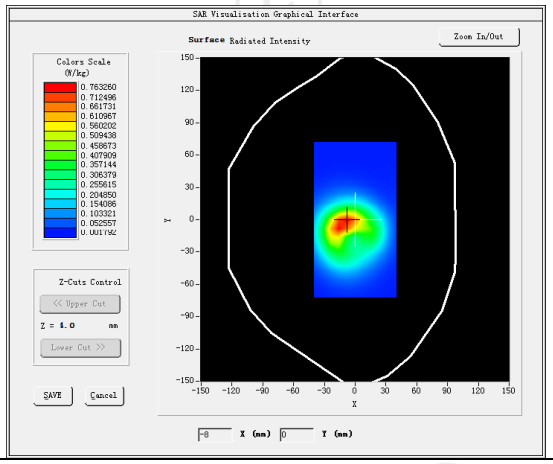
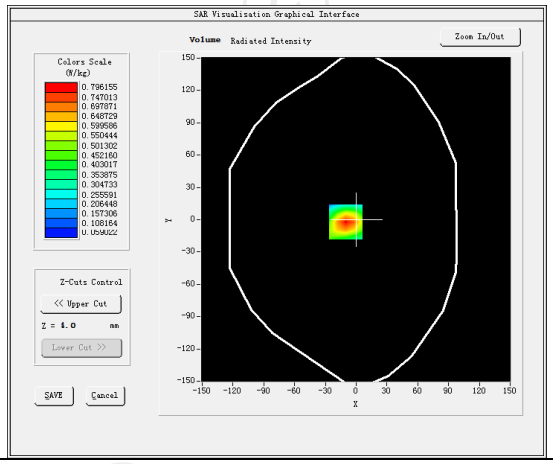
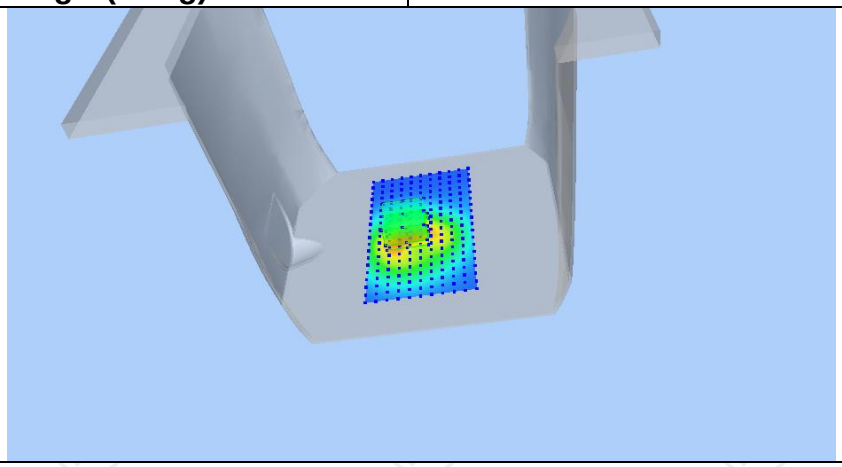
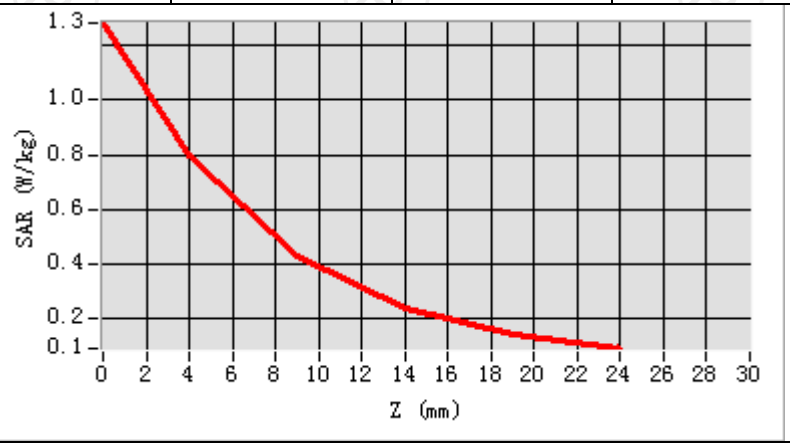
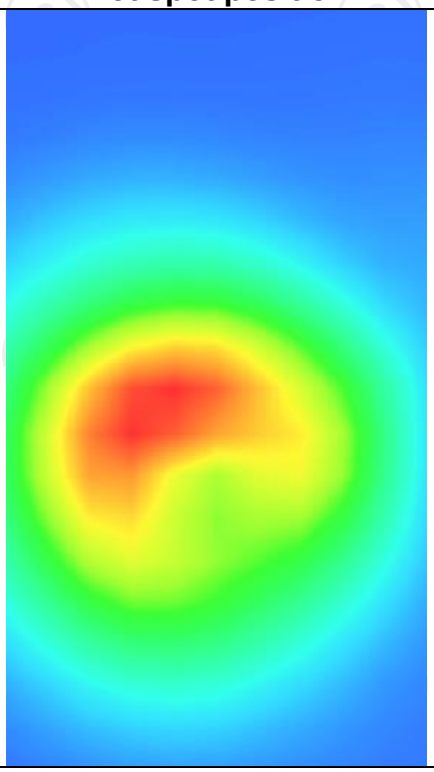
MEASUREMENT 2	
Middle Band SAR (Channel 4182):	Date: 11/17/2017
Frequency (MHz)	836.400024
Relative permittivity (real part)	55.239883
Relative permittivity (imaginary part)	21.373374
Conductivity (S/m)	0.941375
Variation (%)	0.700000
Crest Factor:	1.0
Probe Conversion factor	5.65
E-Field Probe:	SSE5 (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 top(5mm)
Band	BAND5 WCDMA850(hotspot)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-10.00, Y=-2.00 SAR Peak: 1.29 W/kg	
SAR 10g (W/Kg)	0.392976
SAR 1g (W/Kg)	0.702485
	

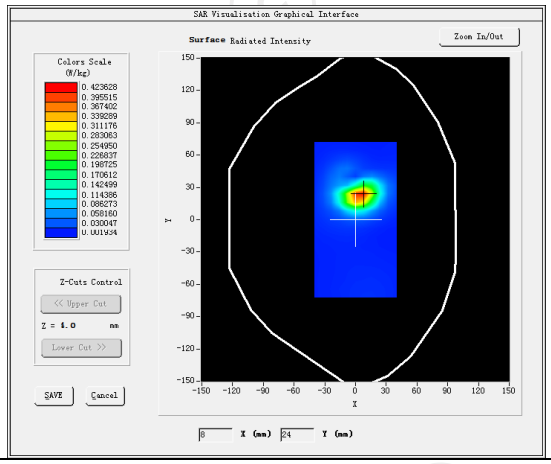
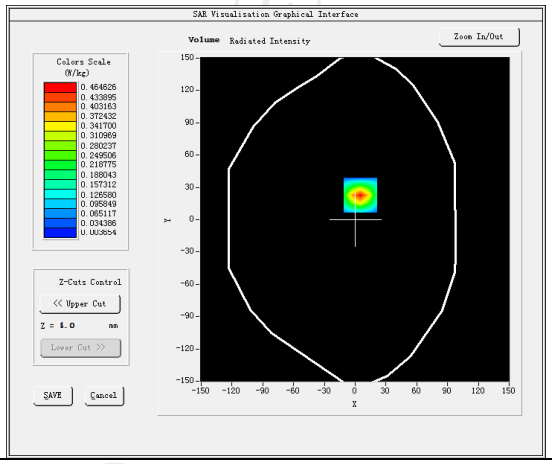
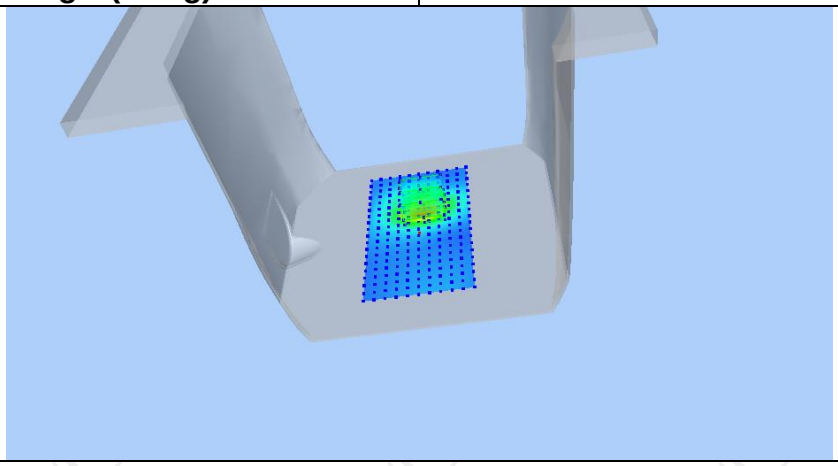
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.2812	0.7962	0.4297	0.2390	0.1462



Hot spot position



LTE Band 2

MEASUREMENT 1	
Higher Band SAR (Channel 19100):	Date: 11/27/2017
Frequency (MHz)	1899.500000
Relative permittivity (real part)	53.309999
Relative permittivity (imaginary part)	14.329440
Conductivity (S/m)	1.510354
Variation (%)	1.060000
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(hotspot 5mm)
Band	LTE band 2 (1 RB#0)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=5.00, Y=23.00 SAR Peak: 0.70 W/kg	
SAR 10g (W/Kg)	0.205270
SAR 1g (W/Kg)	0.417733
	

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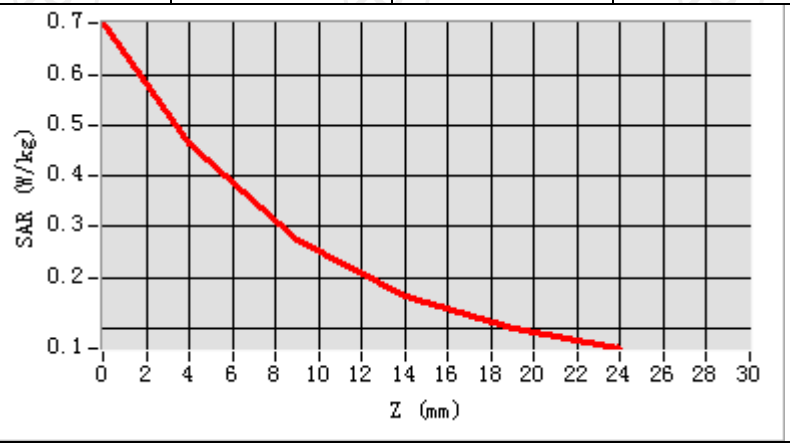
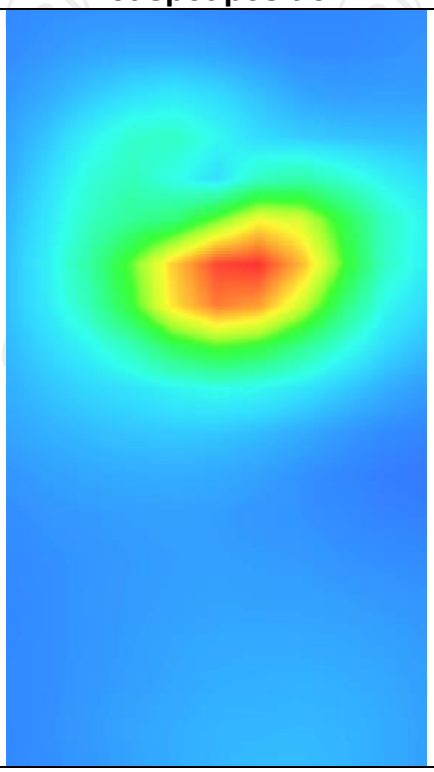
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.7007	0.4646	0.2732	0.1623	0.1003



Hot spot position



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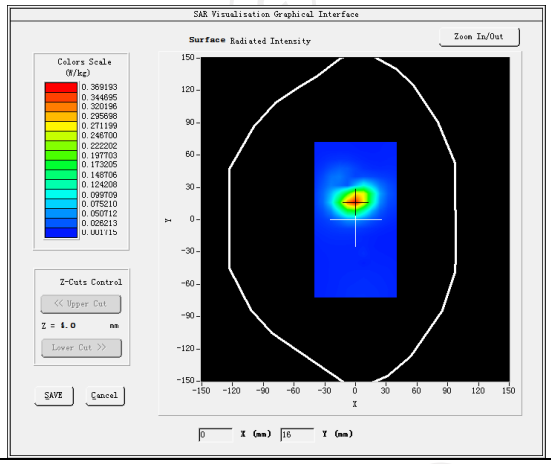
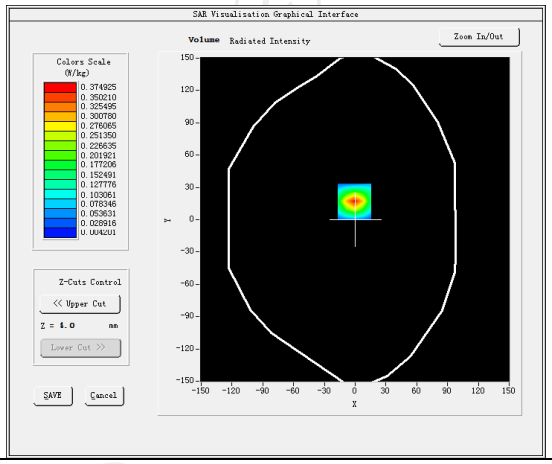
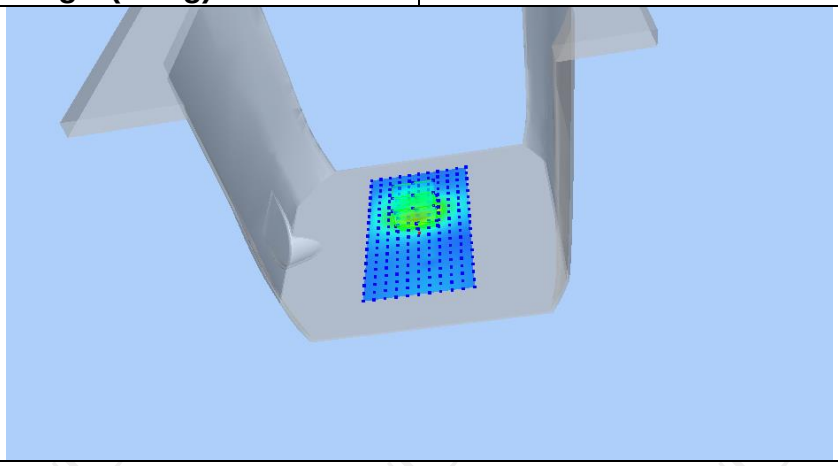
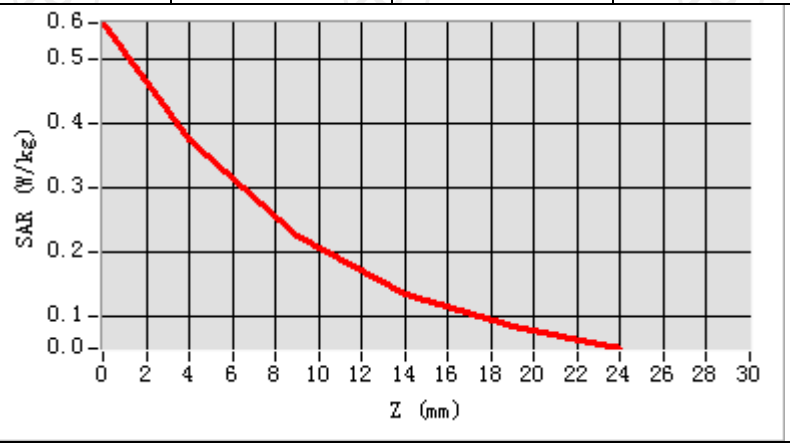
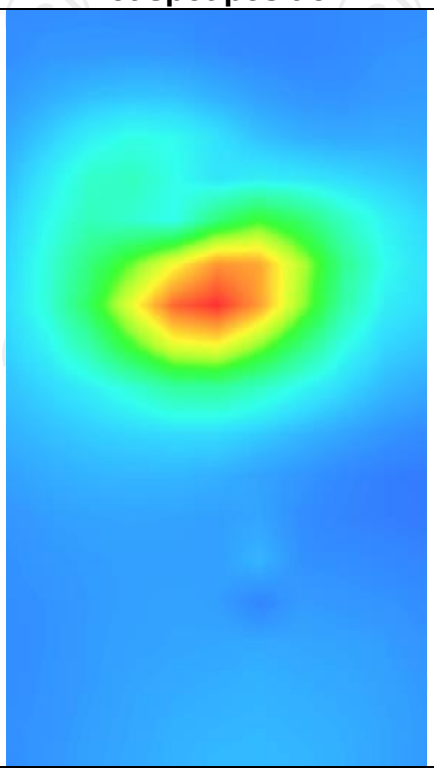
MEASUREMENT 2	
Higher Band SAR (Channel 19100):	Date: 11/27/2017
Frequency (MHz)	1899.500000
Relative permittivity (real part)	53.309999
Relative permittivity (imaginary part)	14.329440
Conductivity (S/m)	1.510354
Variation (%)	0.710000
Crest Factor	1.0
Probe Conversion factor	5.01
E-Field Probe:	SSE5 (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 (hotspot 5mm)
Band	LTE band 2 (50 RB#0)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-1.00, Y=17.00 SAR Peak: 0.56 W/kg	
SAR 10g (W/Kg)	0.166044
SAR 1g (W/Kg)	0.333787
	

