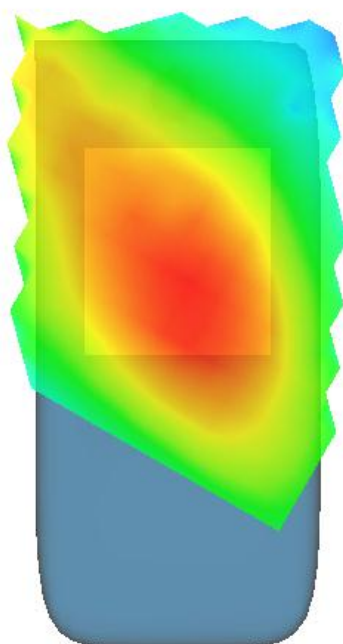
Higher Band SAR (Channel 23800):		Date: 08/15/2018
Frequency (MHz)	711.000000	
Relative permittivity (real part)	40.392517	
Relative permittivity (imaginary part)	12.468850	
Conductivity (S/m)	0.881392	
Variation (%)	3.020000	
Crest Factor	1.0	
Probe Conversion factor	4.38	
E-Field Probe:	SSE5 (SN 07/15 EP248)	
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>Right head</u>	
Device Position	<u>Cheek</u>	
Band	<u>LTE band 17(1 RB#25)</u>	
SURFACE SAR	VOLUME SAR	
		
Maximum location: X=-49.00, Y=-31.00 SAR Peak: 0.07 W/kg		
SAR 10g (W/Kg)	0.044111	
SAR 1g (W/Kg)	0.056373	



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.0671	0.0566	0.0463	0.0385	0.0327



Hot spot position



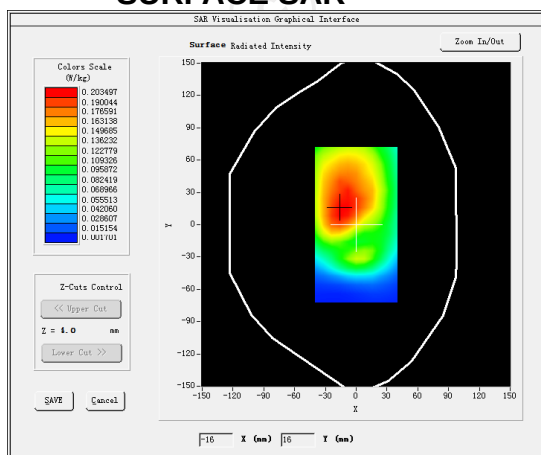
MEASUREMENT 2

Higher Band SAR (Channel 23800):

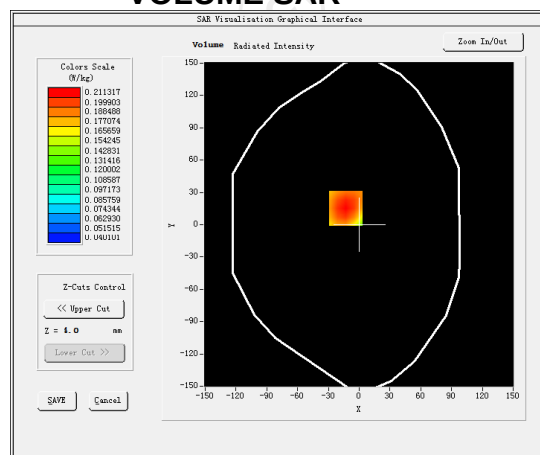
Date: 08/15/2018

Frequency (MHz)	711.000000
Relative permittivity (real part)	40.392517
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	0.881392
Variation (%)	0.080000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(10mm)</u>
Band	<u>LTE band 17(1 RB#25)</u>

SURFACE SAR



VOLUME SAR



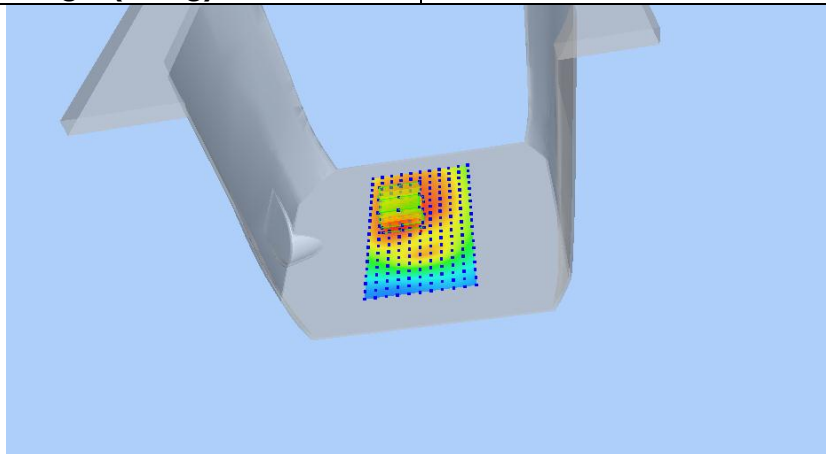
Maximum location: X=-13.00, Y=15.00 SAR Peak: 0.26 W/kg

SAR 10g (W/Kg)

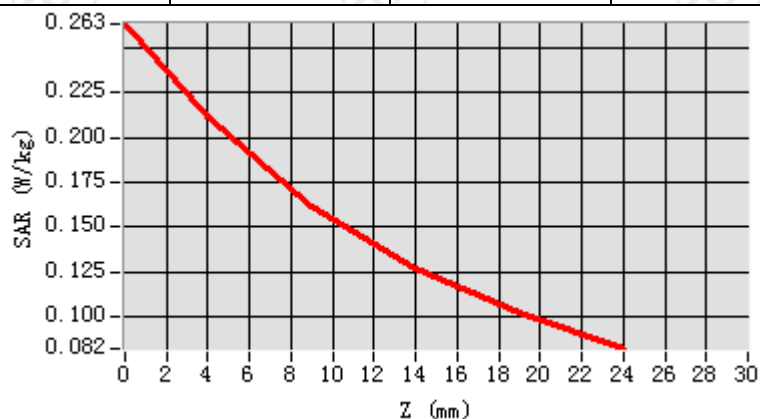
0.156741

SAR 1g (W/Kg)

