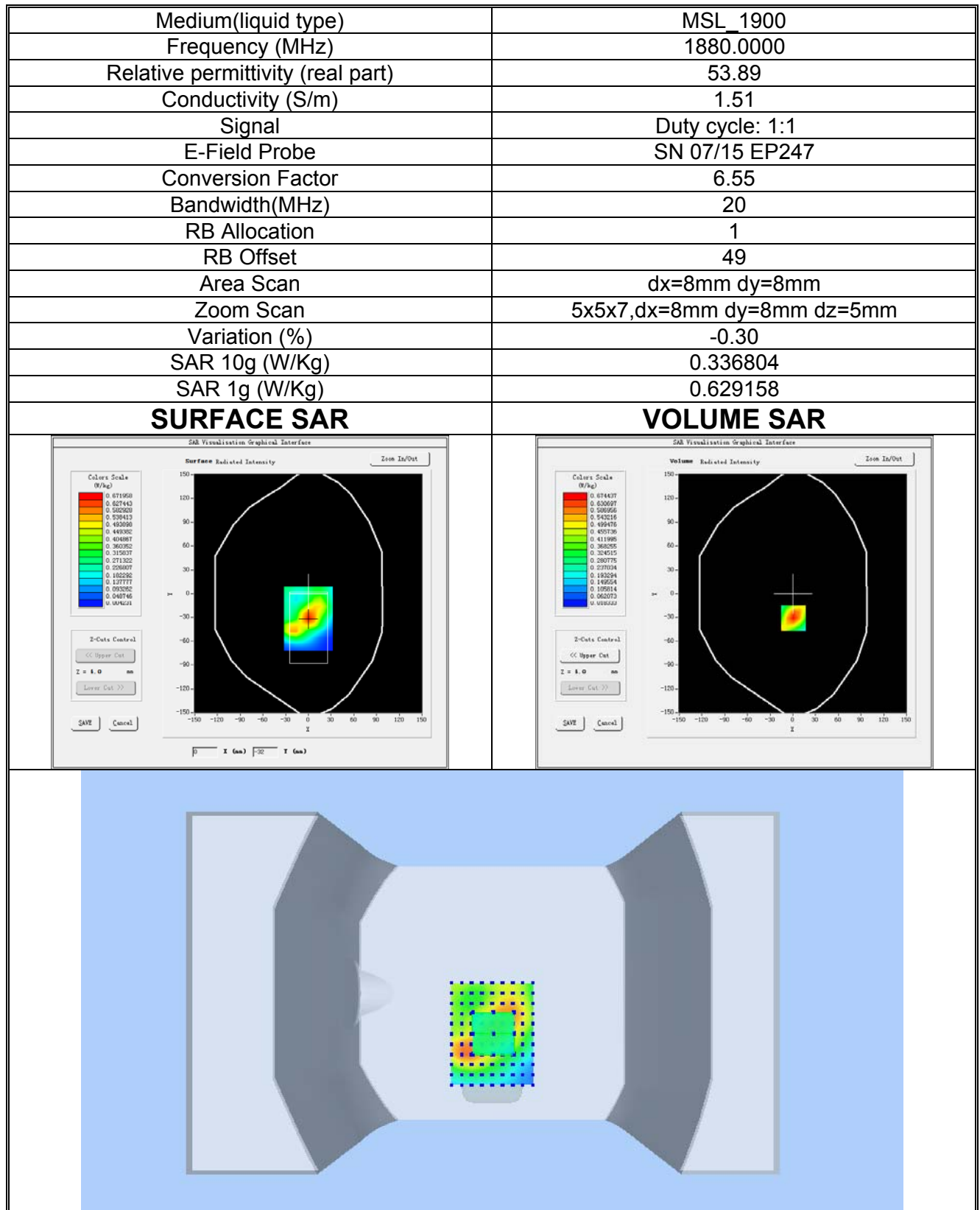
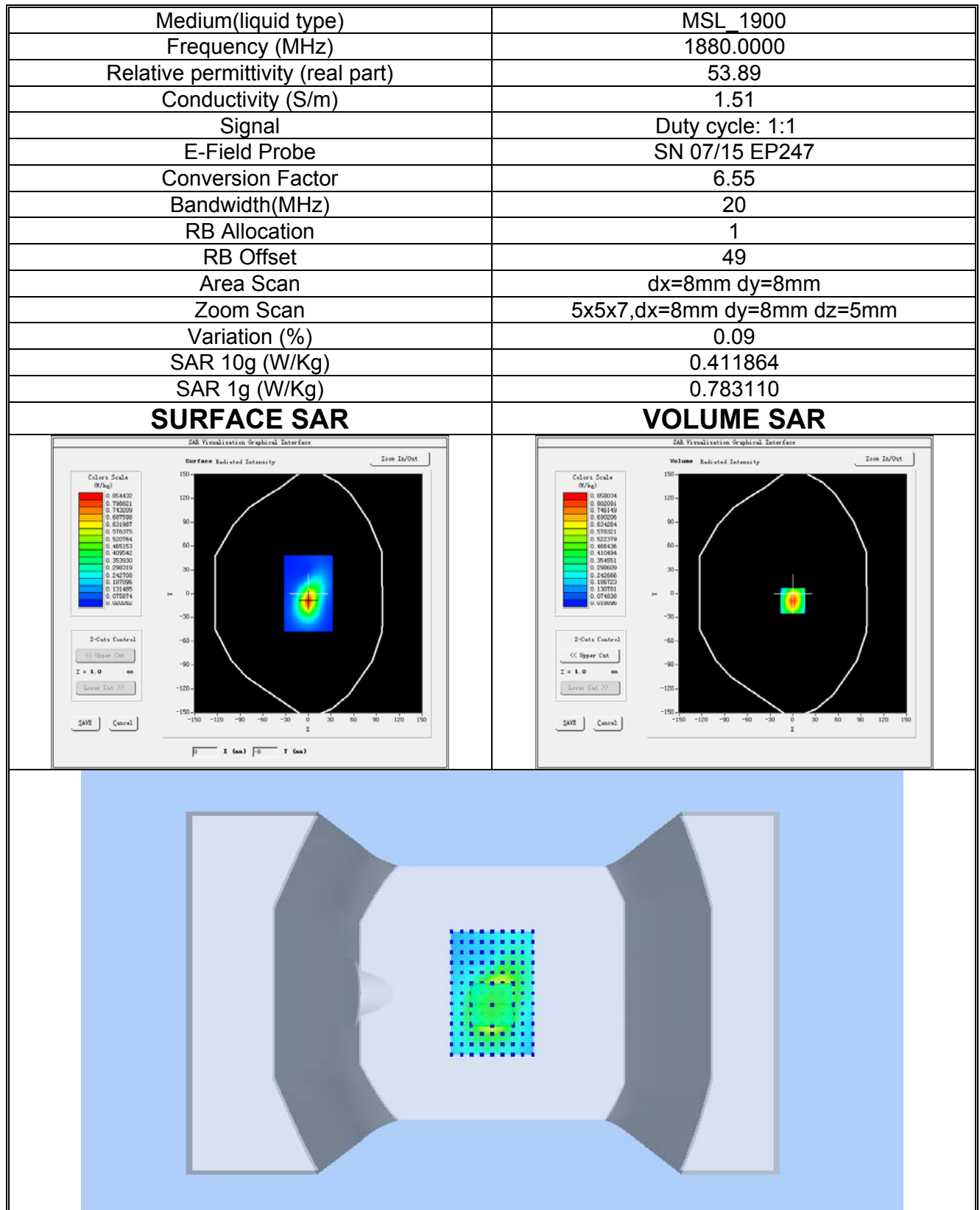
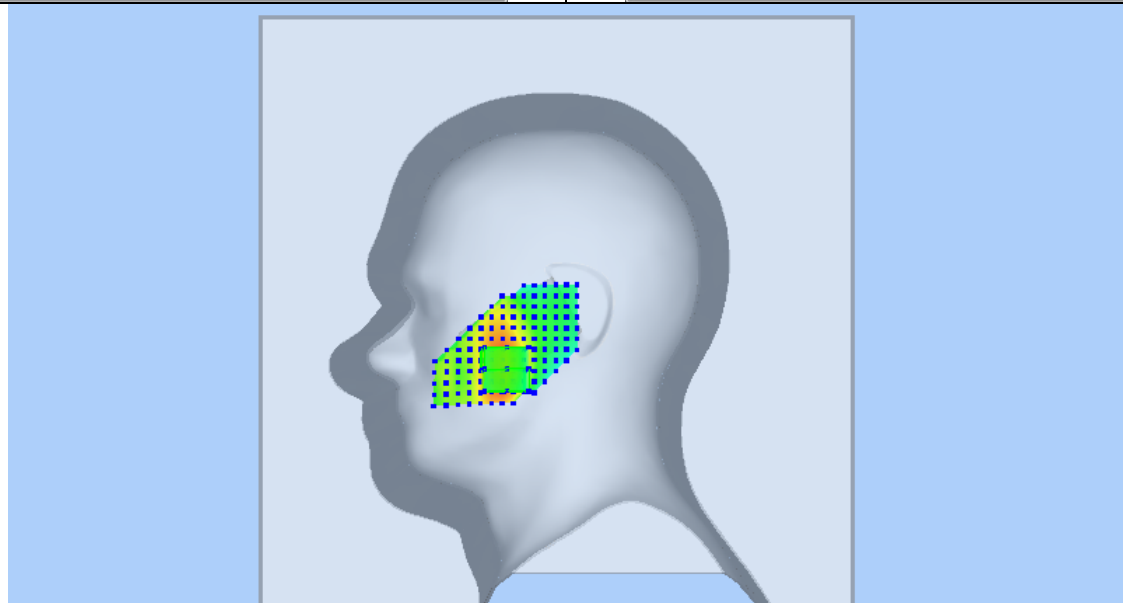
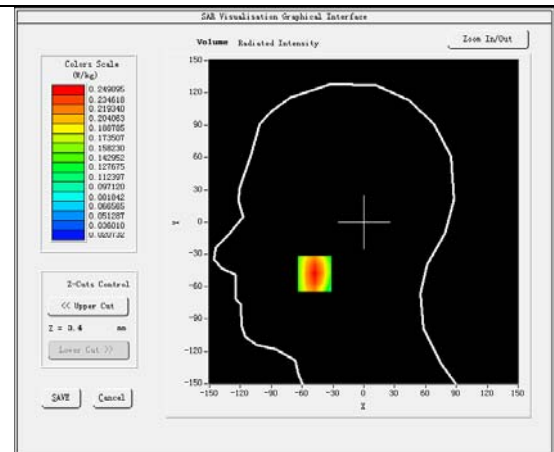
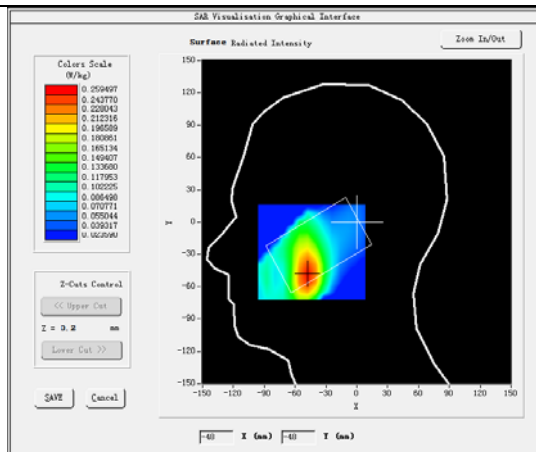