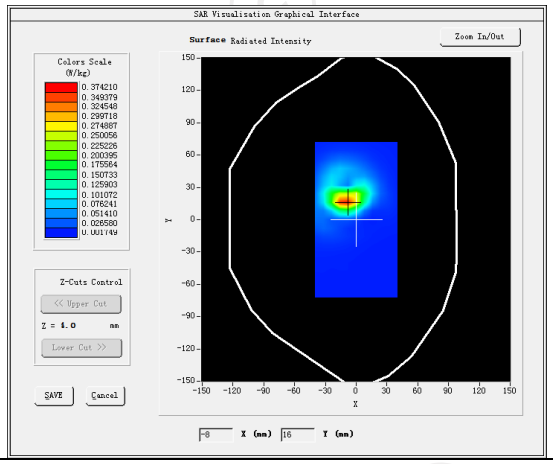
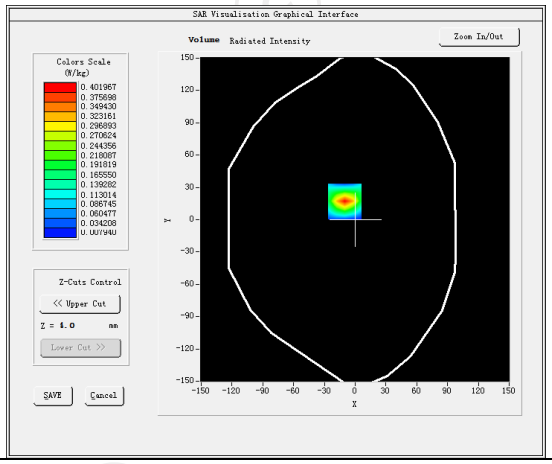
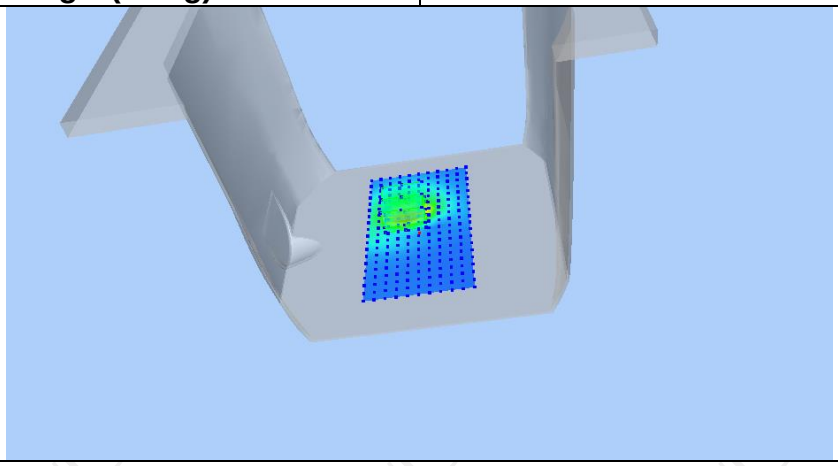
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.5572	0.3749	0.2244	0.1348	0.0829



Hot spot position



LTE Band 4

MEASUREMENT 1	
Lower Band SAR (Channel 20050):	Date: 11/22/2017
Frequency (MHz)	1719.500000
Relative permittivity (real part)	54.313866
Relative permittivity (imaginary part)	12.464763
Conductivity (S/m)	1.452764
Variation (%)	-1.730000
Crest Factor	1.0
Probe Conversion factor	4.87
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(hotspot 5mm)
Band	LTE band 4(1 RB#0)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-10.00, Y=17.00 SAR Peak: 0.57 W/kg	
SAR 10g (W/Kg)	0.180275
SAR 1g (W/Kg)	0.356284
	

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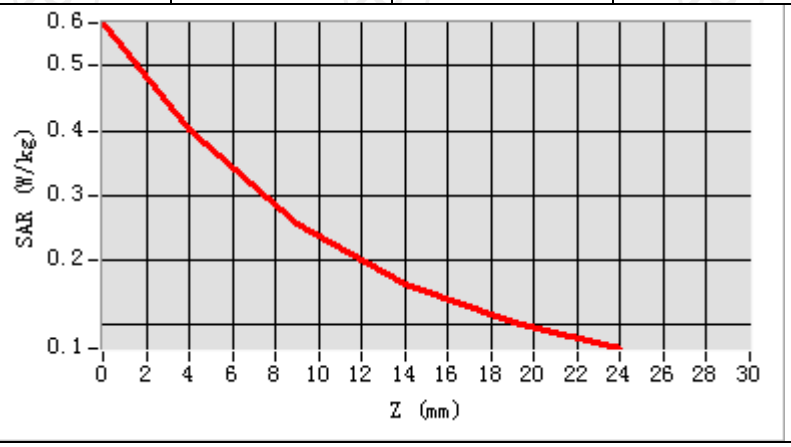
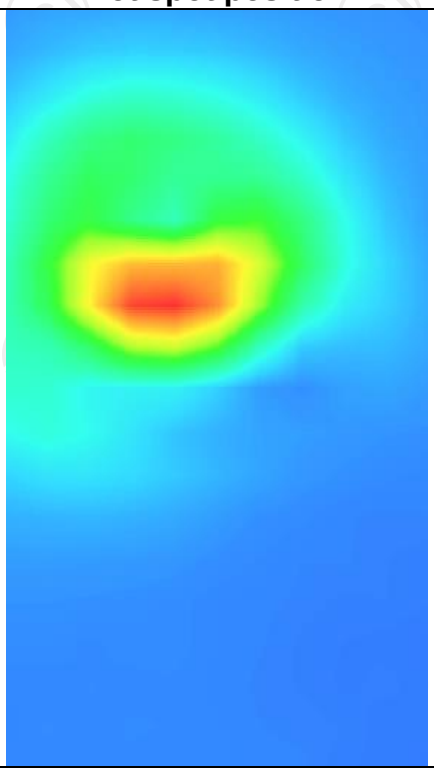
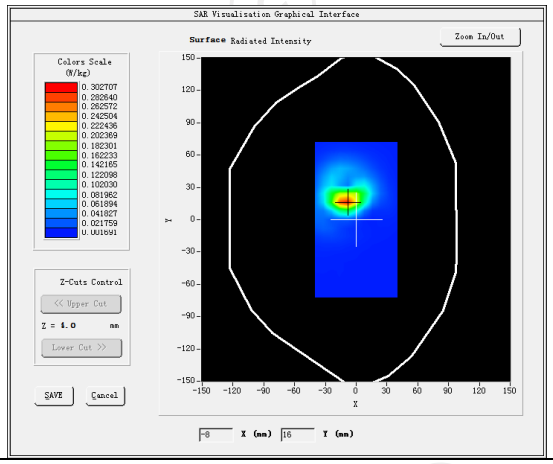
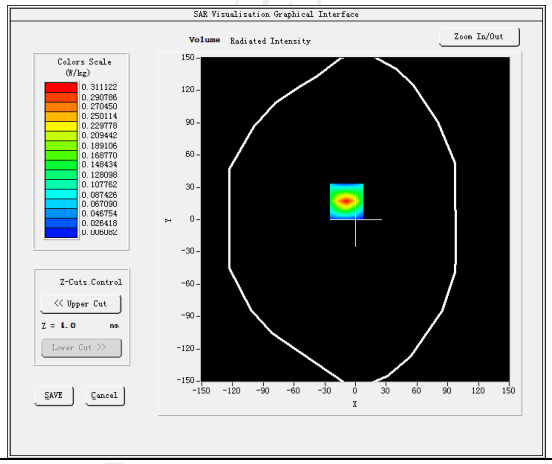
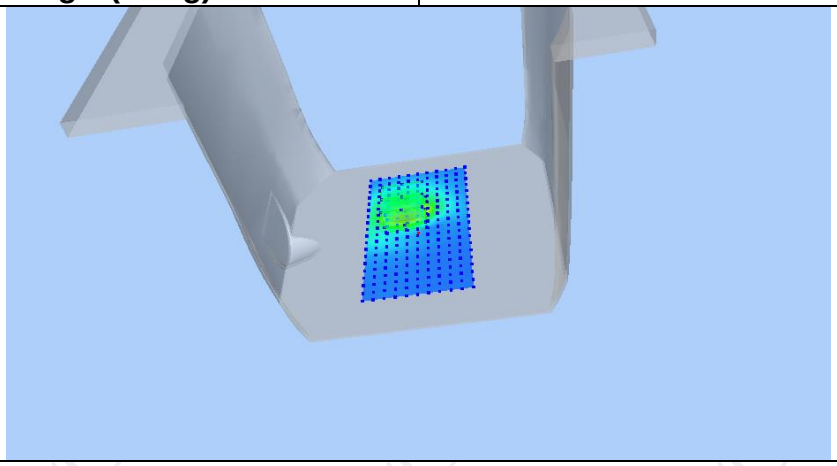
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.5666	0.4020	0.2576	0.1642	0.1047

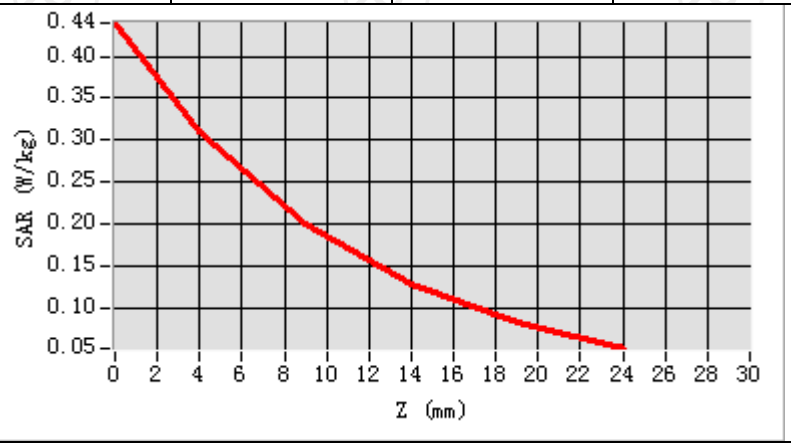


Hot spot position

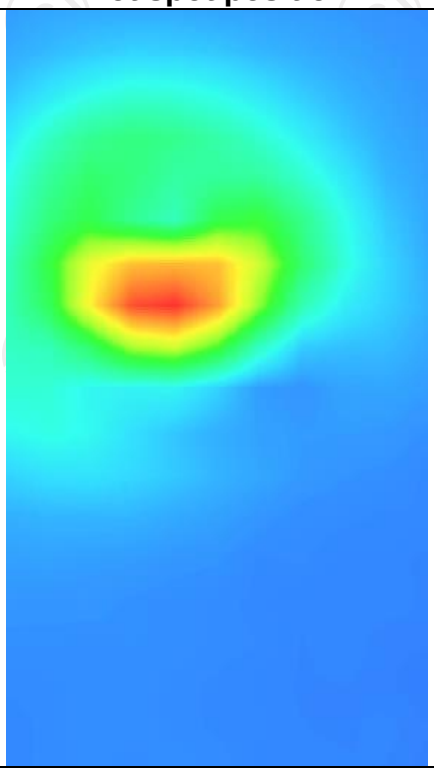


MEASUREMENT 2	
Lower Band SAR (Channel 20050):	Date: 11/22/2017
Frequency (MHz)	1719.500000
Relative permittivity (real part)	54.313866
Relative permittivity (imaginary part)	12.464763
Conductivity (S/m)	1.452764
Variation (%)	-2.940001
Crest Factor	1.0
Probe Conversion factor	4.87
E-Field Probe:	SSE5 (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(hotspot 5mm)
Band	LTE band 4(50 RB#0)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-9.00, Y=17.00 SAR Peak: 0.44 W/kg	
SAR 10g (W/Kg)	0.140615
SAR 1g (W/Kg)	0.276203
	