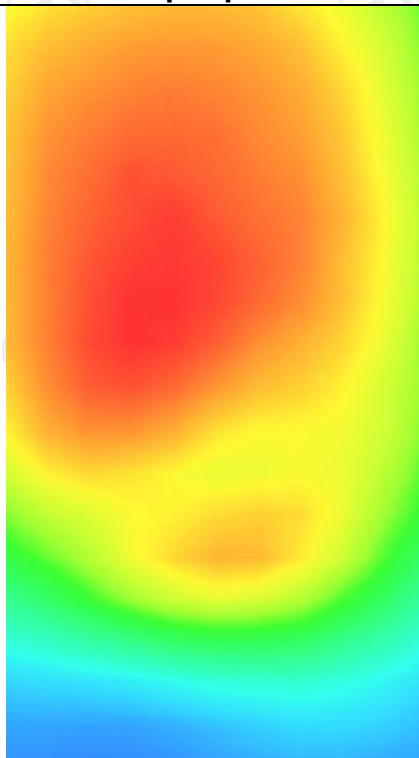
0.208190



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2633	0.2113	0.1620	0.1268	0.1019



Hot spot position



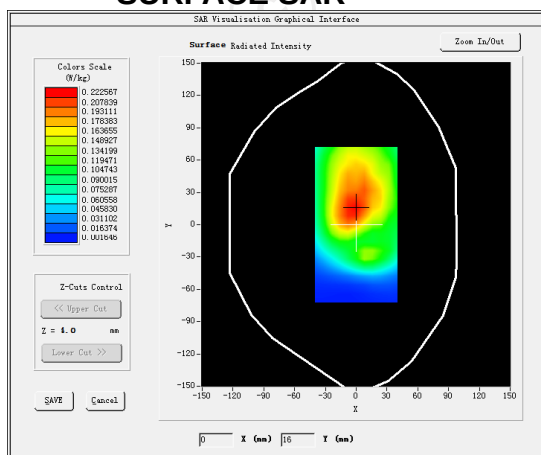
MEASUREMENT 3

Higher Band SAR (Channel 23800):

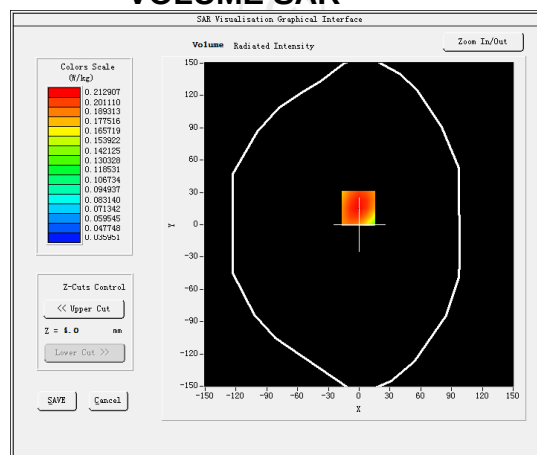
Date: 08/15/2018

Frequency (MHz)	711.000000
Relative permittivity (real part)	40.392517
Relative permittivity (imaginary part)	12.468850
Conductivity (S/m)	0.881392
Variation (%)	-0.230000
Crest Factor	1.0
Probe Conversion factor	4.52
E-Field Probe:	SSE5 (SN 07/15 EP248)
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 back(hotspot 10mm)</u>
Band	<u>LTE band 17(1 RB#25)</u>

SURFACE SAR



VOLUME SAR



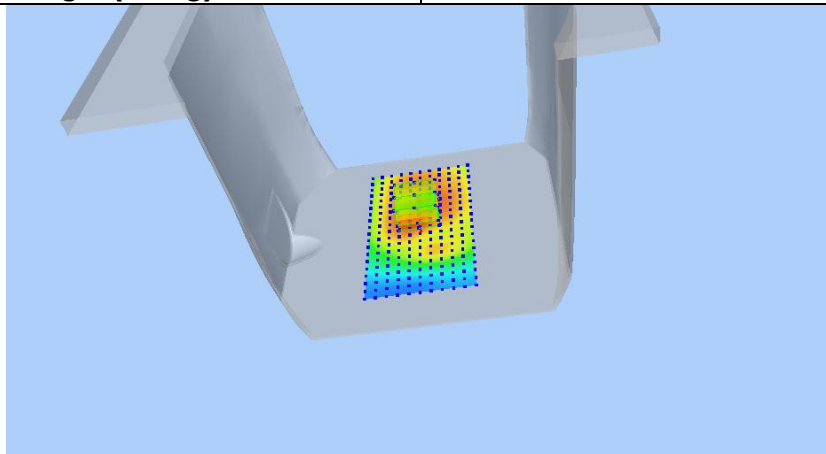
Maximum location: X=-1.00, Y=15.00 SAR Peak: 0.25 W/kg

SAR 10g (W/Kg)

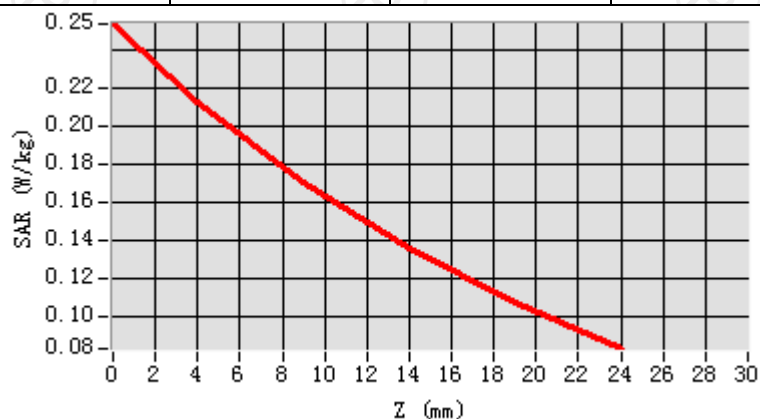
0.161829

SAR 1g (W/Kg)