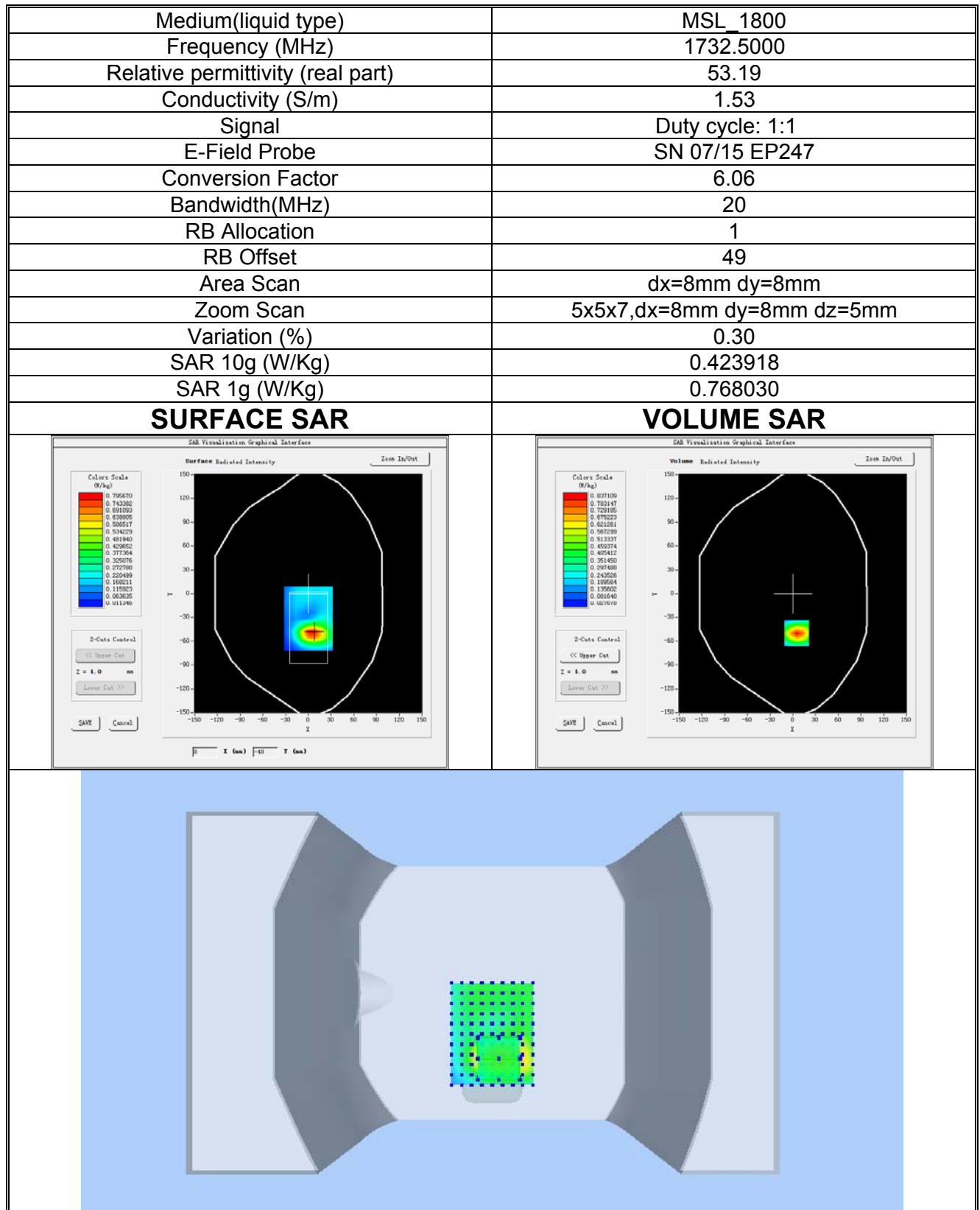
Plot 20:LTE BAND2, Middle channel (Body-worn, Back Surface)**Product Description:**Smart phone**Test Date:** 2019-01-23