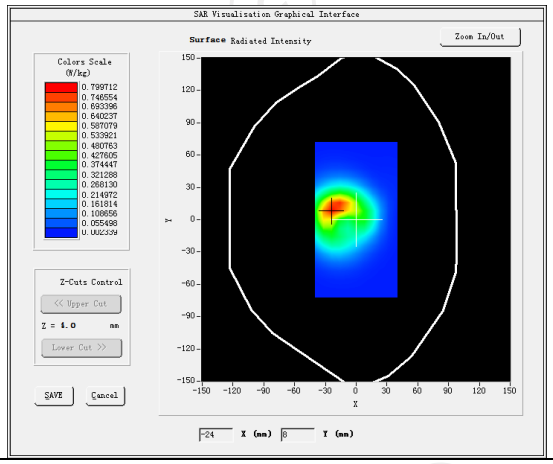
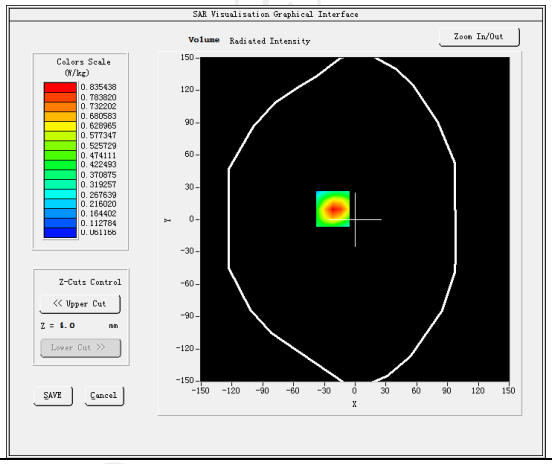
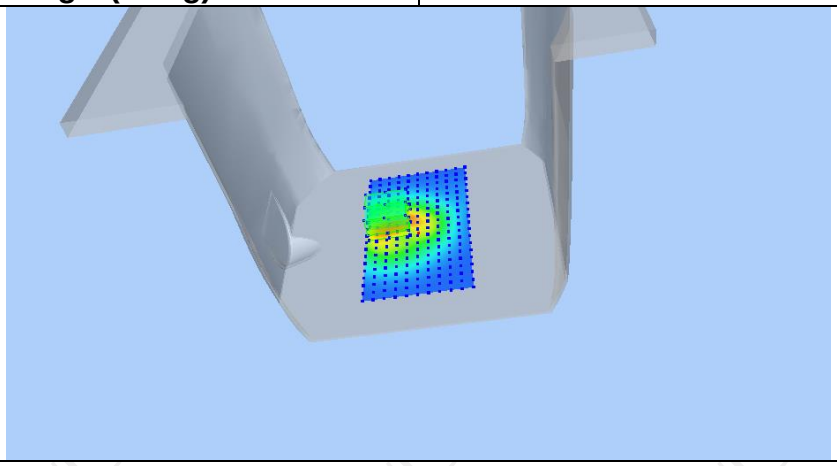
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4396	0.3111	0.1993	0.1277	0.0826



Hot spot position



LTE Band 5

MEASUREMENT 1	
Middle Band SAR (Channel 20525):	Date: 11/17/2017
Frequency (MHz)	836.500000
Relative permittivity (real part)	55.239883
Relative permittivity (imaginary part)	21.373374
Conductivity (S/m)	0.941375
Variation (%)	0.540000
Crest Factor	1.0
Probe Conversion factor	5.65
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 top(hotspot 5mm)
Band	LTE band 5(1 RB#49)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-22.00, Y=10.00 SAR Peak: 1.38 W/kg	
SAR 10g (W/Kg)	0.369249
SAR 1g (W/Kg)	0.689760
	

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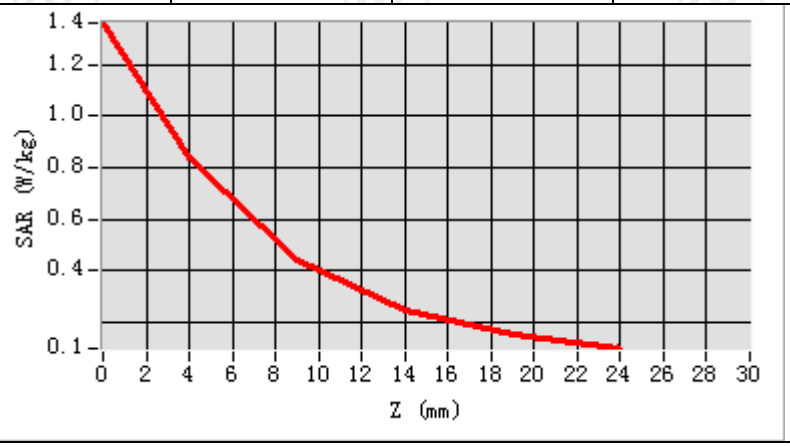
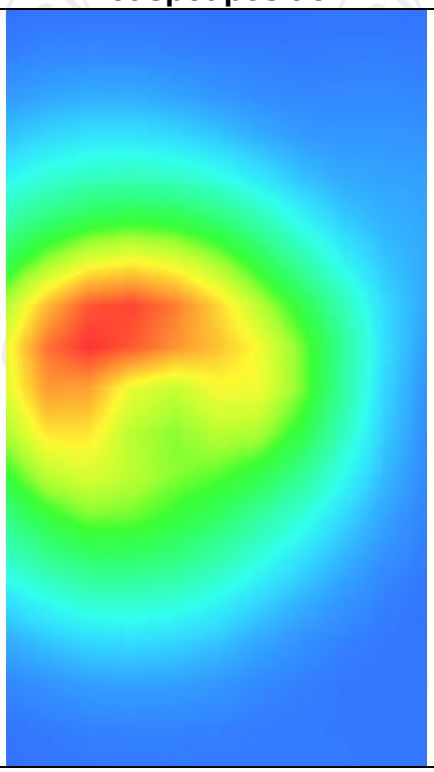
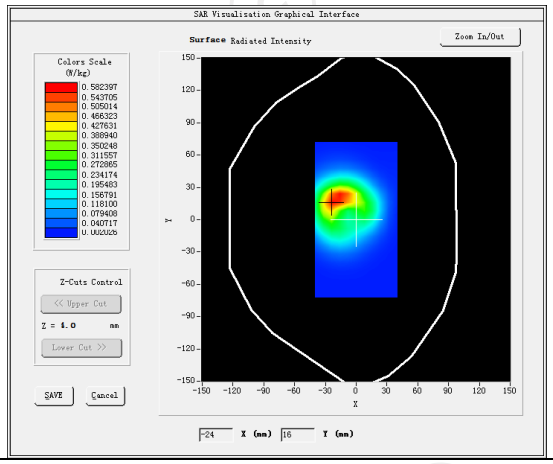
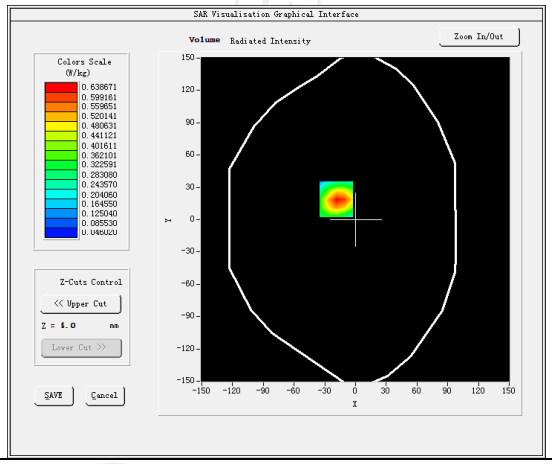
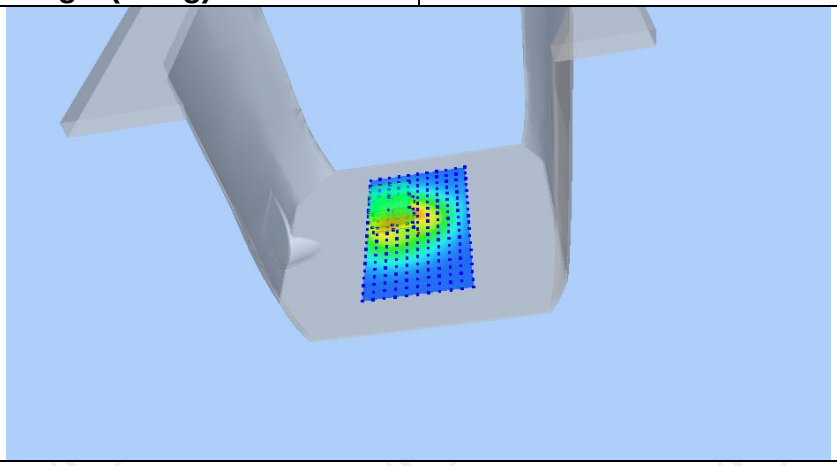
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.3629	0.8354	0.4426	0.2428	0.1487

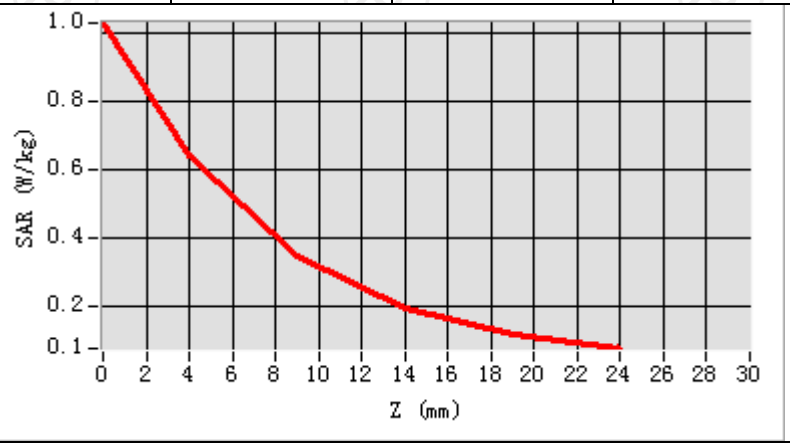


Hot spot position

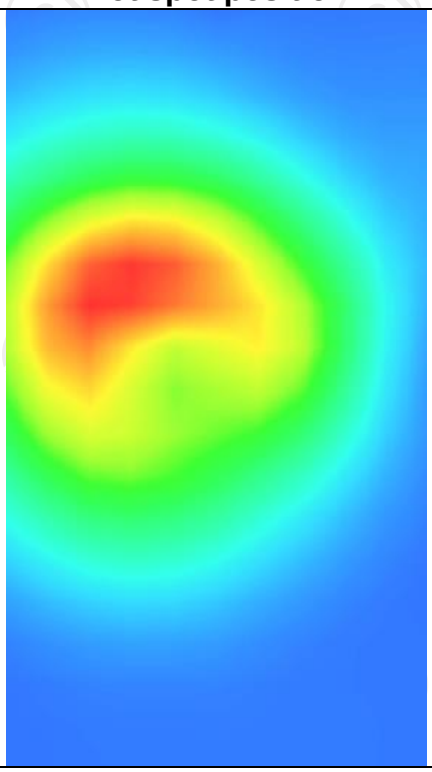


MEASUREMENT 2	
Middle Band SAR (Channel 20525):	Date: 11/17/2017
Frequency (MHz)	836.500000
Relative permittivity (real part)	55.239883
Relative permittivity (imaginary part)	21.373374
Conductivity (S/m)	0.941375
Variation (%)	0.630000
Crest Factor	1.0
Probe Conversion factor	5.65
E-Field Probe:	SSE5 (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 top(hotspot 5mm)
Band	LTE band 5(25 RB#0)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-19.00, Y=19.00 SAR Peak: 1.05 W/kg	
SAR 10g (W/Kg)	0.302301
SAR 1g (W/Kg)	0.503985
	

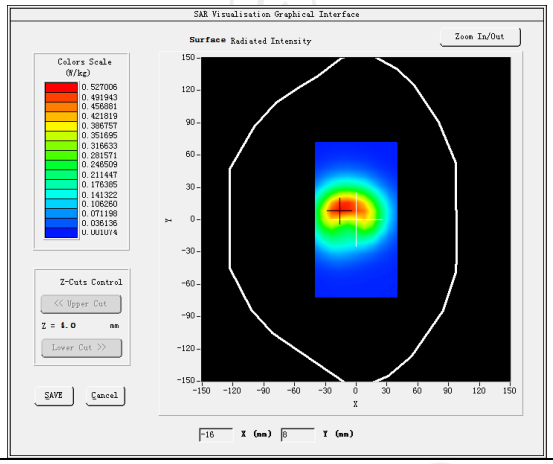
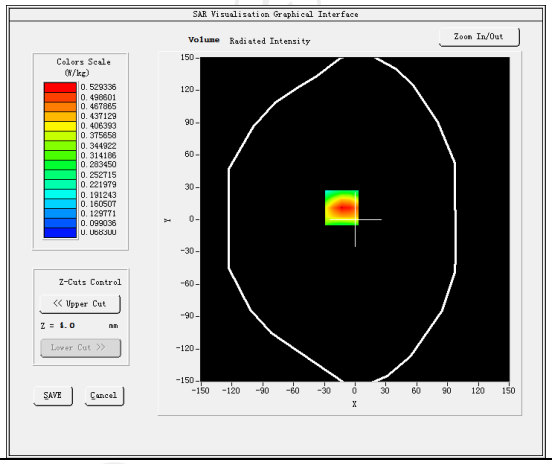
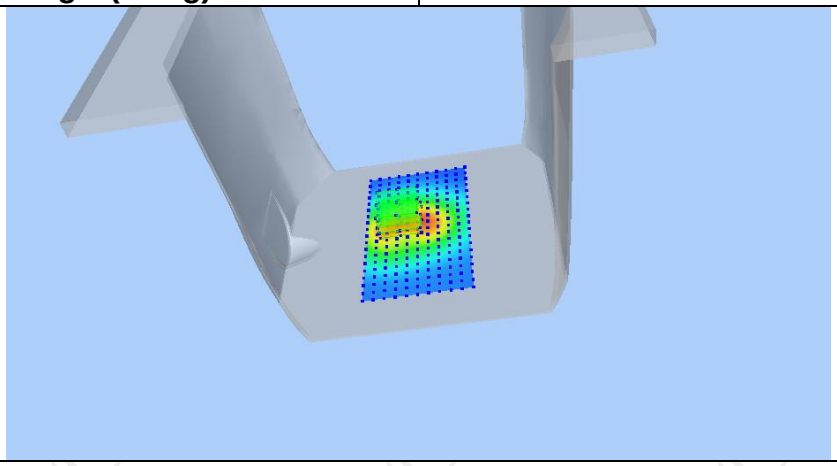
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.0276	0.6387	0.3446	0.1913	0.1166



Hot spot position



LTE Band 12

MEASUREMENT 1	
Higher Band SAR (Channel 23130):	Date: 11/14/2017
Frequency (MHz)	710.500000
Relative permittivity (real part)	55.601352
Relative permittivity (imaginary part)	12.462264
Conductivity (S/m)	0.932772
Variation (%)	0.470000
Crest Factor	1.0
Probe Conversion factor	4.93
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 top(hotspot 5mm)
Band	LTE band 12(1 RB#25)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-13.00, Y=11.00 SAR Peak: 0.81 W/kg	
SAR 10g (W/Kg)	0.300473
SAR 1g (W/Kg)	0.500984
	