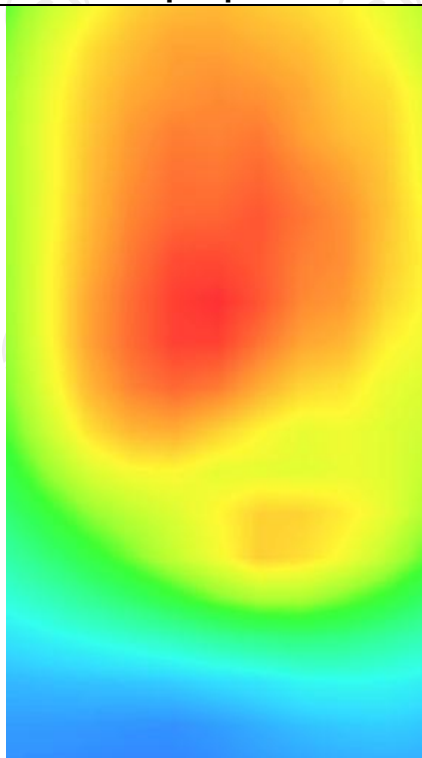
0.210726



Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.2533	0.2129	0.1704	0.1357	0.1074

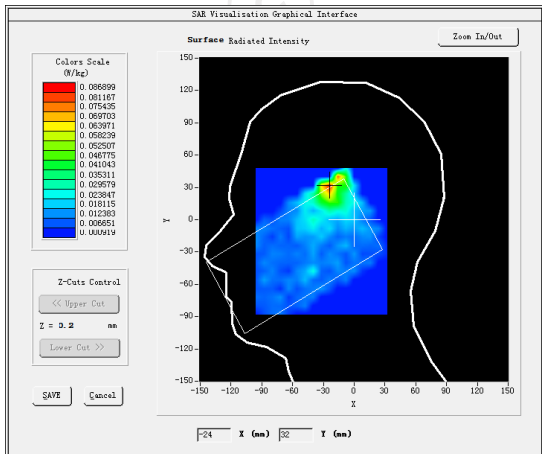
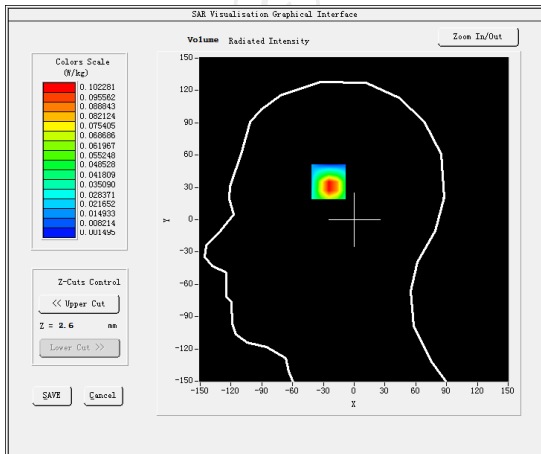
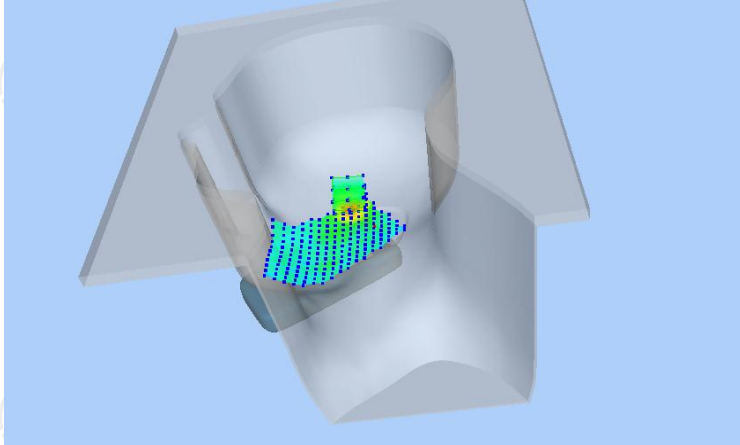


Hot spot position

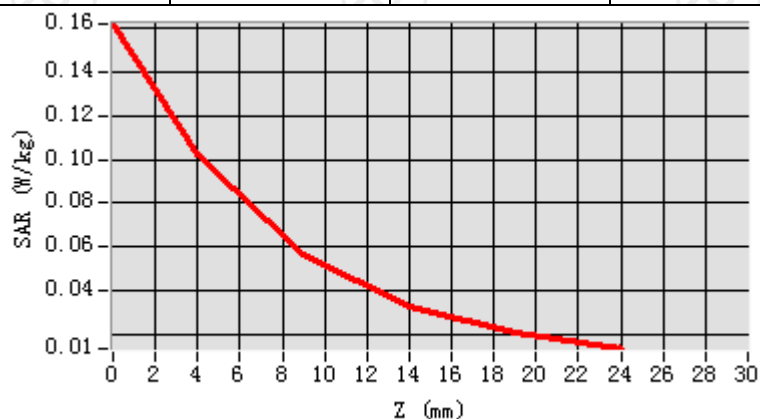


WLAN 2.4

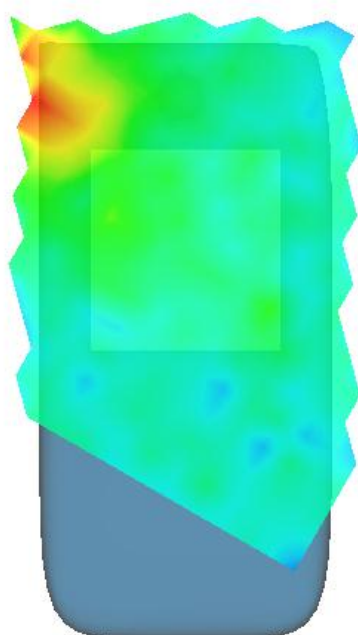
MEASUREMENT 1

Middle Band SAR (Channel 6):		Date: 08/24/2018
Frequency (MHz)	2437.000000	
Relative permittivity (real part)	37.851613	
Relative permittivity (imaginary part)	13.546980	
Conductivity (S/m)	1.814111	
Variation (%)	1.220000	
Crest Factor	1.0	
Probe Conversion factor	4.58	
E-Field Probe:	SSE5 (SN 07/15 EP248)	
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	Right head	
Device Position	Cheek	
Band	IEEE 802.11b ISM	
SURFACE SAR		VOLUME SAR
		
Maximum location: X=-25.00, Y=40.00 SAR Peak: 0.16 W/kg		
SAR 10g (W/Kg)		0.051602
SAR 1g (W/Kg)		0.104019
		

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1621	0.1032	0.0510	0.0347	0.0210