Plot 21:LTE BAND2, Middle channel (Hotspot, Bottom edge)**Product Description:**Smart phone**Test Date:** 2019-01-23

Plot 22:LTE BAND4, Middle channel (Right Head Cheek)**Product Description:**Smart phone**Test Date:** 2019-01-21

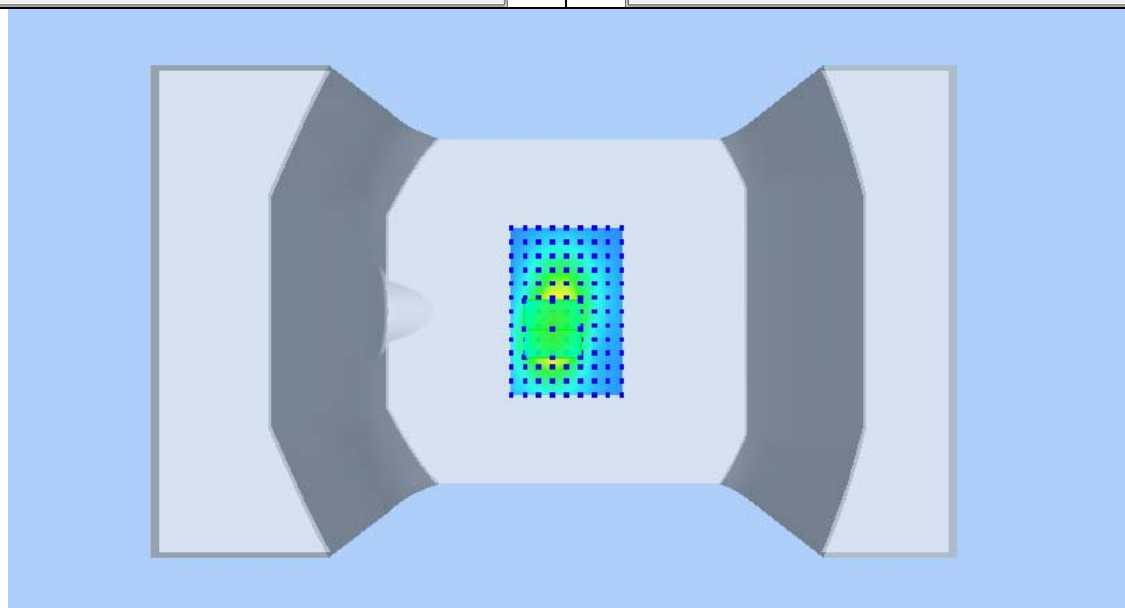
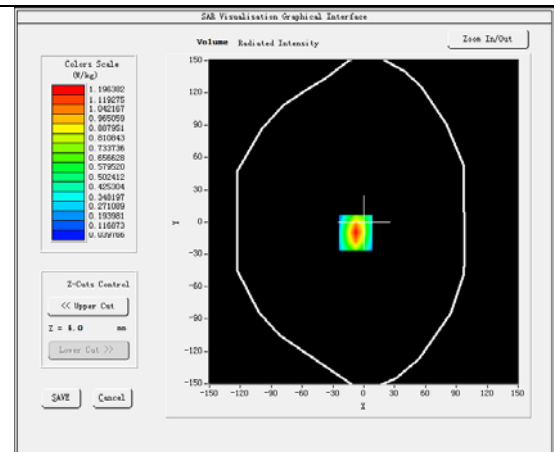
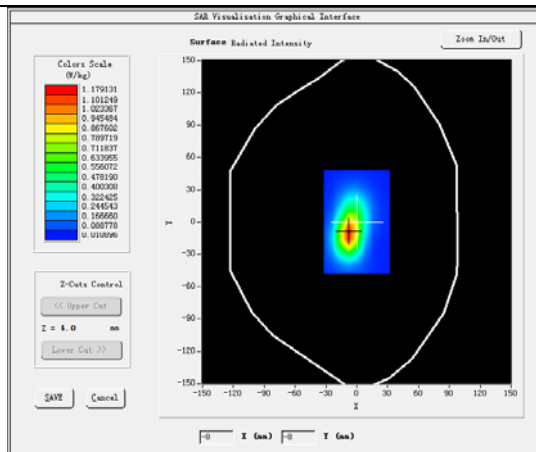
Medium(liquid type)	HSL_1800
Frequency (MHz)	1732.5000
Relative permittivity (real part)	41.49
Conductivity (S/m)	1.38
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	5.84
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	49
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-2.16
SAR 10g (W/Kg)	0.153613
SAR 1g (W/Kg)	0.236579
SURFACE SAR	VOLUME SAR