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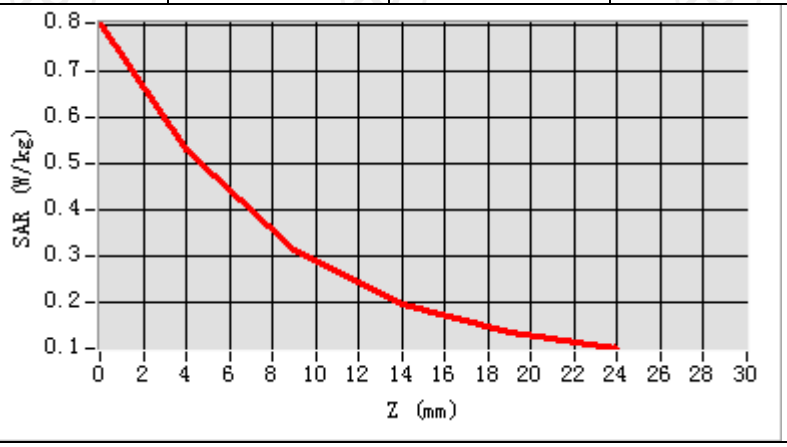
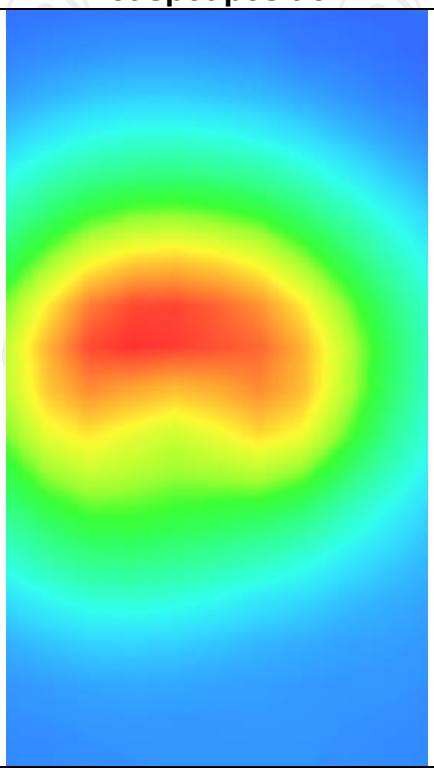
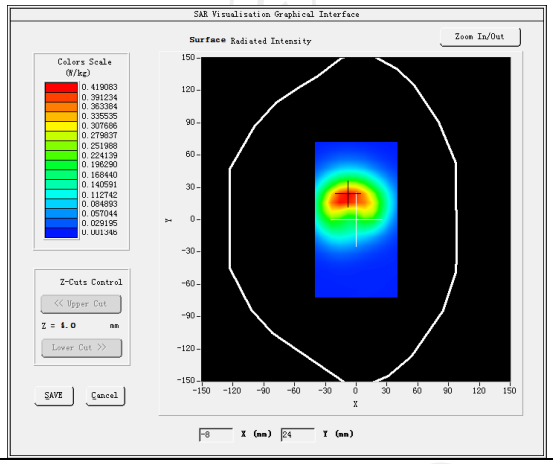
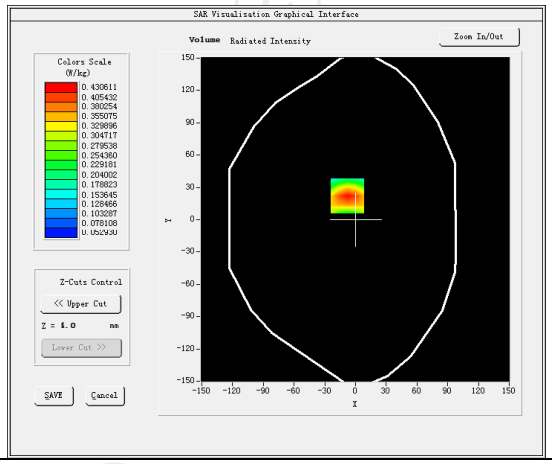
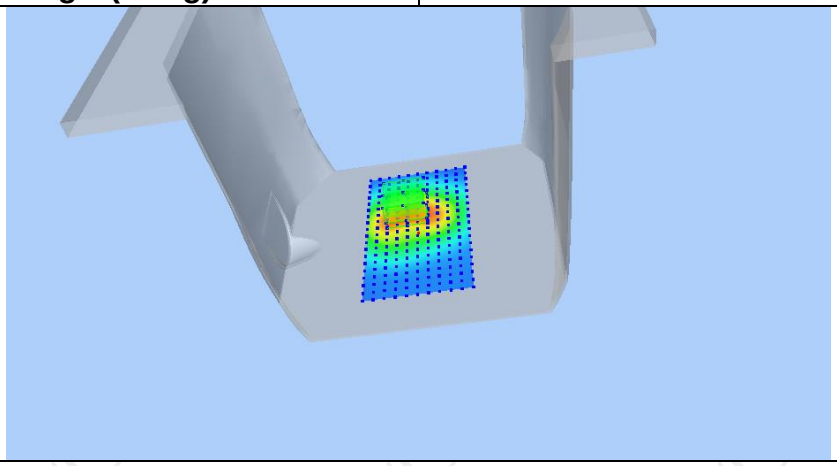
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.8051	0.5293	0.3132	0.1951	0.1345

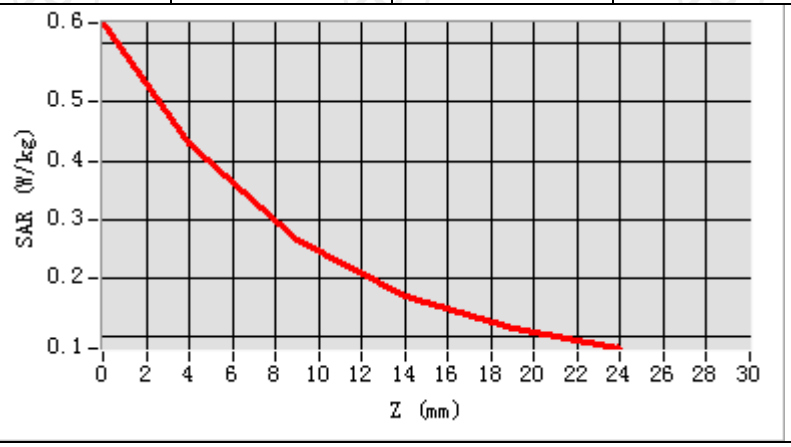


Hot spot position

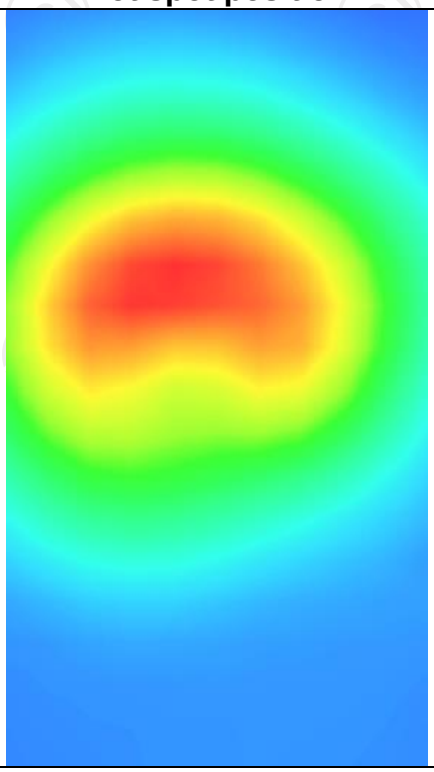


MEASUREMENT 2	
Higher Band SAR (Channel 23130):	Date: 11/14/2017
Frequency (MHz)	710.500000
Relative permittivity (real part)	55.601352
Relative permittivity (imaginary part)	12.462264
Conductivity (S/m)	0.932772
Variation (%)	-0.750000
Crest Factor	1.0
Probe Conversion factor	4.93
E-Field Probe:	SSE5 (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 top(hotspot 5mm)
Band	LTE band 12(25 RB#13)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-8.00, Y=22.00 SAR Peak: 0.64 W/kg	
SAR 10g (W/Kg)	0.244269
SAR 1g (W/Kg)	0.405531
	

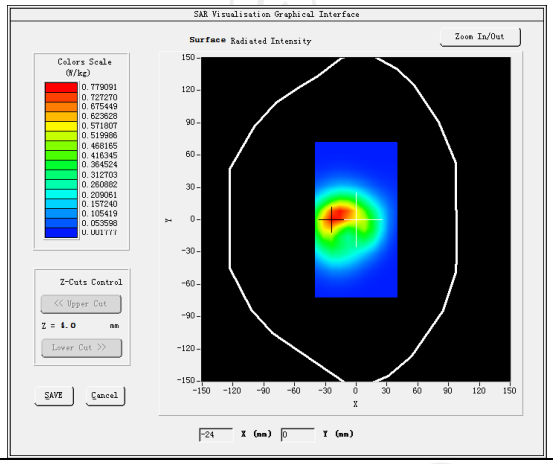
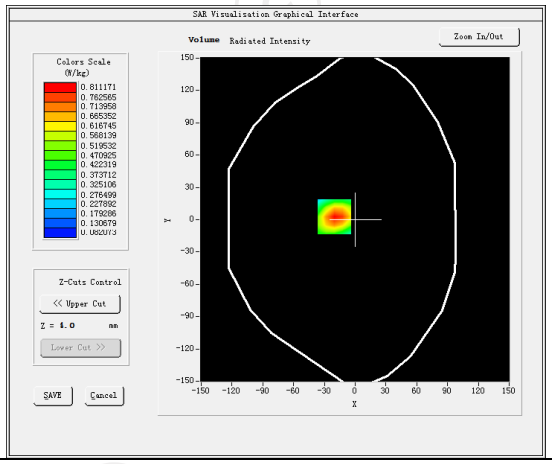
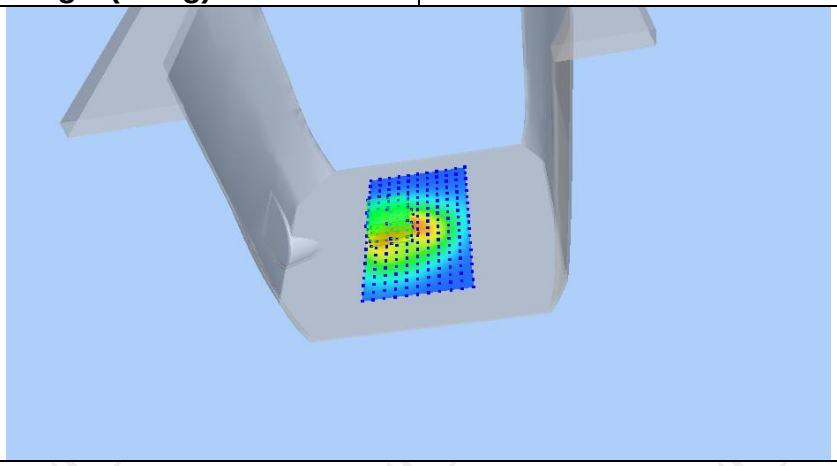
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.6358	0.4306	0.2637	0.1670	0.1130



Hot spot position



LTE Band 13

MEASUREMENT 1	
Lower Band SAR (Channel 23230):	Date: 11/14/2017
Frequency (MHz)	781.500000
Relative permittivity (real part)	55.481672
Relative permittivity (imaginary part)	12.462430
Conductivity (S/m)	0.942699
Variation (%)	1.030000
Crest Factor	1.0
Probe Conversion factor	4.93
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 top(hotspot 5mm)
Band	LTE band 13(1 RB#0)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-20.00, Y=3.00 SAR Peak: 1.25 W/kg	
SAR 10g (W/Kg)	0.404966
SAR 1g (W/Kg)	0.613682
	

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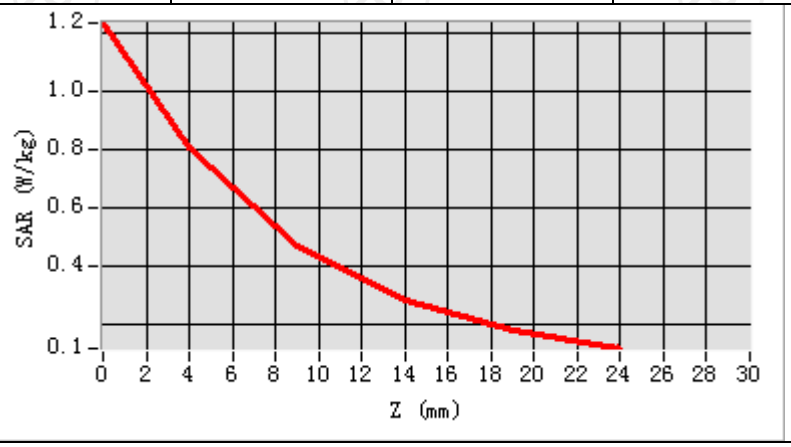
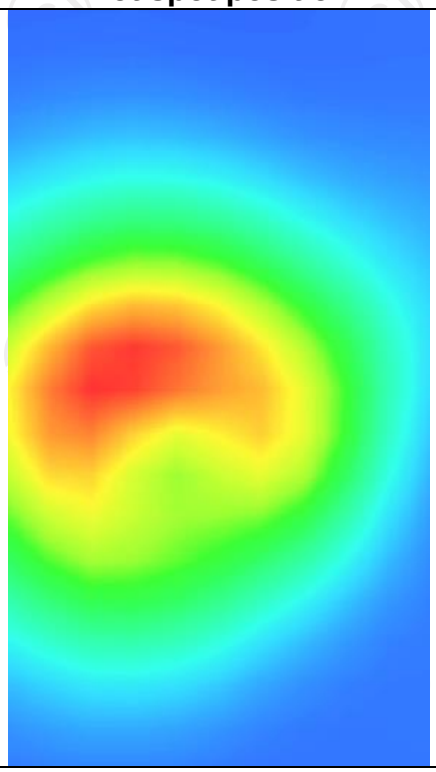
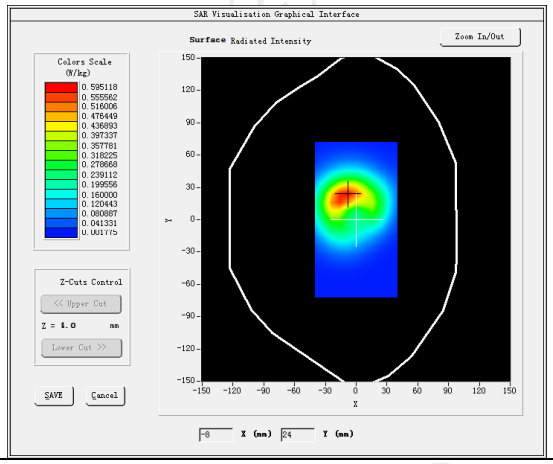
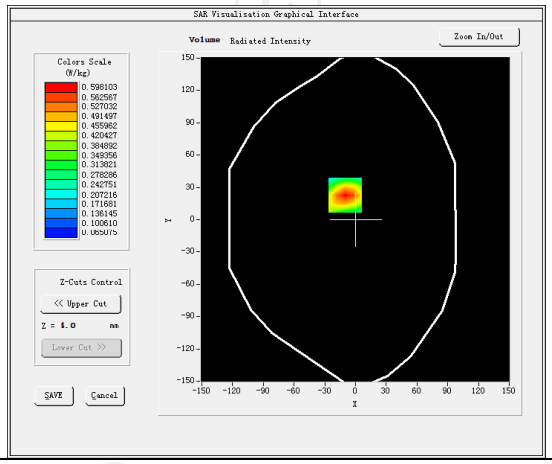
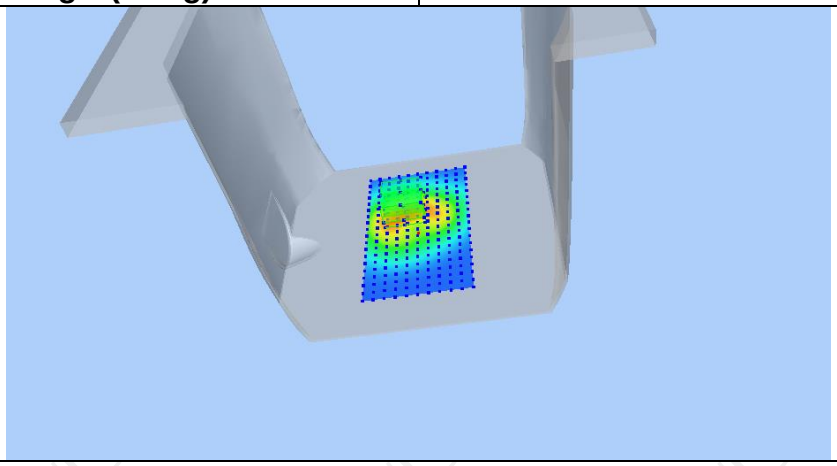
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	1.2354	0.8112	0.4738	0.2843	0.1825