Hot spot position



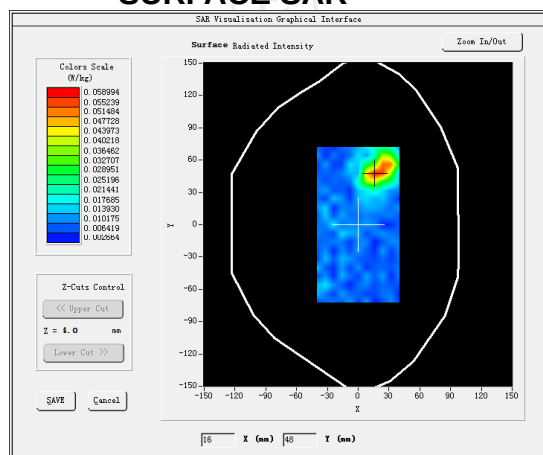
MEASUREMENT 2

Middle Band SAR (Channel 6):

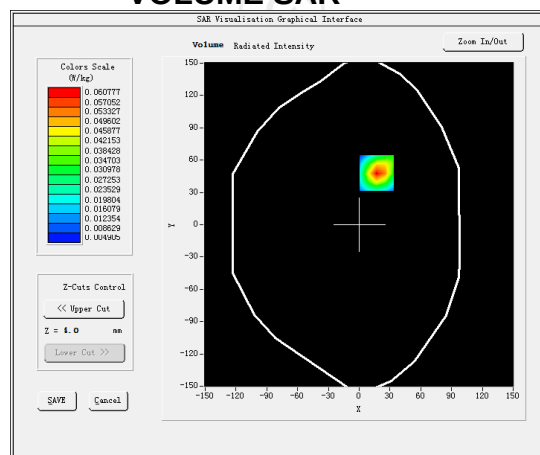
Date: 08/24/2018

Frequency (MHz)	2437.000000
Relative permittivity (real part)	54.630667
Relative permittivity (imaginary part)	14.318444
Conductivity (S/m)	1.982536
Variation (%)	-0.950000
Crest Factor	1.0
Probe Conversion factor	4.70
E-Field Probe:	SSE5 (SN 07/15 EP248)
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(10mm)
Band	<u>IEEE 802.11b ISM(hotspot)</u>

SURFACE SAR



VOLUME SAR



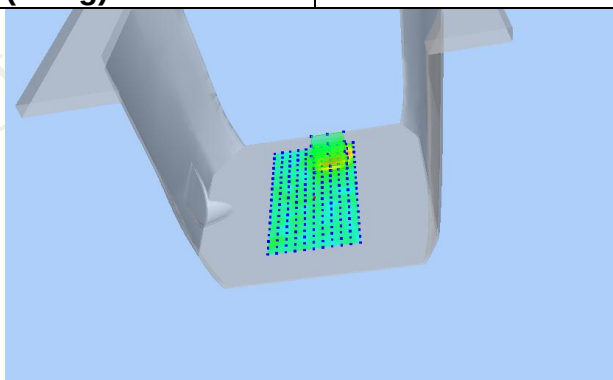
Maximum location: X=17.00, Y=48.00 SAR Peak: 0.10 W/kg

SAR 10g (W/Kg)

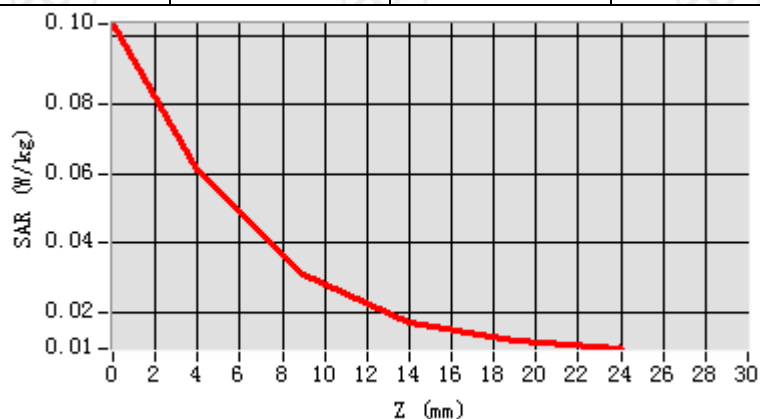
0.040641

SAR 1g (W/Kg)

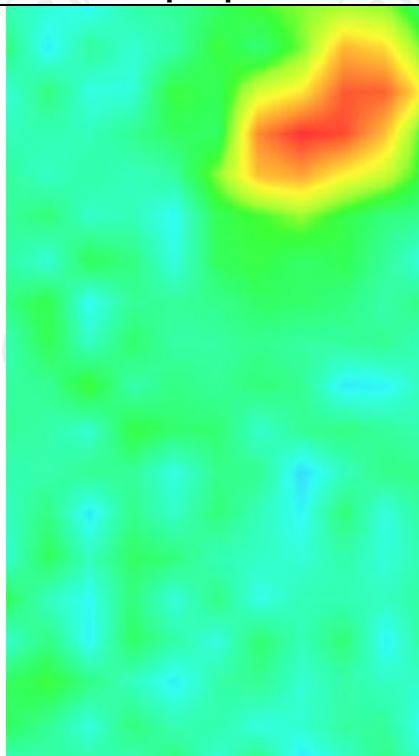
0.078530



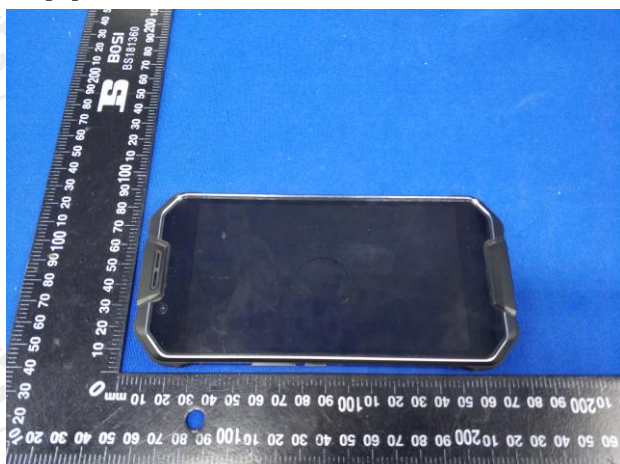
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1034	0.0608	0.0308	0.0170	0.0116



Hot spot position



Appendix A: EUT Photos



Liquid depth



The Body Liquid of 835MHz (15.4cm)



The Body Liquid of 1800MHz (15.2 cm)