Plot 23:LTE BAND4, Middle channel (Body-worn, Back Surface)**Product Description:**Smart phone**Test Date:** 2019-01-21

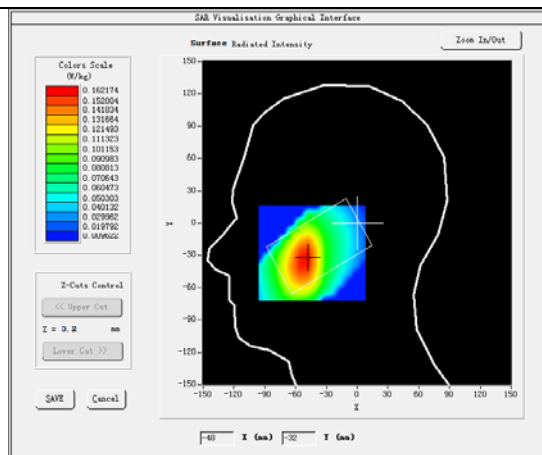
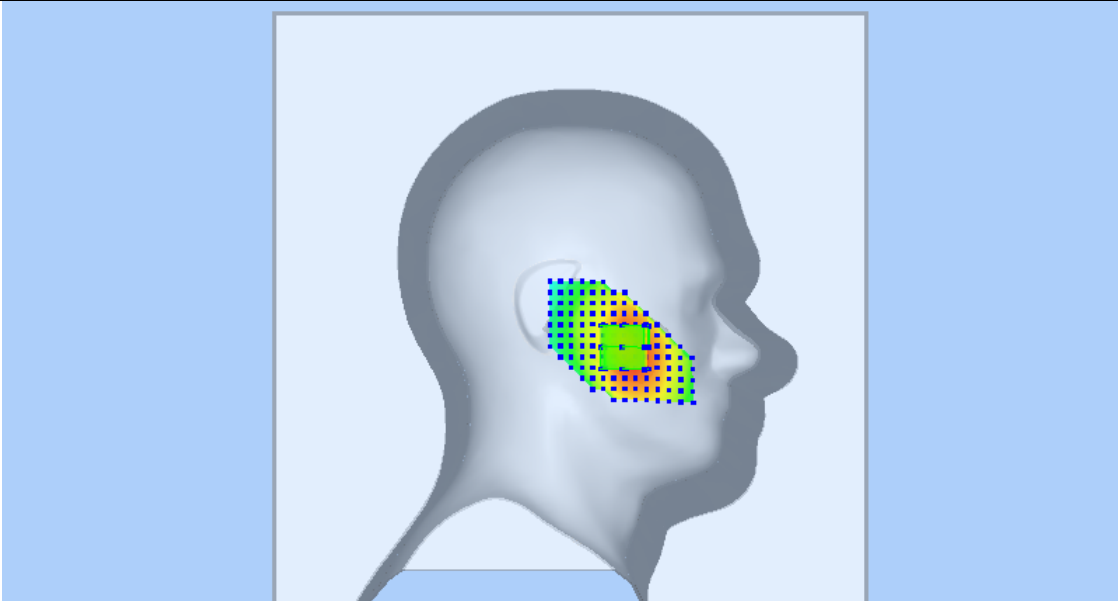
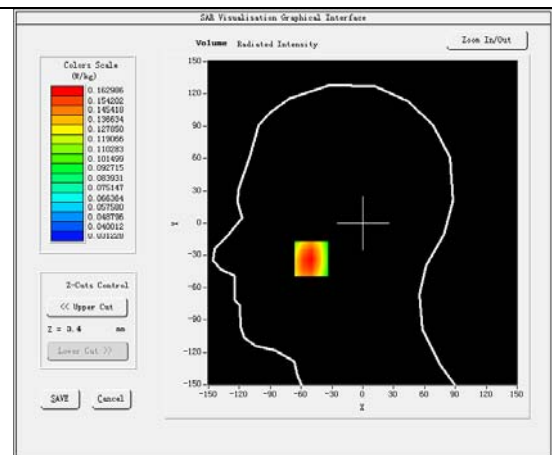
Plot 24:LTE BAND4, Low channel (Hotspot, Bottom edge)**Product Description:**Smart phone**Test Date:** 2019-01-21

Medium(liquid type)	MSL_1800
Frequency (MHz)	1720.0000
Relative permittivity (real part)	53.19
Conductivity (S/m)	1.53
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	6.06
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	49
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.03
SAR 10g (W/Kg)	0.580935
SAR 1g (W/Kg)	1.088623
SURFACE SAR	VOLUME SAR