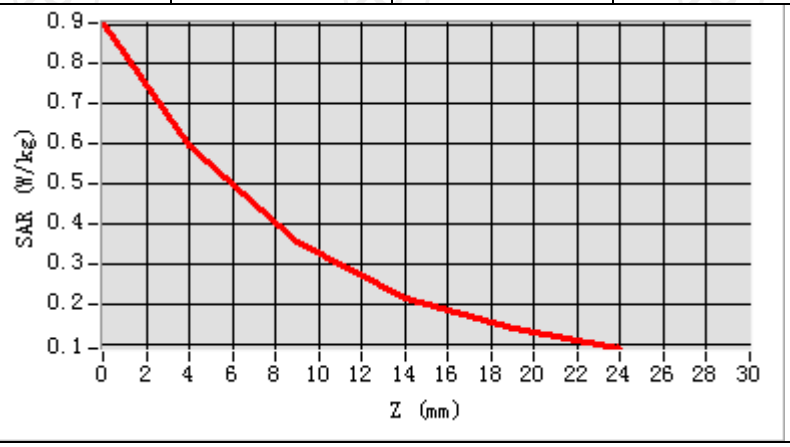


Hot spot position

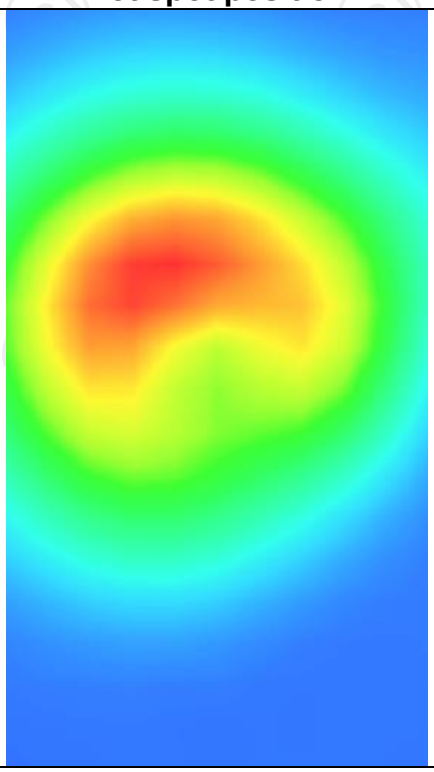


MEASUREMENT 2	
Lower Band SAR (Channel 23230):	Date: 11/14/2017
Frequency (MHz)	781.500000
Relative permittivity (real part)	55.481672
Relative permittivity (imaginary part)	12.462430
Conductivity (S/m)	0.942699
Variation (%)	-1.740000
Crest Factor	1.0
Probe Conversion factor	4.93
E-Field Probe:	SSE5 (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 top(hotspot 5mm)
Band	LTE band 13(25 RB#0)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-10.00, Y=23.00 SAR Peak: 0.91 W/kg	
SAR 10g (W/Kg)	0.292355
SAR 1g (W/Kg)	0.458642
	

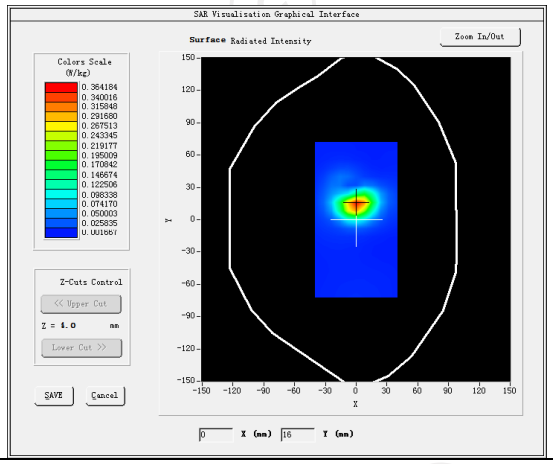
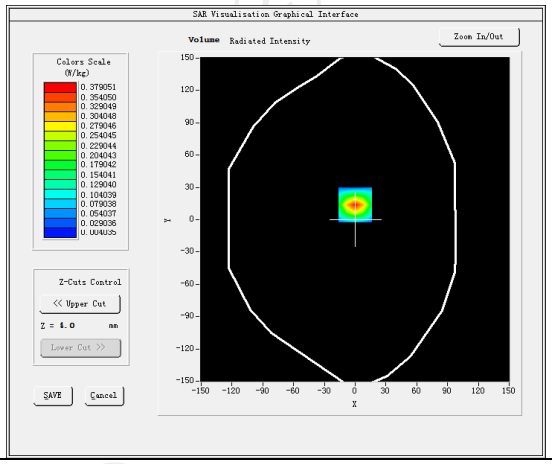
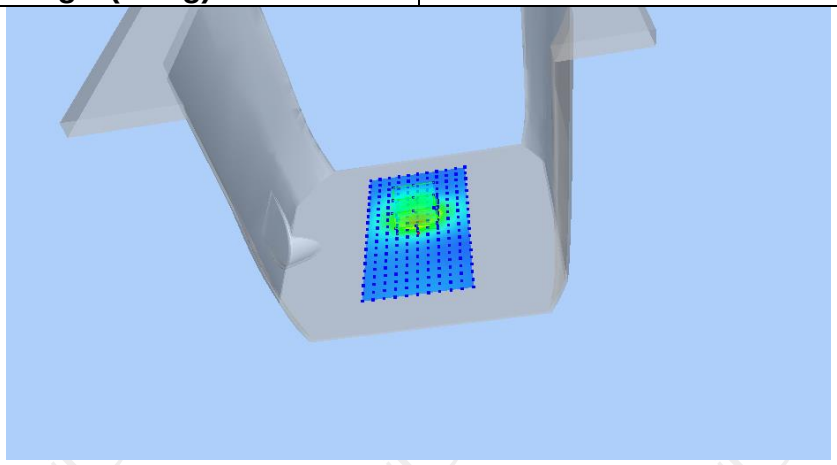
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.9025	0.5981	0.3536	0.2143	0.1380



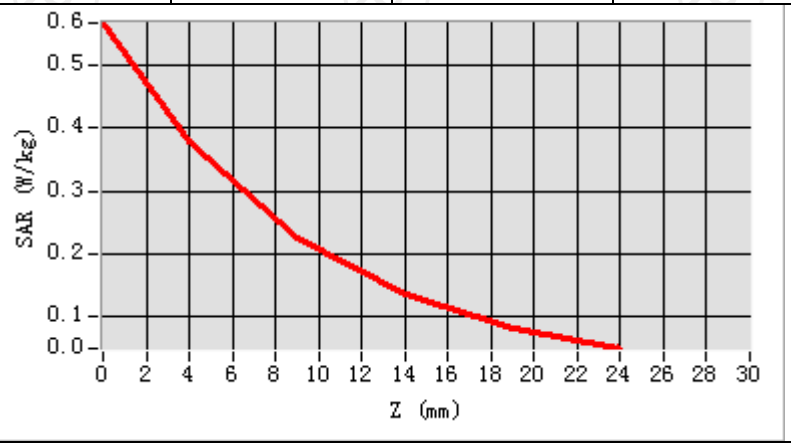
Hot spot position



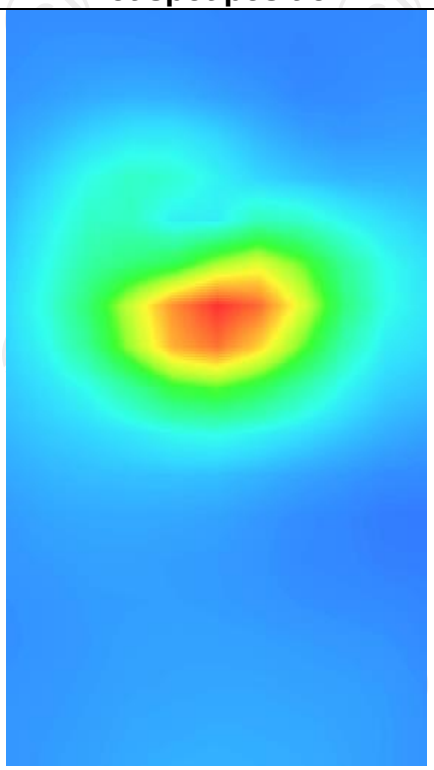
LTE Band 25

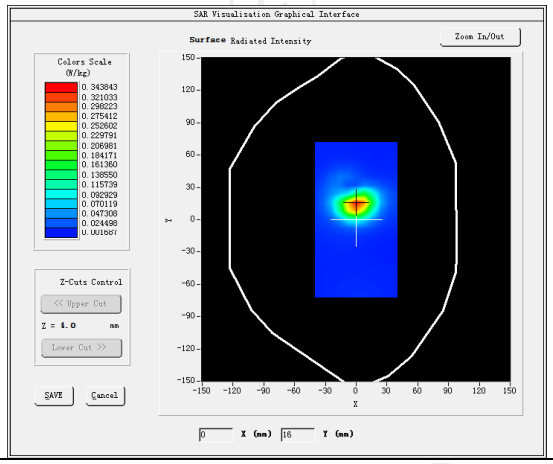
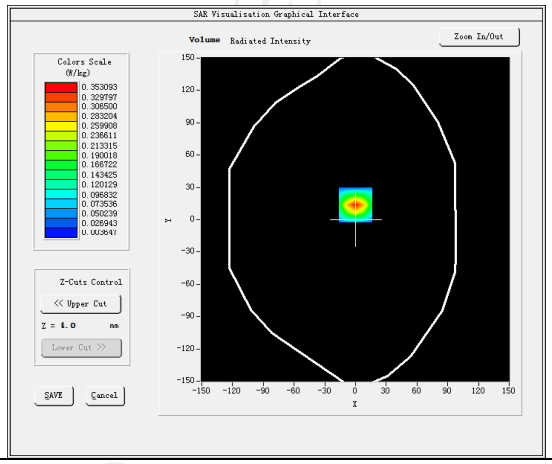
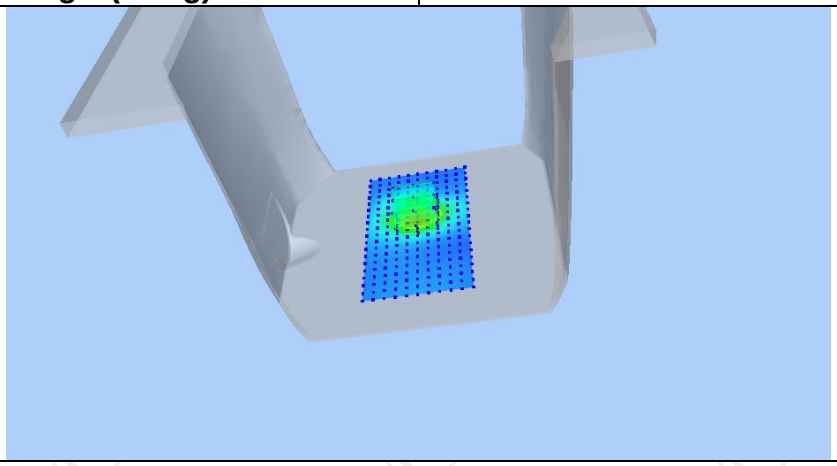
MEASUREMENT 1	
Higher Band SAR (Channel 26590):	Date: 11/27/2017
Frequency (MHz)	1905.000000
Relative permittivity (real part)	53.309999
Relative permittivity (imaginary part)	14.329440
Conductivity (S/m)	1.510354
Variation (%)	-0.330000
Crest Factor	1.0
Probe Conversion factor	5.01
E-Field Probe:	SSE5 (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(hotspot 5mm)
Band	LTE band 25(1 RB#50)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=0.00, Y=14.00 SAR Peak: 0.57 W/kg	
SAR 10g (W/Kg)	0.167845
SAR 1g (W/Kg)	0.339960
	

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.5676	0.3791	0.2246	0.1337	0.0819