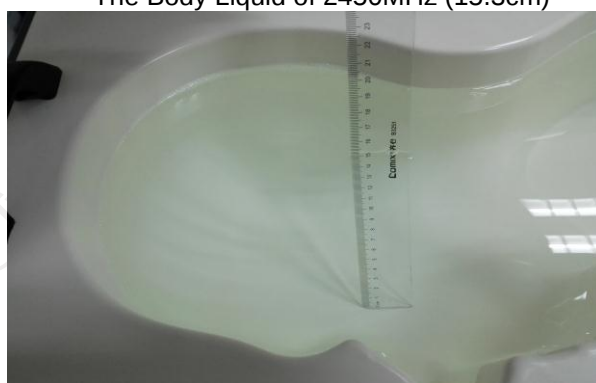
The Body Liquid of 1900MHz (16.4 cm)



The Body Liquid of 2450MHz (15.3cm)



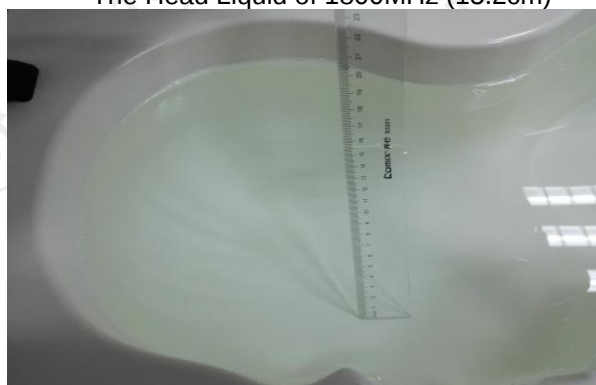
The Body Liquid of 2600MHz (16.5cm)



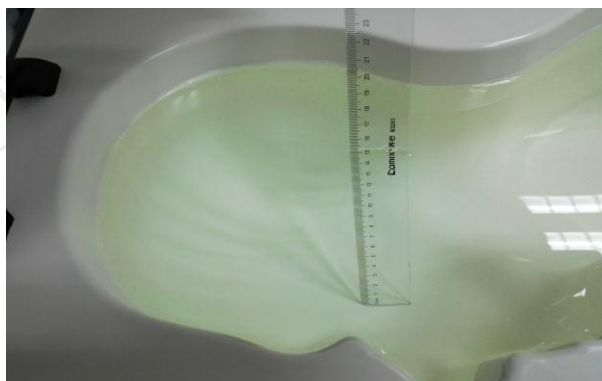
The Head Liquid of 1800MHz (15.2cm)



The Head Liquid of 1900MHz (15.5cm)



The Head Liquid of 2450MHz (15.6cm)

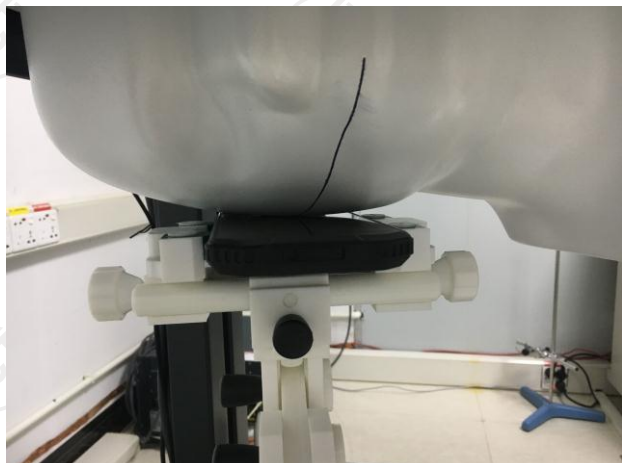


The Head Liquid of 835MHz (15.3cm)



The Head Liquid of 2600MHz (15.1cm)