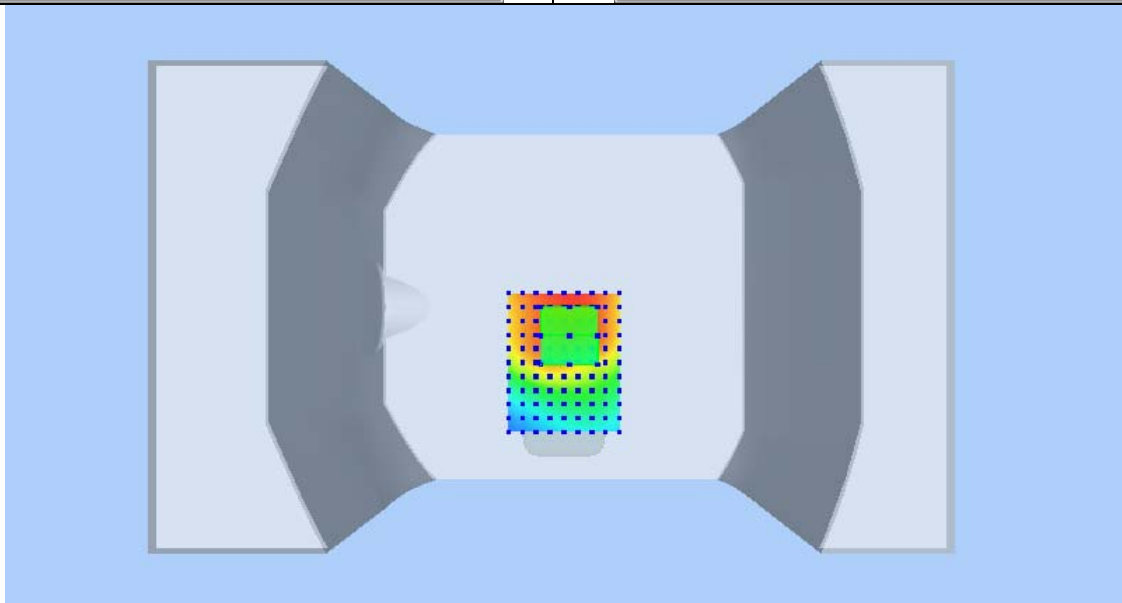
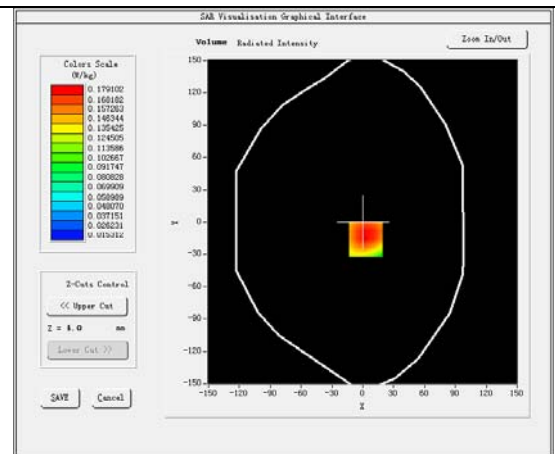
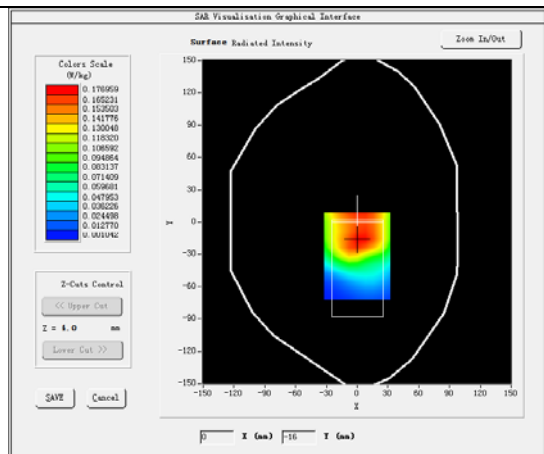
Plot 25: LTE BAND5, Middle channel (Left Head Cheek)**Product Description: Smart Phone****Test Date: 2019-01-07**

Medium(liquid type)	HSL_850
Frequency (MHz)	829.0000
Relative permittivity (real part)	41.15
Conductivity (S/m)	0.92
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	6.93
Bandwidth(MHz)	10
RB Allocation	1
RB Offset	49
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.39
SAR 10g (W/Kg)	0.109323
SAR 1g (W/Kg)	0.156763

SURFACE SAR**VOLUME SAR**

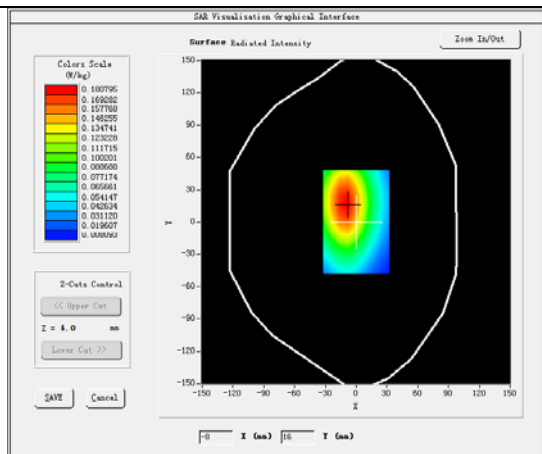
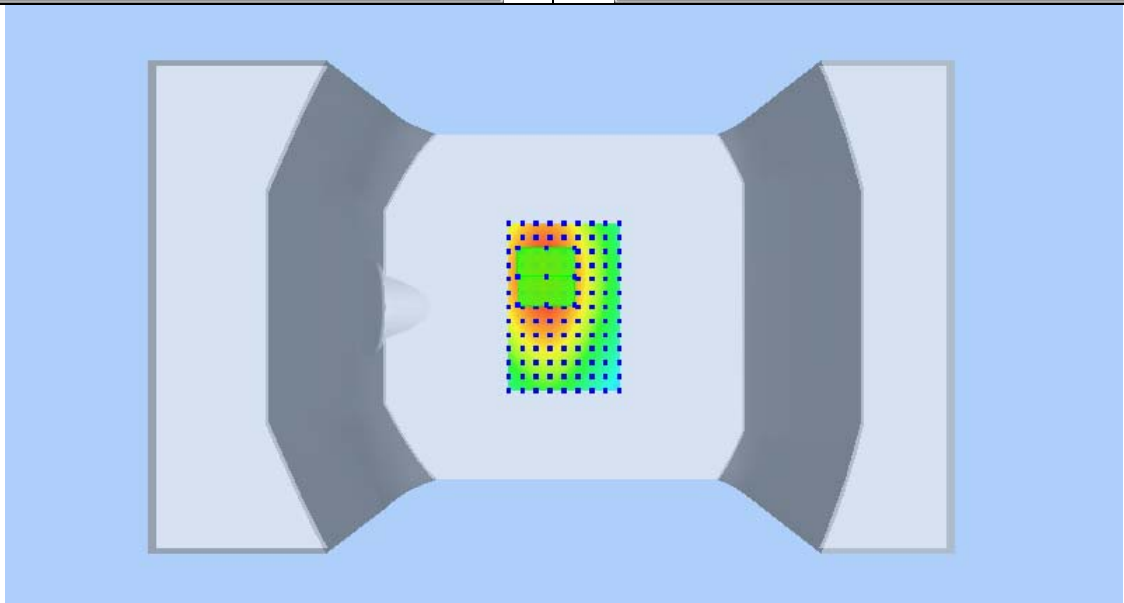
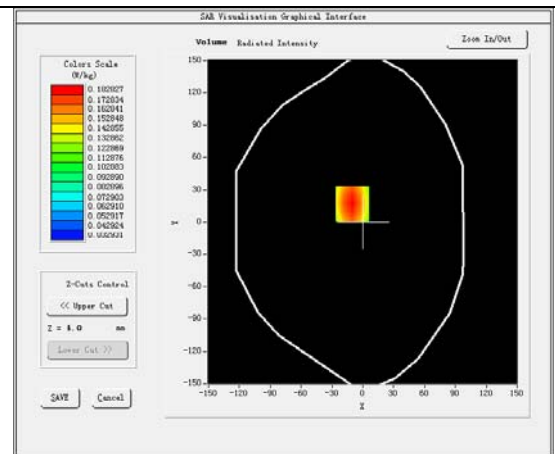
Plot 26: LTE BAND5, Middle channel (Body-worn, Back Surface)**Product Description: Smart Phone****Test Date: 2019-01-07**