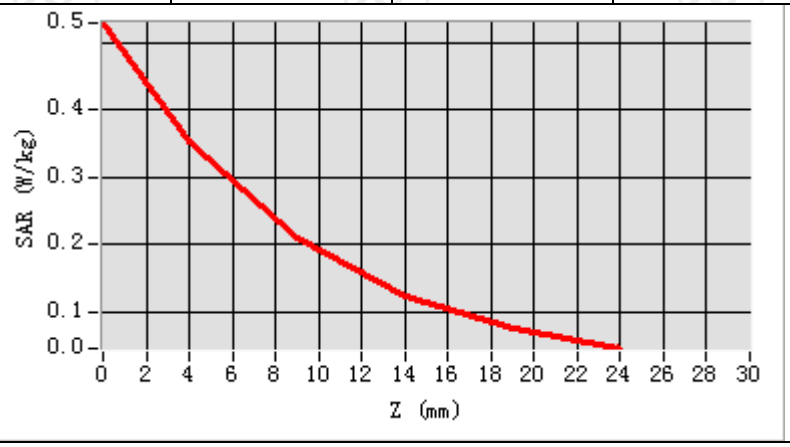


Hot spot position

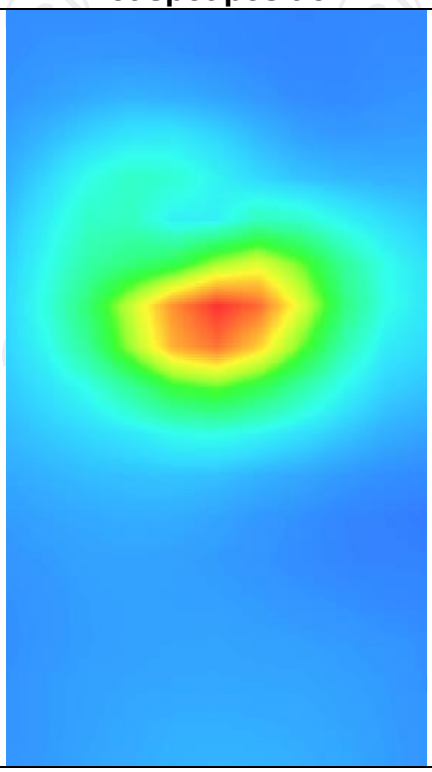


MEASUREMENT 2	
Higher Band SAR (Channel 26590):	Date: 11/27/2017
Frequency (MHz)	1905.000000
Relative permittivity (real part)	53.309999
Relative permittivity (imaginary part)	14.329440
Conductivity (S/m)	1.510354
Variation (%)	-1.510000
Crest Factor	1.0
Probe Conversion factor	5.01
E-Field Probe:	SSE5 (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(hotspot 5mm)
Band	LTE band 25(50 RB#25)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=0.00, Y=14.00 SAR Peak: 0.53 W/kg	
SAR 10g (W/Kg)	0.156445
SAR 1g (W/Kg)	0.316791
	

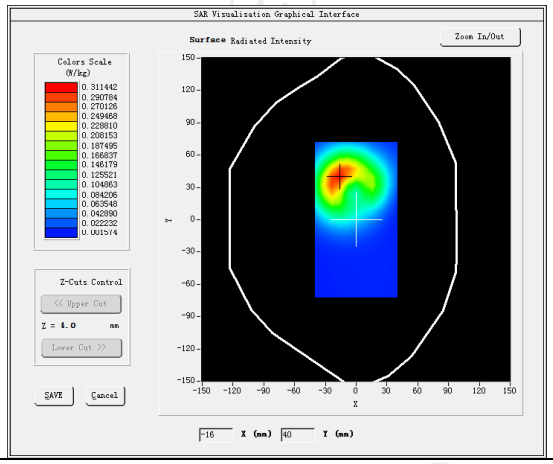
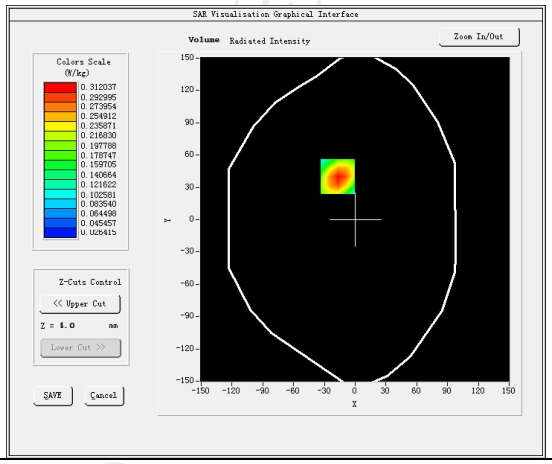
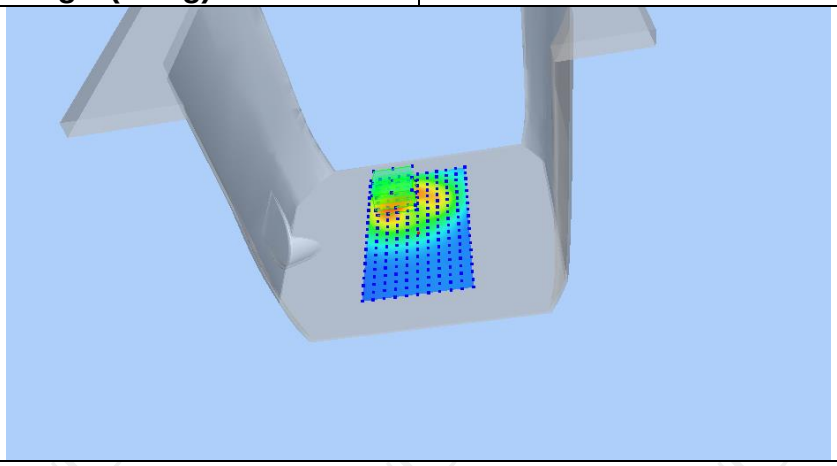
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.5289	0.3531	0.2091	0.1245	0.0763



Hot spot position



LTE Band 26

MEASUREMENT 1	
Middle Band SAR (Channel 26865):	Date: 11/17/2017
Frequency (MHz)	831.500000
Relative permittivity (real part)	55.239883
Relative permittivity (imaginary part)	21.373374
Conductivity (S/m)	0.941375
Variation (%)	1.040000
Crest Factor	1.0
Probe Conversion factor	5.65
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(hotspot 5mm)
Band	LTE band 26(1 RB#0)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-17.00, Y=40.00 SAR Peak: 0.47 W/kg	
SAR 10g (W/Kg)	0.173165
SAR 1g (W/Kg)	0.294565
	

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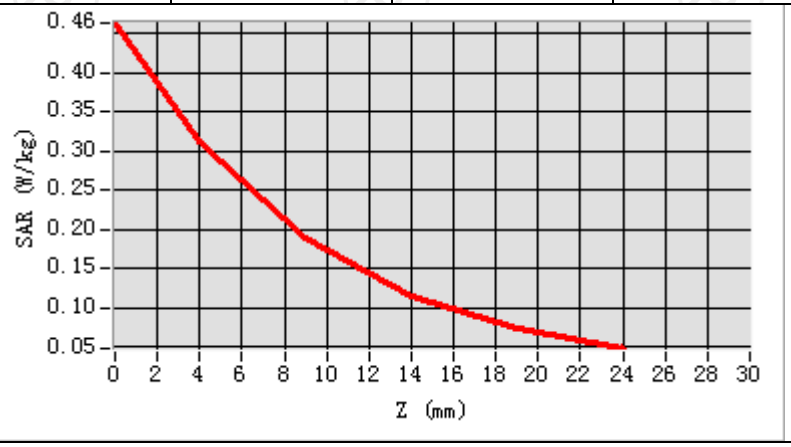
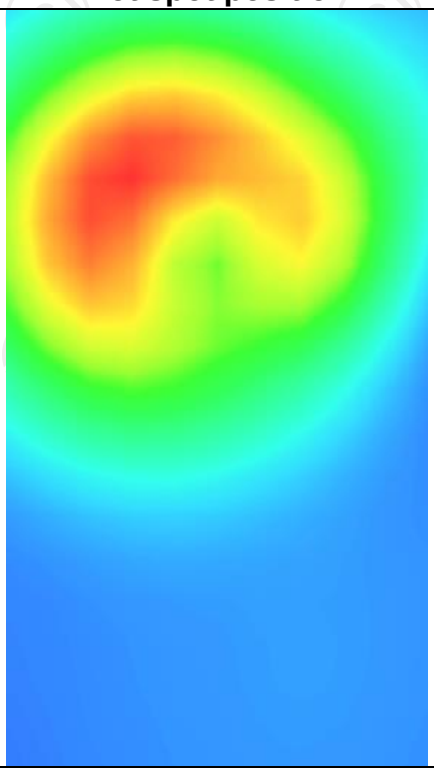
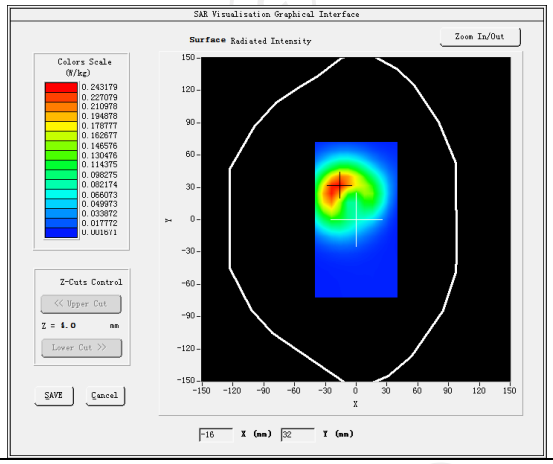
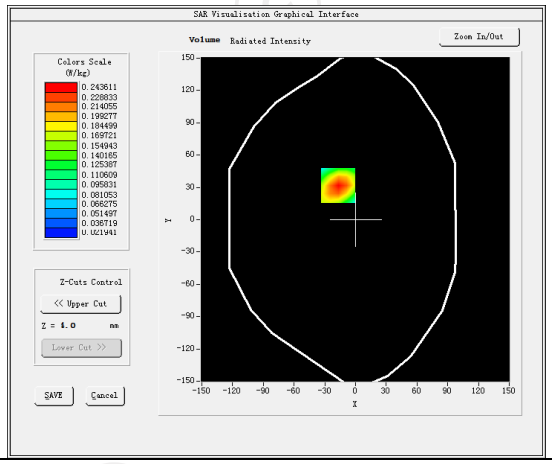
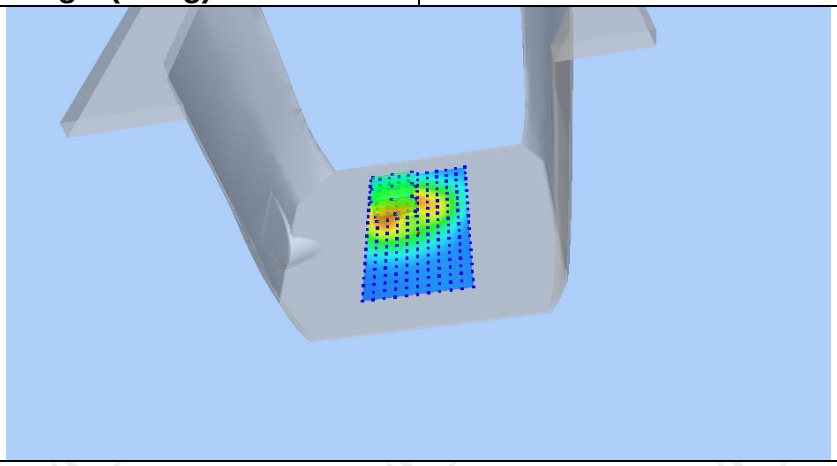
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.4629	0.3120	0.1885	0.1160	0.0748

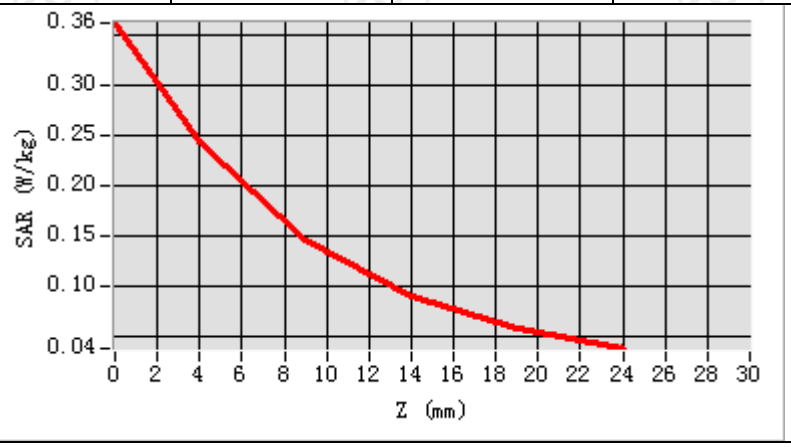


Hot spot position

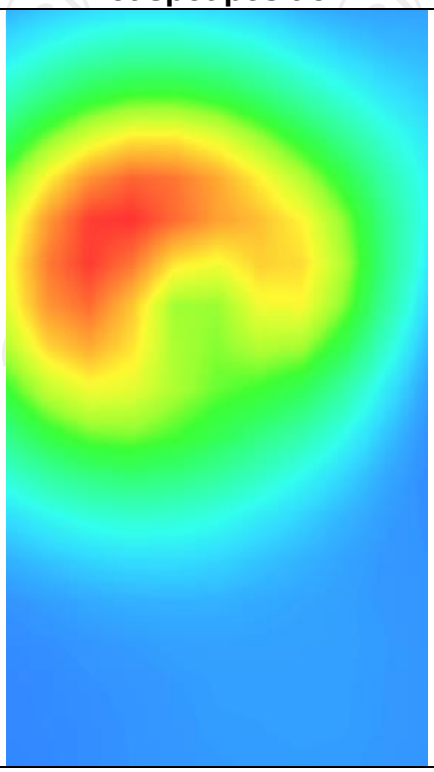


MEASUREMENT 2	
Middle Band SAR (Channel 26865):	Date: 11/17/2017
Frequency (MHz)	831.500000
Relative permittivity (real part)	55.239883
Relative permittivity (imaginary part)	21.373374
Conductivity (S/m)	0.941375
Variation (%)	-1.500000
Crest Factor	1.0
Probe Conversion factor	5.65
E-Field Probe:	SSE5 (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(hotspot 5mm)
Band	LTE band 26(36 RB#0)
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=-17.00, Y=32.00 SAR Peak: 0.36 W/kg	
SAR 10g (W/Kg)	0.135379
SAR 1g (W/Kg)	0.230153
	