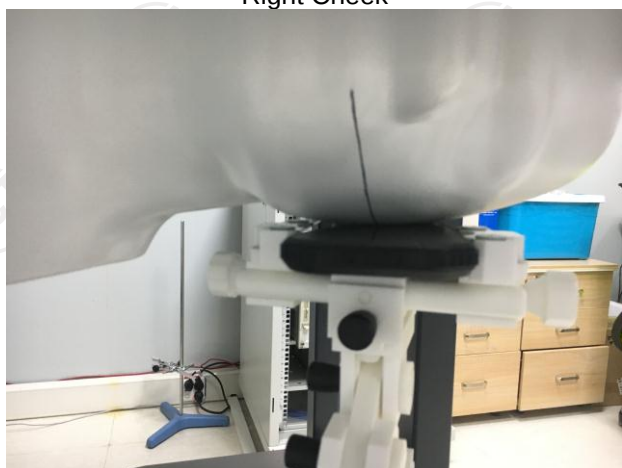
Appendix B: Test Setup Photos



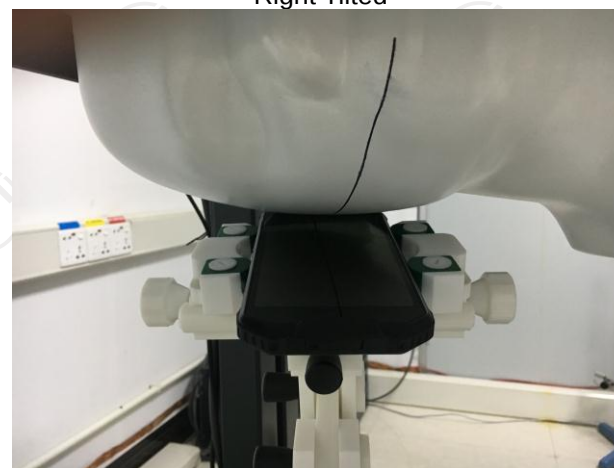
Right Cheek



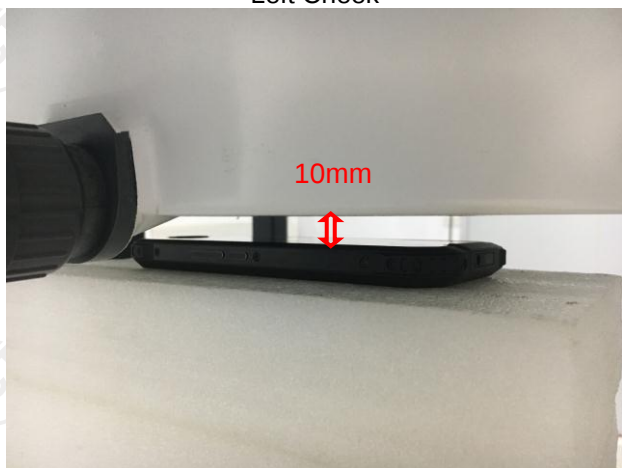
Right Tilted



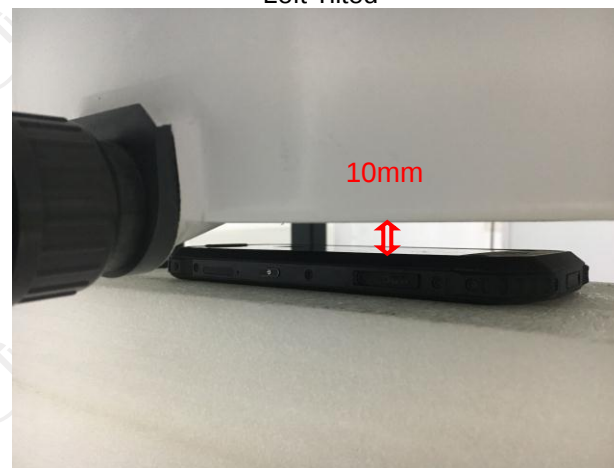
Left Cheek



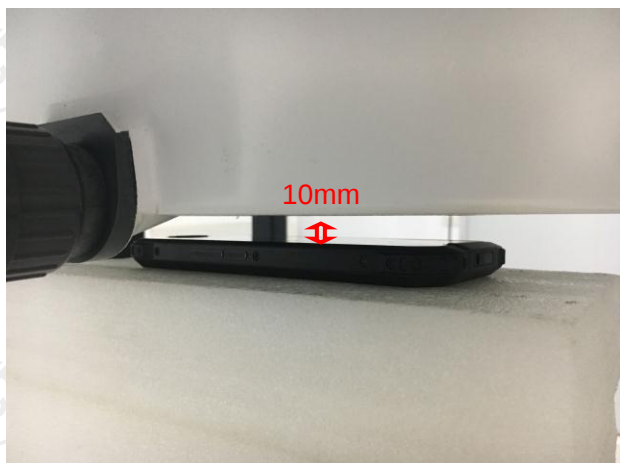
Left Tilted



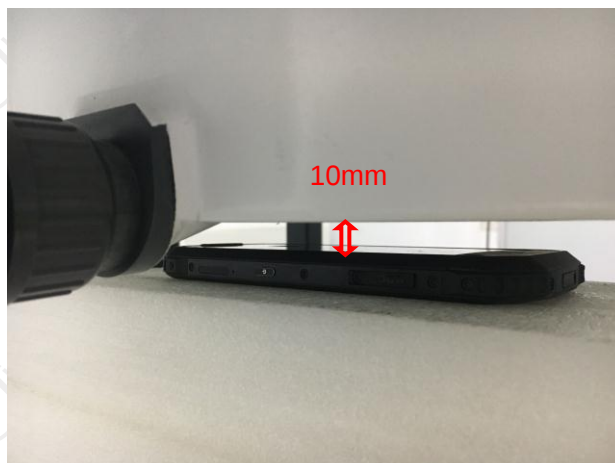
Body worn – Front (10mm)



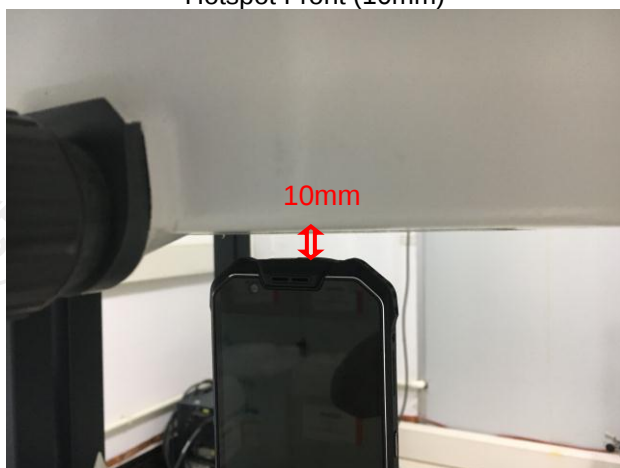
Body worn – Back (10mm)



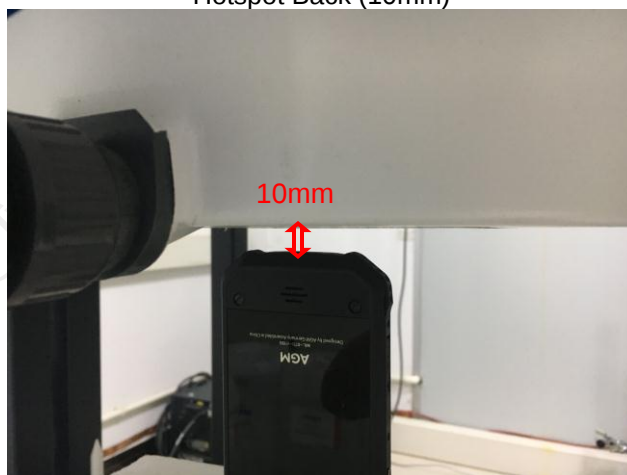
Hotspot Front (10mm)



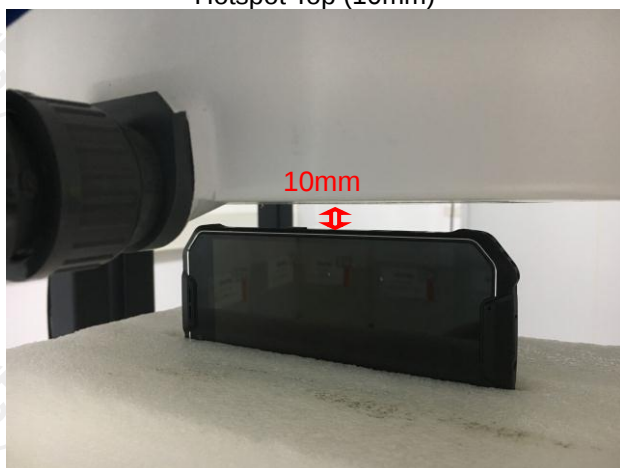
Hotspot Back (10mm)



Hotspot Top (10mm)



Hotspot Bottom (10mm)



Hotspot Right (10mm)



Hotspot Left (10mm)

Appendix C: Probe Calibration Certificate

COMOSAR E-FIELD Probe



COMOSAR E-Field Probe Calibration Report

Ref : ACR.138.5.15.SATU.A

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

1B/F., Building 1, Yibaolai Industrial Park,
Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, China

MVG COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 07/15 EP248

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 01/09/2018

Summary:

This document presents the method and results from an accredited COMOSAR Dosimetric E-Field Probe calibration performed in MVG USA using the CALISAR / CALIBAIR test bench, for use with a COMOSAR system only. All calibration results are traceable to national metrology institutions.



COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.138.5.15.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	01/09/2018	<i>JS</i>
Checked by :	Jérôme LUC	Product Manager	01/09/2018	<i>JS</i>
Approved by :	Kim RUTKOWSKI	Quality Manager	01/09/2018	<i>Kim Rutkowski</i>

	Customer Name
Distribution :	Shenzhen Tongce Testing Lab

Issue	Date	Modifications
A	01/09/2018	Initial release

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.138.5.15.SATU.A

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.138.5.15.SATU.A

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	MVG
Model	SSE5
Serial Number	SN 07/15 EP248
Product Condition (new / used)	Used
Frequency Range of Probe	0.45 GHz -3GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.216 MΩ Dipole 2: R2=0.216 MΩ Dipole 3: R3=0.217 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION**2.1 GENERAL INFORMATION**

MVG's COMOSAR E field Probes are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards.



Figure 1 – MVG COMOSAR Dosimetric E field Dipole

Probe Length	330 mm
Length of Individual Dipoles	4.5 mm
Maximum external diameter	8 mm
Probe Tip External Diameter	5 mm
Distance between dipoles / probe extremity	2.7 mm

3 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 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.

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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 - 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°).

3.5 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.

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 (%)
Incident or forward power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Reflected power	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Liquid conductivity	5.00%	Rectangular	$\sqrt{3}$	1	2.887%
Liquid permittivity	4.00%	Rectangular	$\sqrt{3}$	1	2.309%
Field homogeneity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Field probe positioning	5.00%	Rectangular	$\sqrt{3}$	1	2.887%

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.138.5.15.SATU.A

Field probe linearity	3.00%	Rectangular	$\sqrt{3}$	1	1.732%
Combined standard uncertainty					5.831%
Expanded uncertainty 95 % confidence level k = 2					12.0%

5 CALIBRATION MEASUREMENT RESULTS

Calibration Parameters	
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

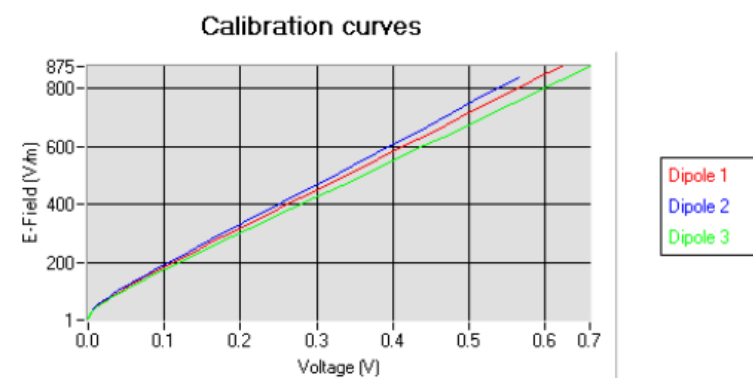
5.1 SENSITIVITY IN AIR

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 ($\mu\text{V}/(\text{V}/\text{m})^2$)
6.77	6.10	7.10

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
96	92	96

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

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



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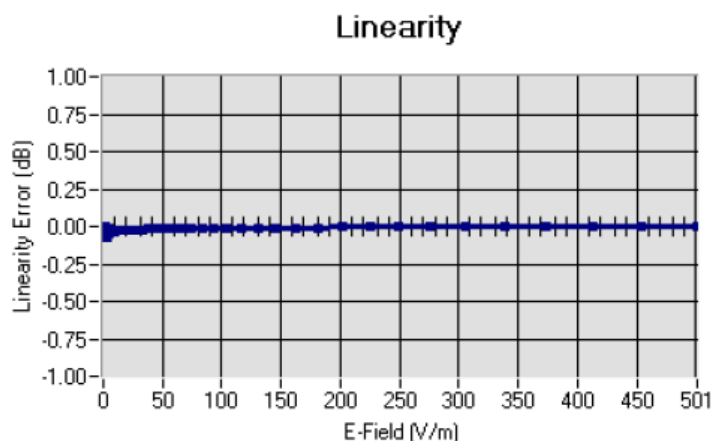
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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.138.5.15.SATU.A

5.2 LINEARITY



Linearity: $\pm 1.58\%$ ($\pm 0.07\text{dB}$)

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz $\pm$ 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL450	450	42.17	0.86	5.38
BL450	450	57.65	0.96	5.57
HL750	750	40.03	0.93	4.69
BL750	750	56.83	1.00	4.88
HL850	835	42.19	0.90	5.43
BL850	835	54.67	1.01	5.60
HL900	900	42.08	1.01	4.96
BL900	900	55.25	1.08	5.13
HL1800	1800	41.68	1.46	4.31
BL1800	1800	53.86	1.46	4.52
HL1900	1900	38.45	1.45	4.82
BL1900	1900	53.32	1.56	5.08
HL2000	2000	38.26	1.38	4.73
BL2000	2000	52.70	1.51	4.76
HL2450	2450	37.50	1.80	4.58
BL2450	2450	53.22	1.89	4.70
HL2600	2600	39.80	1.99	4.43
BL2600	2600	52.52	2.23	4.66

LOWER DETECTION LIMIT: 8mW/kg

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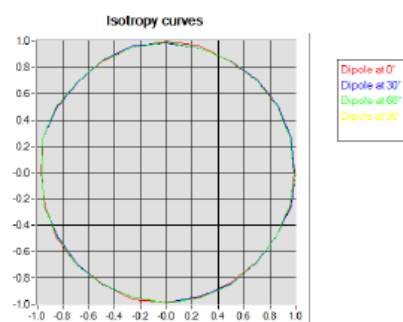
COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.138.5.15.SATU.A