Medium(liquid type)	MSL_850
Frequency (MHz)	829.0000
Relative permittivity (real part)	55.03
Conductivity (S/m)	0.99
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	7.13
Bandwidth(MHz)	10
RB Allocation	1
RB Offset	49
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.13
SAR 10g (W/Kg)	0.111973
SAR 1g (W/Kg)	0.173931
SURFACE SAR	VOLUME SAR



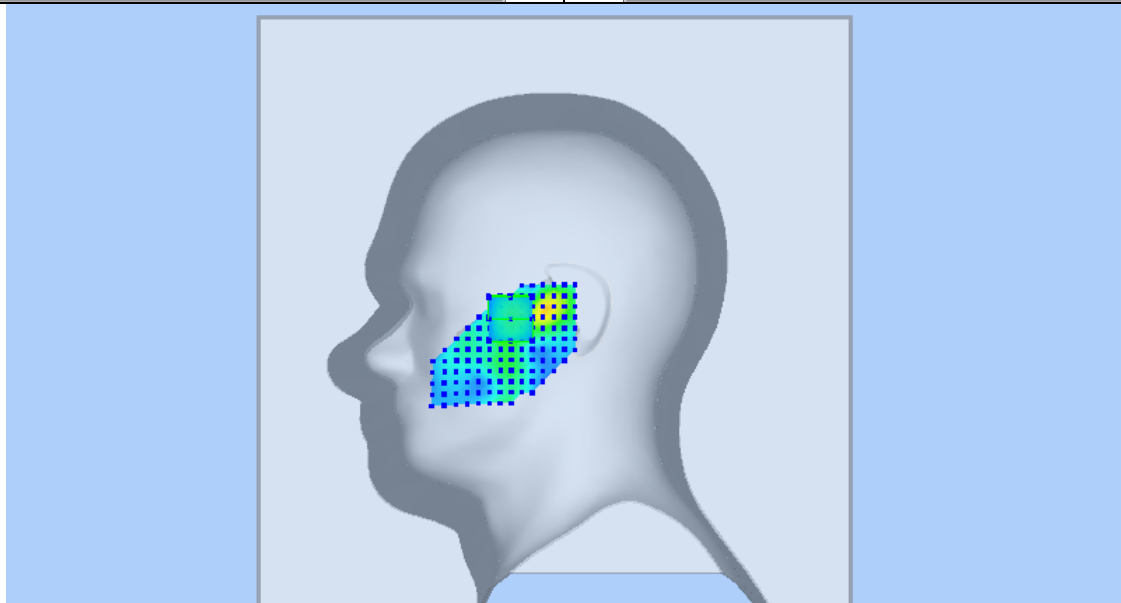
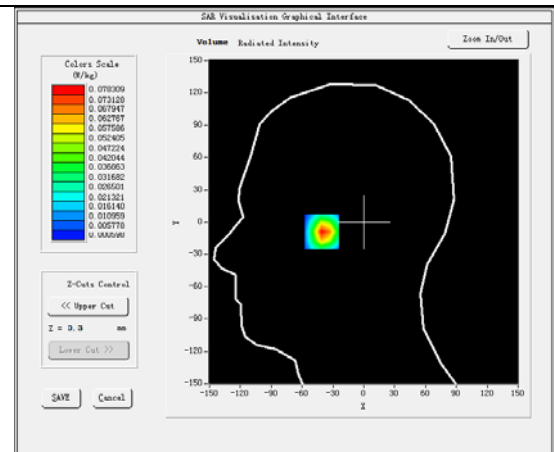
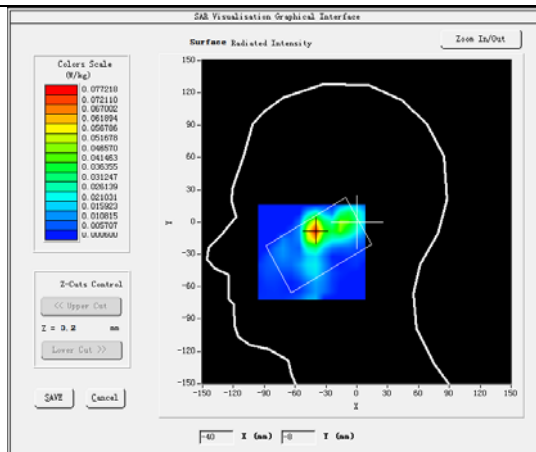
Plot 27: LTE BAND5, Middle channel (Hotspot, Left edge)**Product Description: Smart Phone****Test Date: 2019-01-07**

Medium(liquid type)	MSL_850
Frequency (MHz)	829.0000
Relative permittivity (real part)	55.03
Conductivity (S/m)	0.99
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	7.13
Bandwidth(MHz)	10
RB Allocation	1
RB Offset	49
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	0.10
SAR 10g (W/Kg)	0.117069
SAR 1g (W/Kg)	0.174761