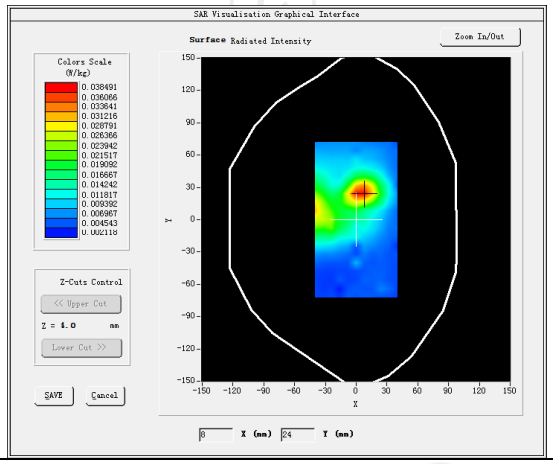
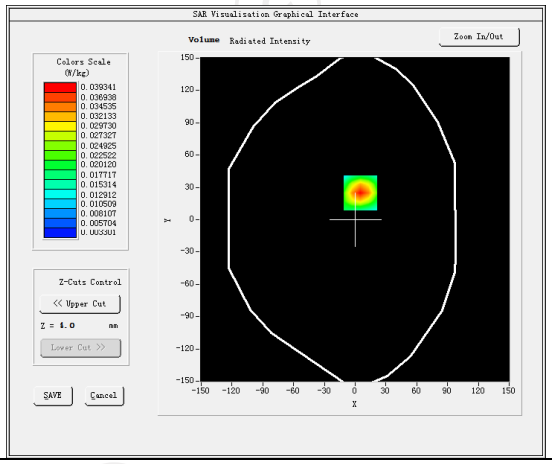
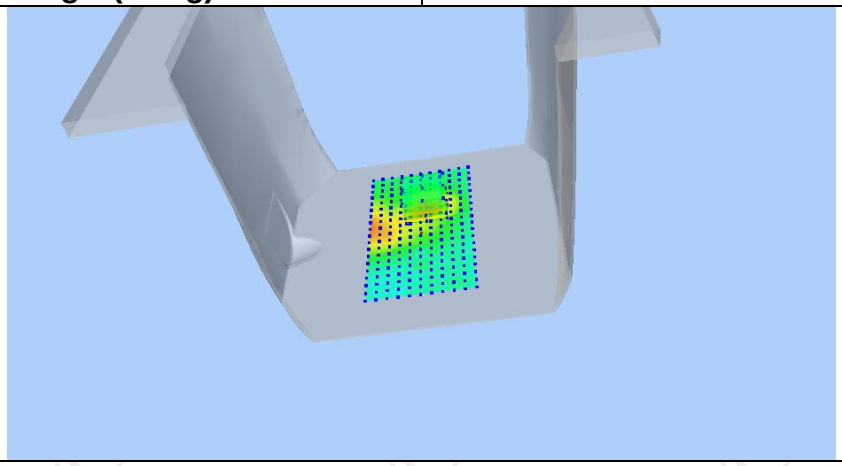
Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.3623	0.2436	0.1467	0.0900	0.0580



Hot spot position

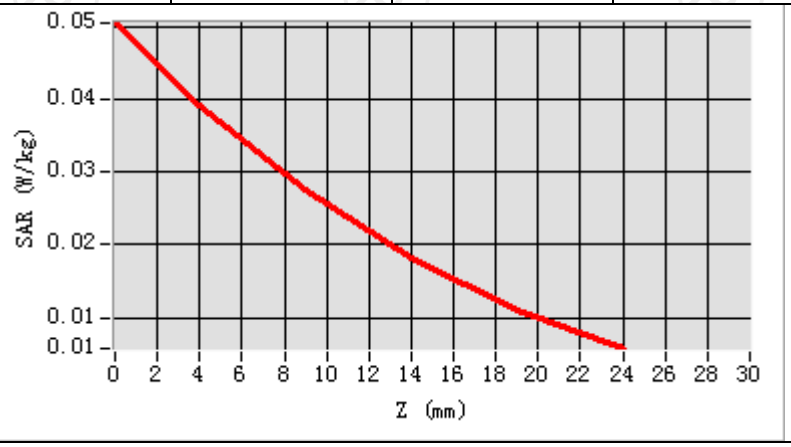


WLAN 2.4

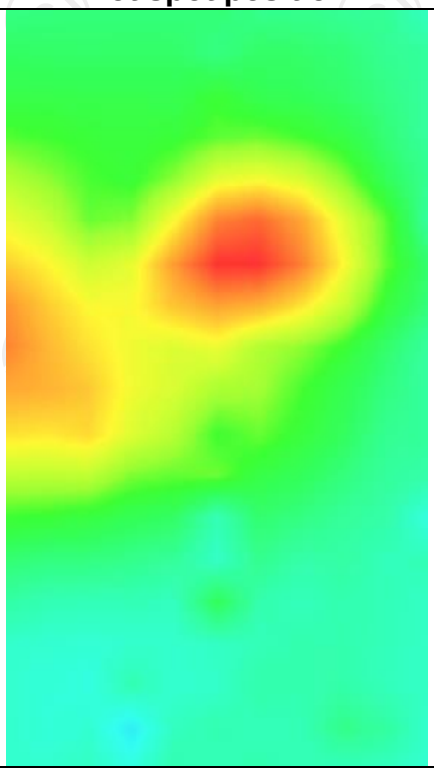
MEASUREMENT 1	
Middle Band SAR (Channel 6):	Date: 11/30/2017
Frequency (MHz)	2437.00000
Relative permittivity (real part)	54.630667
Relative permittivity (imaginary part)	14.318444
Conductivity (S/m)	1.982536
Variation (%)	-1.270000
Crest Factor	1.0
Probe Conversion factor	4.70
E-Field Probe:	SSE5 (SN 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(hotspot 5mm)
Band	IEEE 802.11b ISM
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=5.00, Y=25.00 SAR Peak: 0.05 W/kg	
SAR 10g (W/Kg)	0.021881
SAR 1g (W/Kg)	0.037675
	

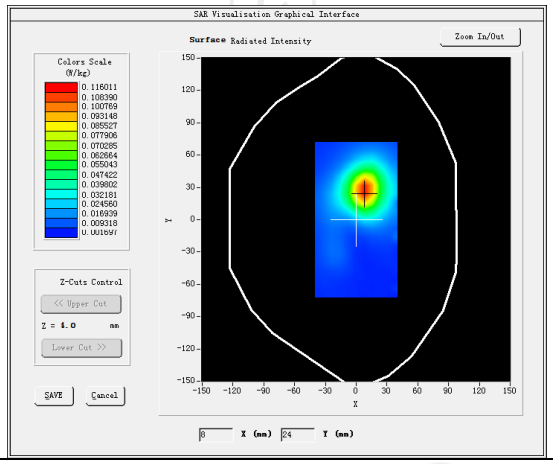
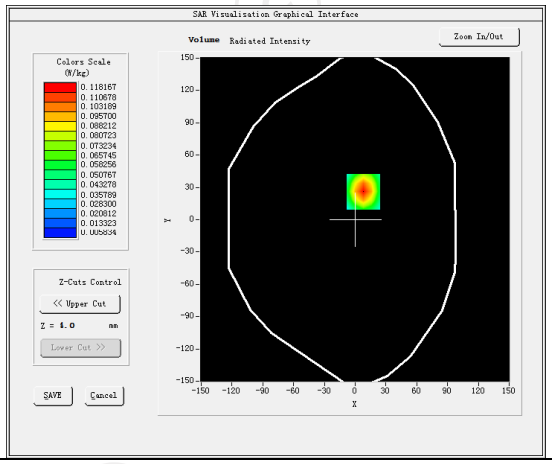
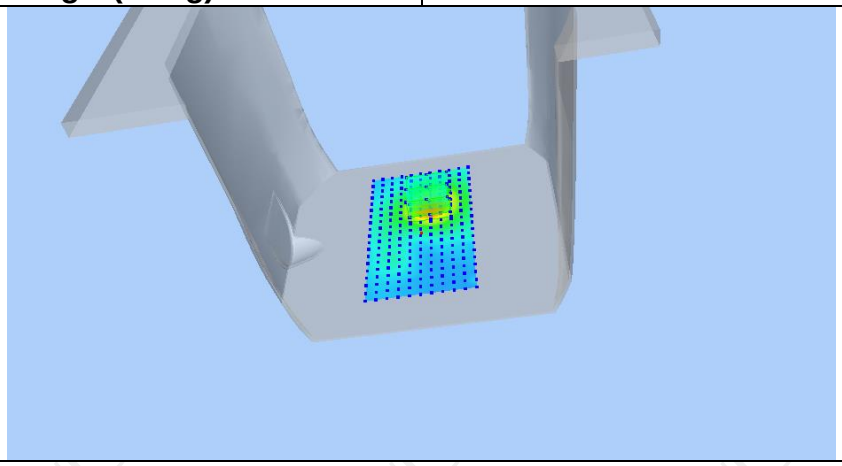
Hotline: 400-6611-140 Tel: 86-755-27673339 Fax: 86-755-27673332 http://www.tct-lab.com

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.0505	0.0393	0.0276	0.0183	0.0111

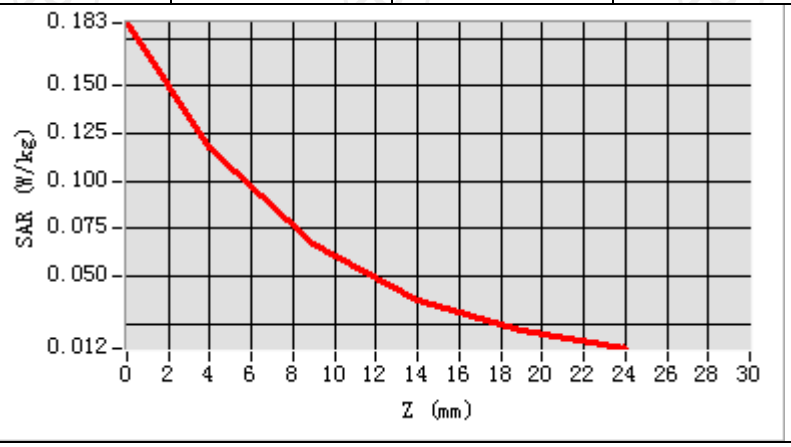


Hot spot position

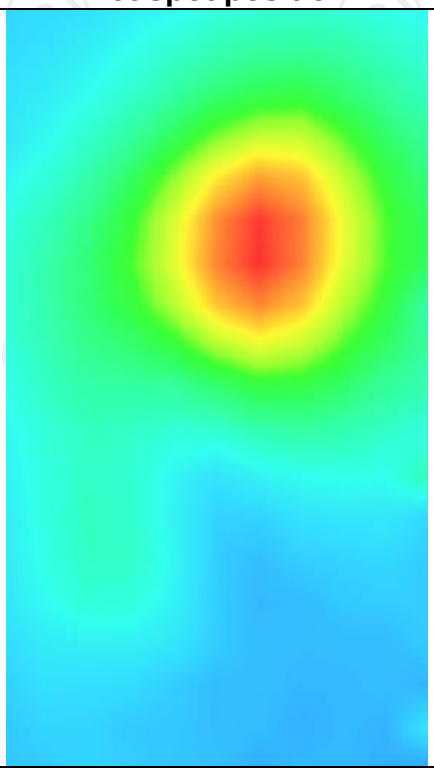


MEASUREMENT 2	
Middle Band SAR (Channel 6):	Date: 11/30/2017
Frequency (MHz)	2437.00000
Relative permittivity (real part)	54.630667
Relative permittivity (imaginary part)	14.318444
Conductivity (S/m)	1.982536
Variation (%)	-0.100000
Crest Factor	1.0
Probe Conversion factor	4.70
E-Field Probe:	SSE5 (SN 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 right(hotspot 5mm)
Band	IEEE 802.11b ISM
SURFACE SAR	**VOLUME SAR**
	
Maximum location: X=8.00, Y=26.00 SAR Peak: 0.18 W/kg	
SAR 10g (W/Kg)	0.059745
SAR 1g (W/Kg)	0.113776
	

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.1832	0.1182	0.0665	0.0373	0.0216



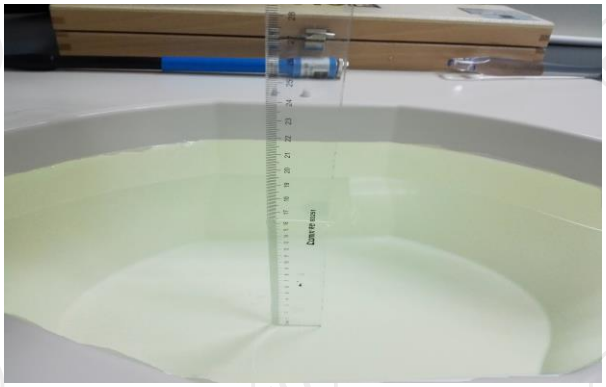
Hot spot position



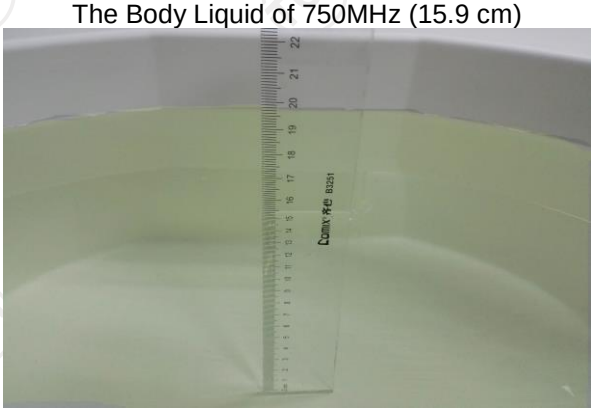
Appendix A: EUT Photos

Liquid depth

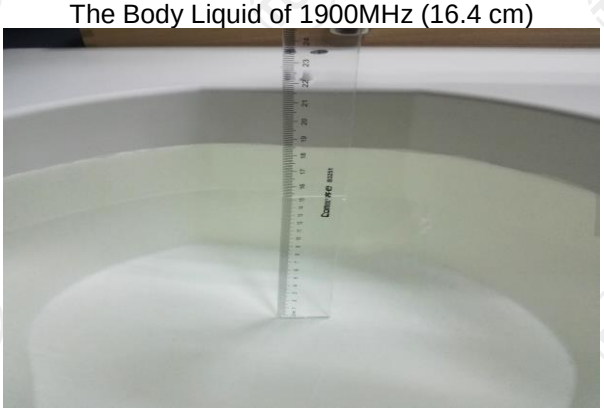
The Body Liquid of 750MHz (15.9 cm)



The Body Liquid of 1900MHz (16.4 cm)



The Body Liquid of 835MHz (15.4cm)

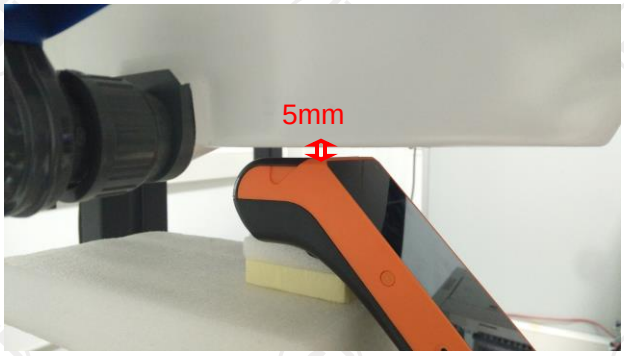


The Body Liquid of 2450MHz (15.3cm)