5.4 ISOTROPY

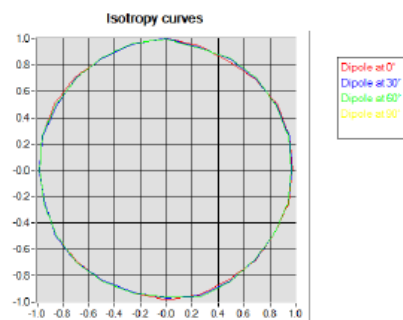
HL900 MHz

- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.04 dB



HL1800 MHz

- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.06 dB



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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.138.5.15.SATU.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	Rhode & Schwarz ZVA	SN100132	02/2015	02/2018
Reference Probe	MVG	EP 94 SN 37/08	02/2017	02/2018
Multimeter	Keithley 2000	1188656	02/2015	02/2018
Signal Generator	Agilent E4438C	MY49070581	02/2015	02/2018
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	02/2015	02/2018
Power Sensor	HP ECP-E26A	US37181460	02/2015	02/2018
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	Control Company	11-681-9	02/2017	02/2018

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Dielectric Probe Calibration Report

Ref : ACR.138.4.33.SATU.A

Shenzhen Tongce Testing Lab.

1B/F., Building 1, Yibaolai Industrial Park,
Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, 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: 06/05/2018

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..SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	06/05/2018	<i>JS</i>
Checked by :	Jérôme LUC	Product Manager	06/05/2018	<i>JS</i>
Approved by :	Kim RUTKOWSKI	Quality Manager	06/05/2018	<i>Kim Rutkowski</i>

	Customer Name
Distribution :	Shenzhen Tongce Testing Lab

Issue	Date	Modifications
A	06/05/2018	Initial release

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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

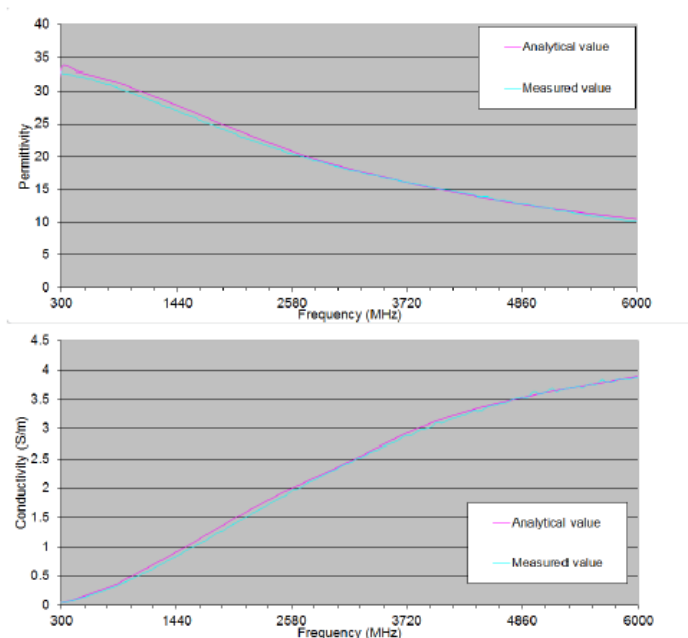
6 CALIBRATION MEASUREMENT RESULTS

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	02/2018	02/2021
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	09/2018	09/2019

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Appendix D: Dipole Calibration Report

SID 835



SAR Reference Dipole Calibration Report

Ref : ACR.156.4.15.SATU.A

SHENZHEN TONGCE TESTING Lab.

1B/F., Building 1, Yibaolai Industrial Park,
Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, China

MVG COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ

SERIAL NO.: SN 16/15 DIP 0G835-369

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144



Calibration Date: 06/05/2018

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.156.4.15.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	06/05/2018	<i>JS</i>
Checked by :	Jérôme LUC	Product Manager	06/05/2018	<i>JS</i>
Approved by :	Kim RUTKOWSKI	Quality Manager	06/05/2018	<i>Kim Rutkowski</i>

	Customer Name
Distribution :	Shenzhen Tongce Testing Lab

Issue	Date	Modifications
A	06/05/2018	Initial release

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.4.15.SATU.A

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.4.15.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 835 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID835
Serial Number	SN 16/15 DIP 0G835-369
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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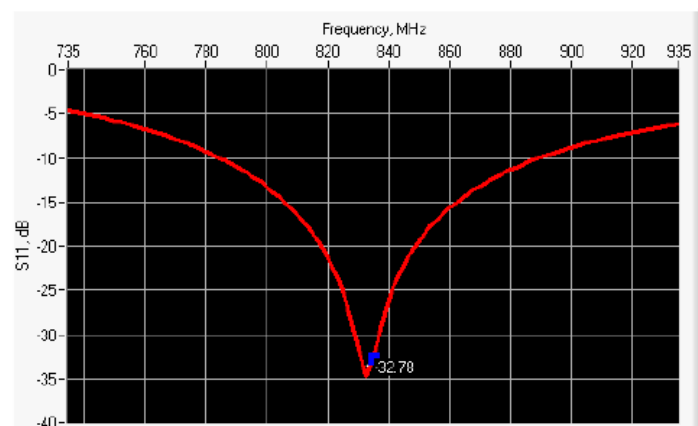
SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.156.4.15.SATU.A

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

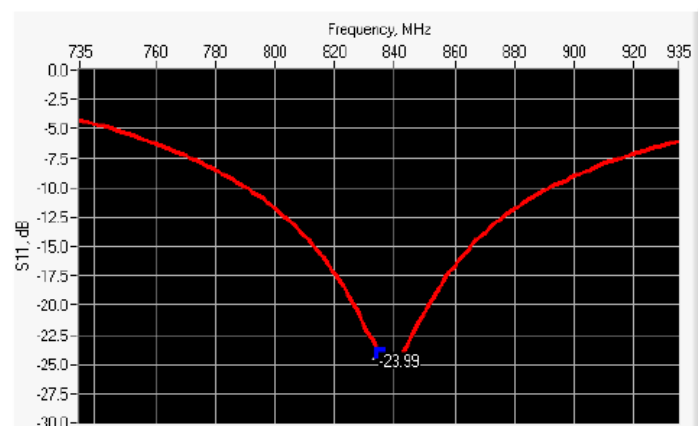
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-32.78	-20	$51.5 \Omega + 1.7 j\Omega$

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
835	-23.99	-20	$47.3 \Omega + 5.6 j\Omega$

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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