SURFACE SAR**VOLUME SAR**

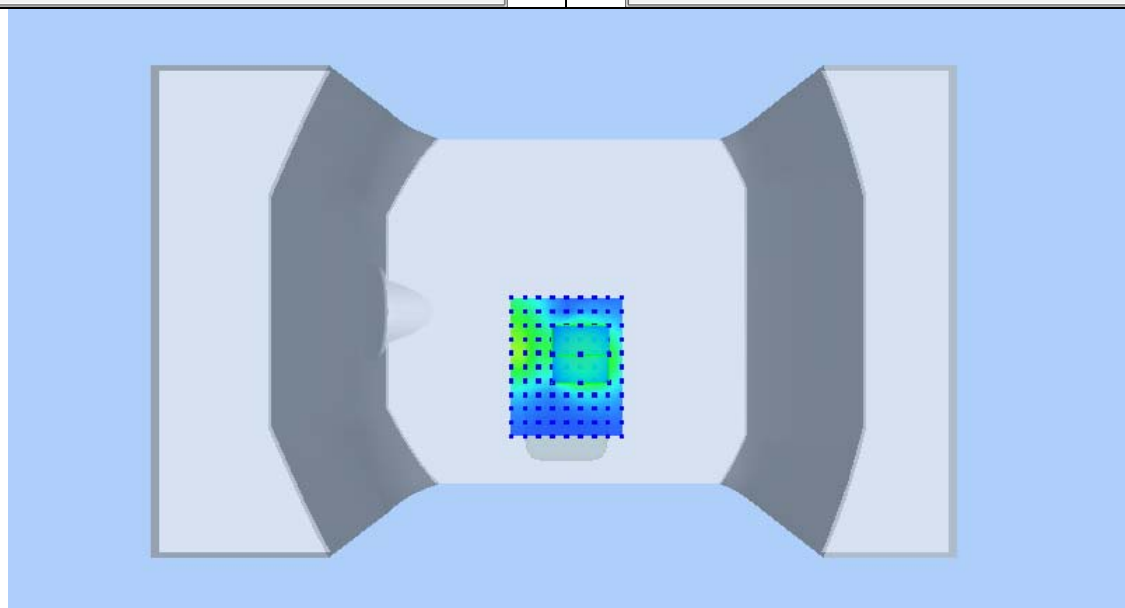
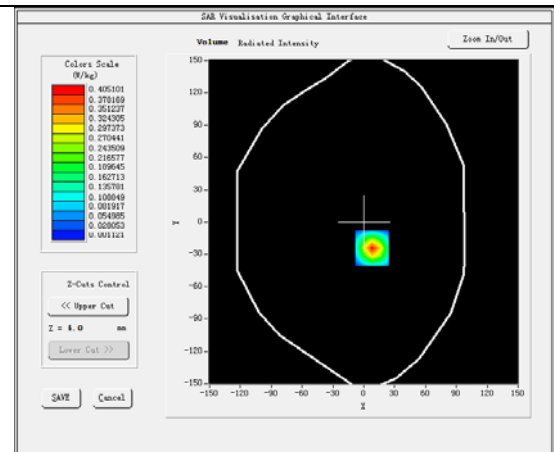
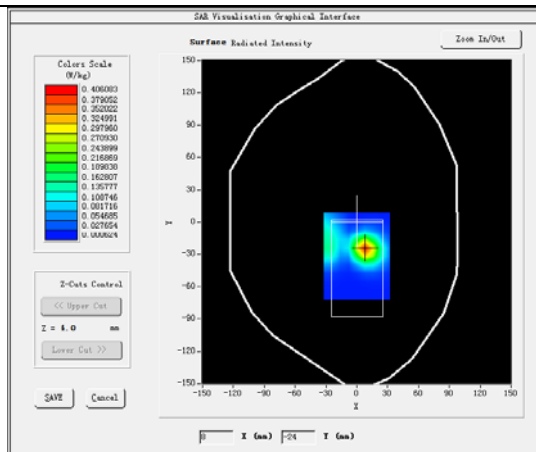
Plot 28:LTE BAND7, Middle channel (Right Head Cheek)**Product Description:**Smart phone**Test Date:** 2019-01-09

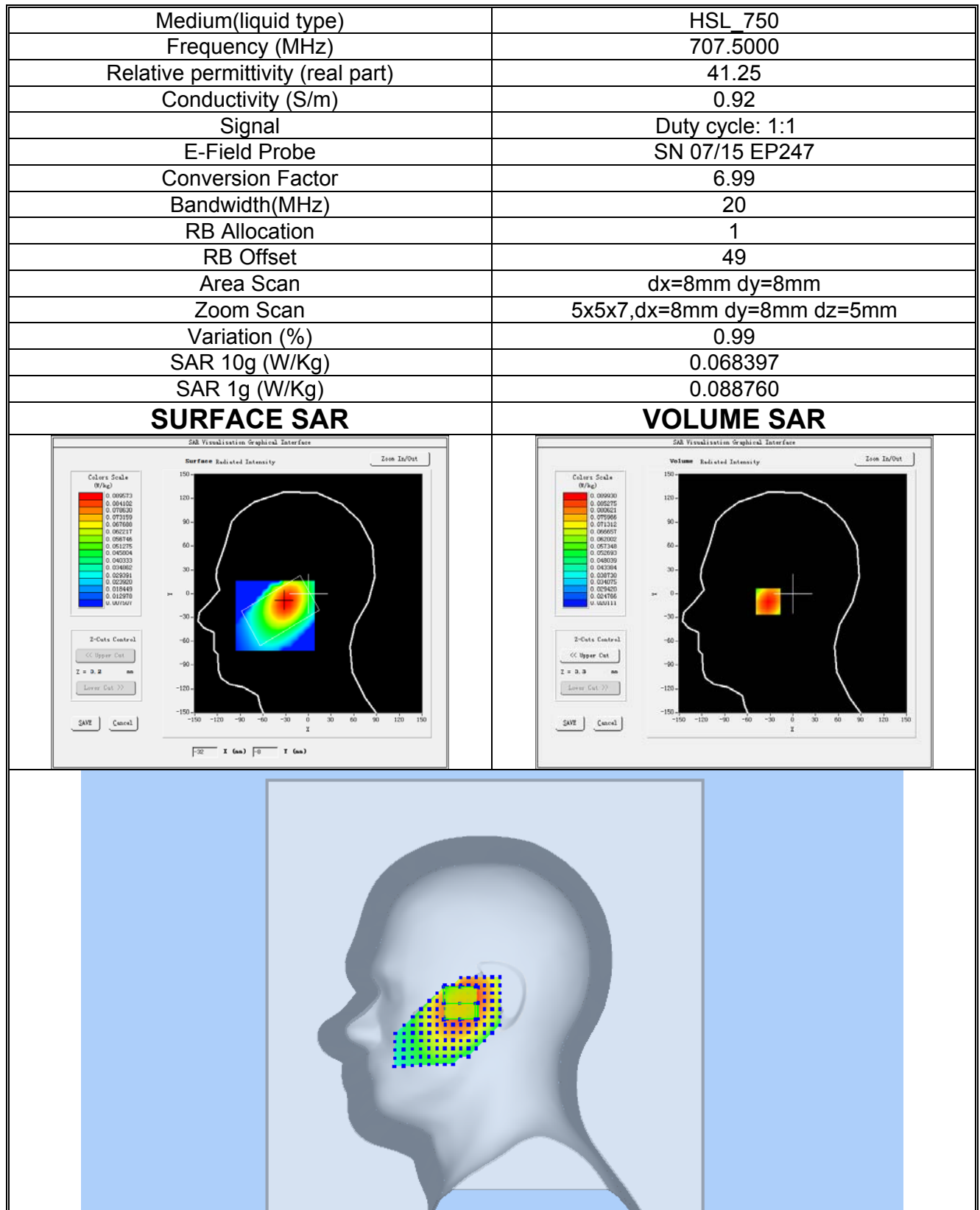
Medium(liquid type)	HSL_2600
Frequency (MHz)	2535.0000
Relative permittivity (real part)	39.59
Conductivity (S/m)	1.97
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	5.37
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	49
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-1.11
SAR 10g (W/Kg)	0.032290
SAR 1g (W/Kg)	0.072208
SURFACE SAR	VOLUME SAR