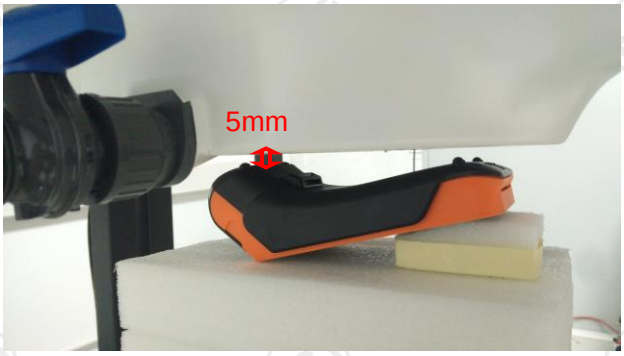
The Body Liquid of 1750MHz (16.5cm)

Hotline: 400-6611-140 Tel: 86-755-27673339 Fax: 86-755-27673332 http://www.tct-lab.com

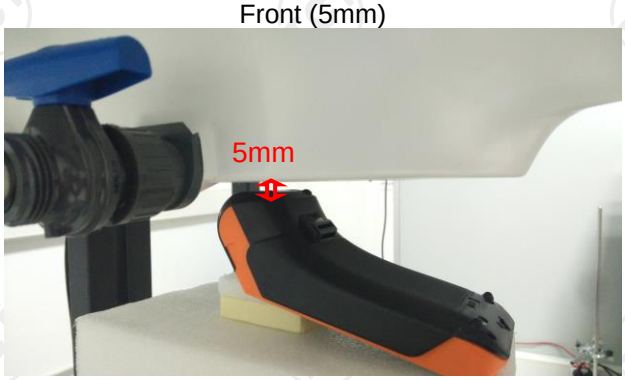
Appendix B: Test Setup Photos



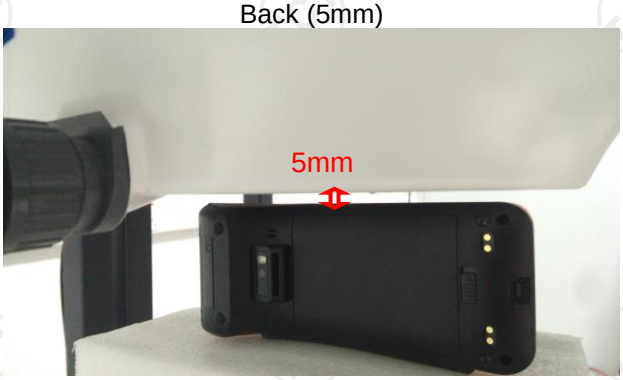
Front (5mm)



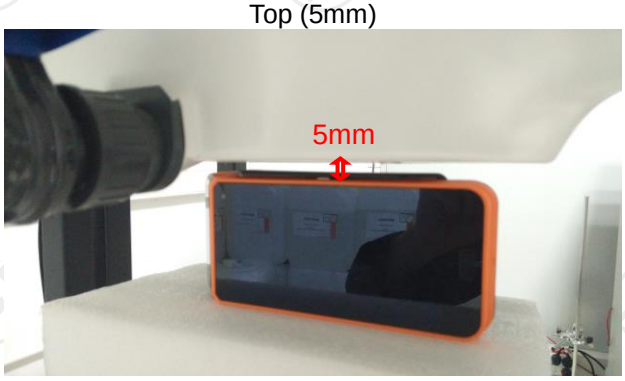
Back (5mm)



Top (5mm)



Left (5mm)



Right (5mm)

Appendix C: Probe Calibration Certificate

COMOSAR E-FIELD Probe

COMOSAR E-Field Probe Calibration Report

Ref : ACR.128.4.17.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

SERIAL NO.: SN 07/15 EP248

Calibrated at MVG US

2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED Calibration CERT #2246-02

Calibration Date: 01/10/2017

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.128.4.17.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	01/10/2017	
Checked by :	Jérôme LUC	Product Manager	01/10/2017	
Approved by :	Kim RUTKOWSKI	Quality Manager	01/10/2017	

	Customer Name
Distribution :	Shenzhen Tongce Testing Lab

Issue	Date	Modifications
A	01/10/2017	Initial release

TABLE OF CONTENTS

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)	New
Frequency Range of Probe	0.45 GHz - 3GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.218 MΩ Dipole 2: R2=0.217 MΩ Dipole 3: R3=0.215 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.

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%

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 %

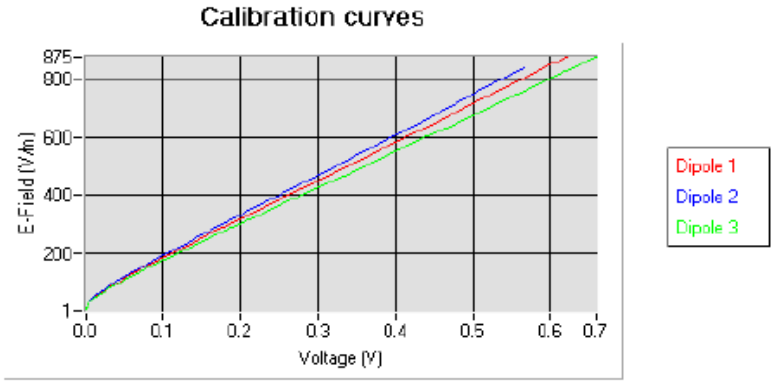
5.1 SENSITIVITY IN AIR

Normx dipole 1 (μV/(V/m)^2)	Normy dipole 2 (μV/(V/m)^2)	Normz dipole 3 (μV/(V/m)^2)
6.90	7.45	6.47

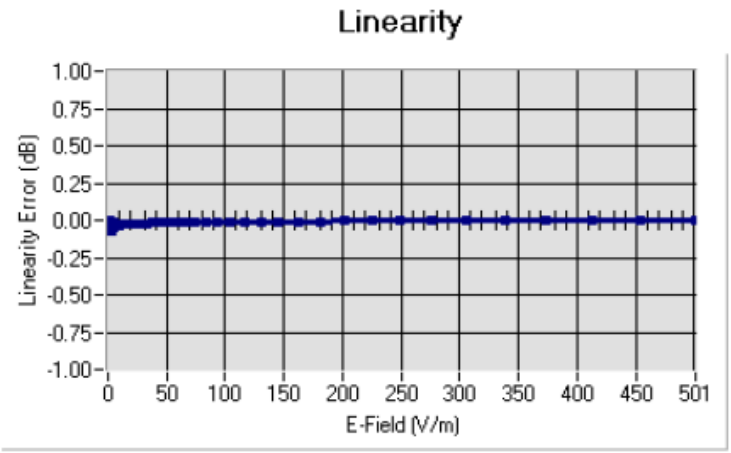
DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
98	94	95

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

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



5.2 LINEARITY



Linearity: +/-1.58% (+/-0.07dB)

5.3 SENSITIVITY IN LIQUID

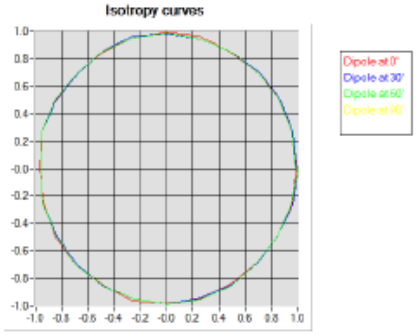
Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL450	450	42.17	0.87	5.33
BL450	450	57.65	0.94	5.51
HL750	750	40.03	0.93	4.74
BL750	750	56.83	1.00	4.93
HL850	835	42.19	0.90	5.50
BL850	835	54.67	1.01	5.65
HL900	900	42.08	1.01	4.93
BL900	900	55.25	1.08	5.04
HL1750	1750	41.46	1.48	4.53
BL1750	1750	53.61	1.47	4.87
HL1900	1900	38.45	1.45	4.85
BL1900	1900	53.32	1.56	5.01
HL2000	2000	38.26	1.38	4.68
BL2000	2000	52.70	1.51	4.80
HL2450	2450	37.50	1.80	4.58
BL2450	2450	53.22	1.89	4.70
HL2600	2600	39.80	1.99	4.36
BL2600	2600	52.52	2.23	4.50

LOWER DETECTION LIMIT: 8mW/kg

5.4 ISOTROPY

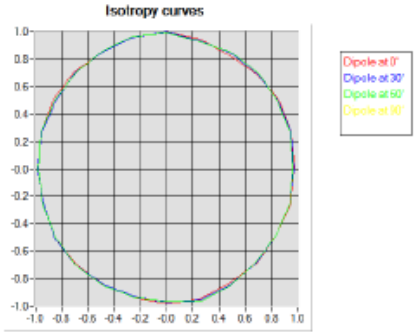
HL850 MHz

- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.07 dB



HL2450 MHz

- Axial isotropy: 0.07 dB
- Hemispherical isotropy: 0.06 dB



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	02/2015	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	02/2016	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	150798832	10/2016	10/2018

Dielectric Probe Calibration Report

Ref : ACR.156.11.15.SATU.A

SHENZHEN TONGCE TESTING Lab.

1B/F., Building 1, Yibaolai Industrial Park,

Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, China

MVG LIMESAR DIELECTRIC 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: 06/05/2015

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.156.11.15.SATU.A

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	06/05/2015	
Checked by :	Jérôme LUC	Product Manager	06/05/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	06/05/2015	

	Customer Name
Distribution :	Shenzhen Tongce Testing Lab

Issue	Date	Modifications
A	06/05/2015	Initial release

TABLE OF CONTENTS

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)	New

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*

4 MEASUREMENT METHOD

The IEEE 1528-2003, 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	√3	1	2.887%
Network analyser-drift, linearity	2.00%	R	√3	1	1.155%
Test-port cable variations	0.00%	U	√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	√3	1	1.732%
Network analyser-drift, linearity	2.00%	R	√3	1	1.155%
Test-port cable variations	0.00%	U	√2	1	0.000%
Combined standard uncertainty					4.072%
Expanded uncertainty (confidence level of 95%, k = 2)					8.1%

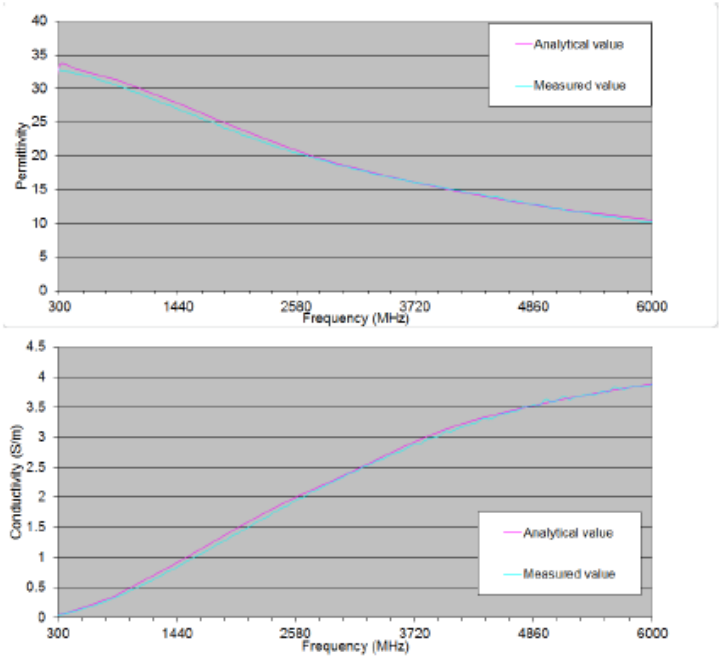
6 CALIBRATION MEASUREMENT RESULTS

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 ε'+jε") are compared with the well-known theoretical values for this liquid.



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	02/2015	02/2018
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	8/2015	8/2018

Appendix D: Dipole Calibration Report

SID 750

SAR Reference Dipole Calibration Report

Ref : ACR.156.3.15.SATU.A

SHENZHEN TONGCE TESTING Lab.

1B/F., Building 1, Yibaolai Industrial Park,

Qiaotou, Fuyong, Baoan District, Shenzhen, Guangdong, 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

ACCREDITED Calibration CERT #2246-02

Calibration Date: 06/05/2015

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	06/05/2015	
Checked by :	Jérôme LUC	Product Manager	06/05/2015	
Approved by :	Kim RUTKOWSKI	Quality Manager	06/05/2015	

	Customer Name
Distribution :	Shenzhen Tongce Testing Lab

Issue	Date	Modifications
A	06/05/2015	Initial release

TABLE OF CONTENTS

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)	New

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 constucted 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

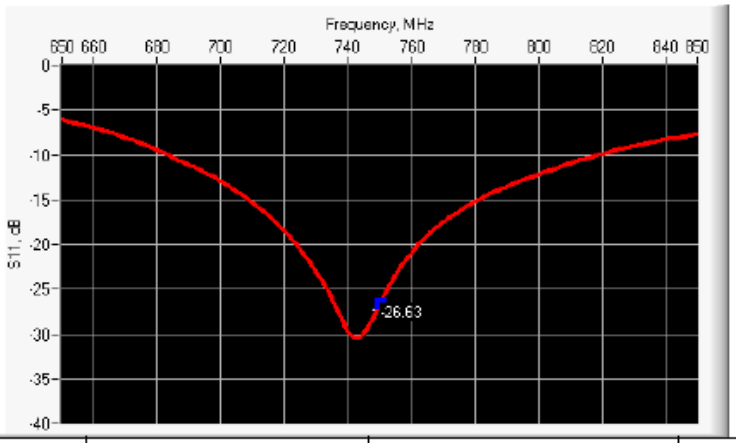
The guidelines outlined in the IEEE 1528, FCC KDBs, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	20.3 %

10 g	20.1 %

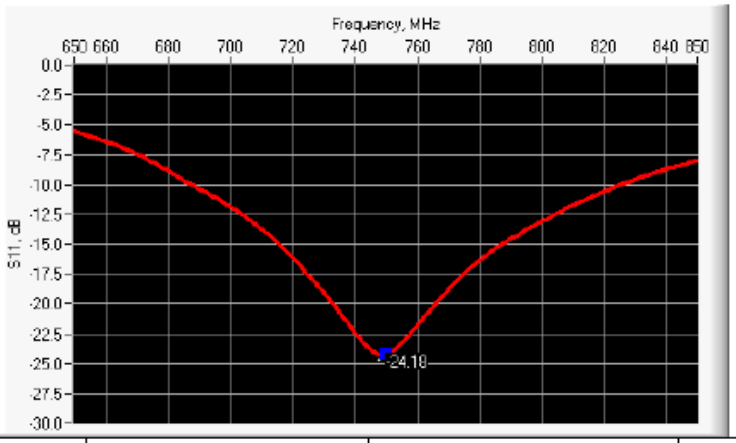
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-26.63	-20	54.4 Ω + 1.4 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-24.18	-20	52.2 Ω + 5.8 jΩ

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 %.	

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 %	