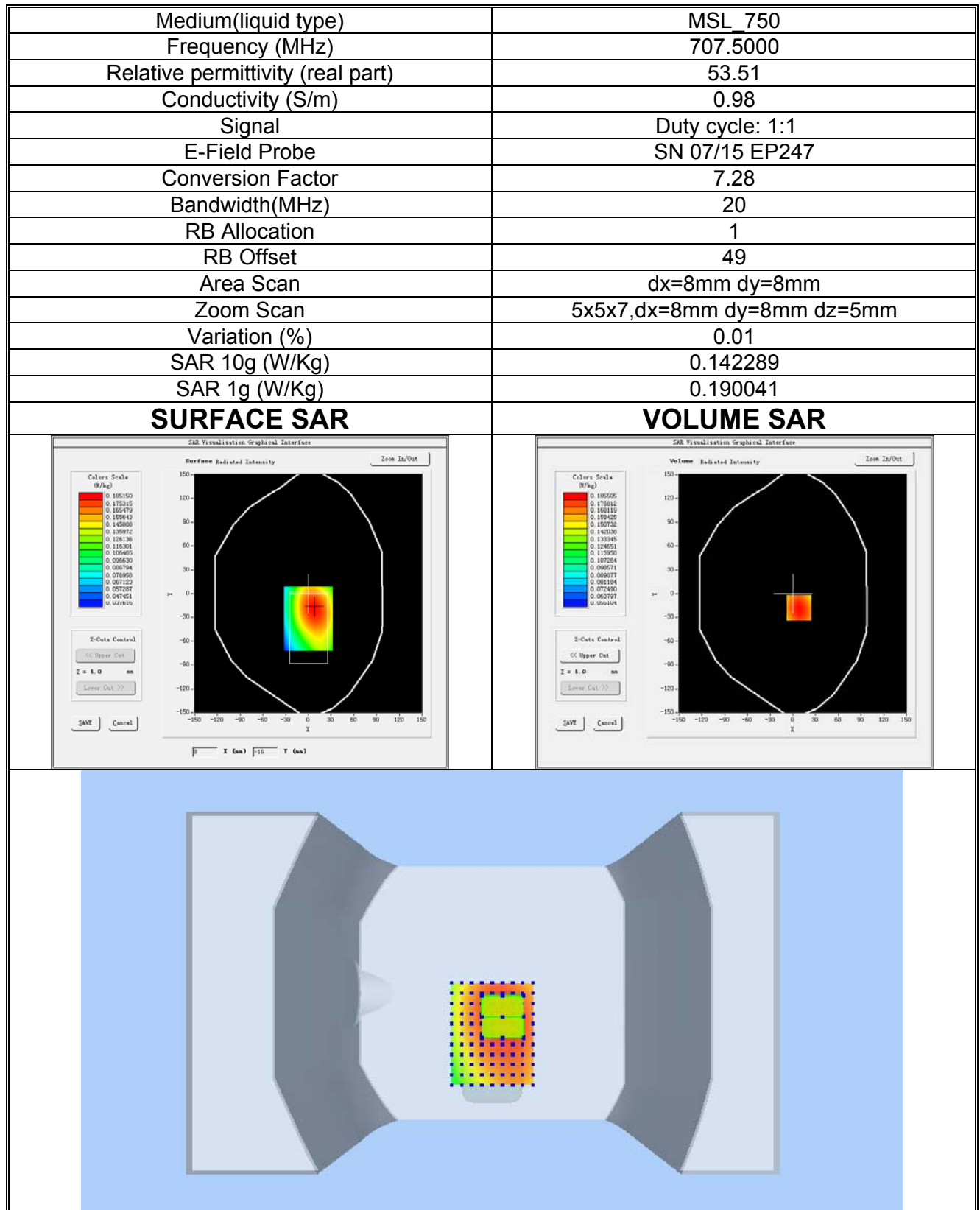


Plot 29:LTE BAND7, Middle channel (Body-worn/Hotspot, Back Surface)**Product Description:**Smart phone**Test Date:** 2019-01-09

Medium(liquid type)	MSL_2600
Frequency (MHz)	2535.0000
Relative permittivity (real part)	52.48
Conductivity (S/m)	2.17
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	5.58
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	49
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	2.89
SAR 10g (W/Kg)	0.156390
SAR 1g (W/Kg)	0.363477
SURFACE SAR	VOLUME SAR

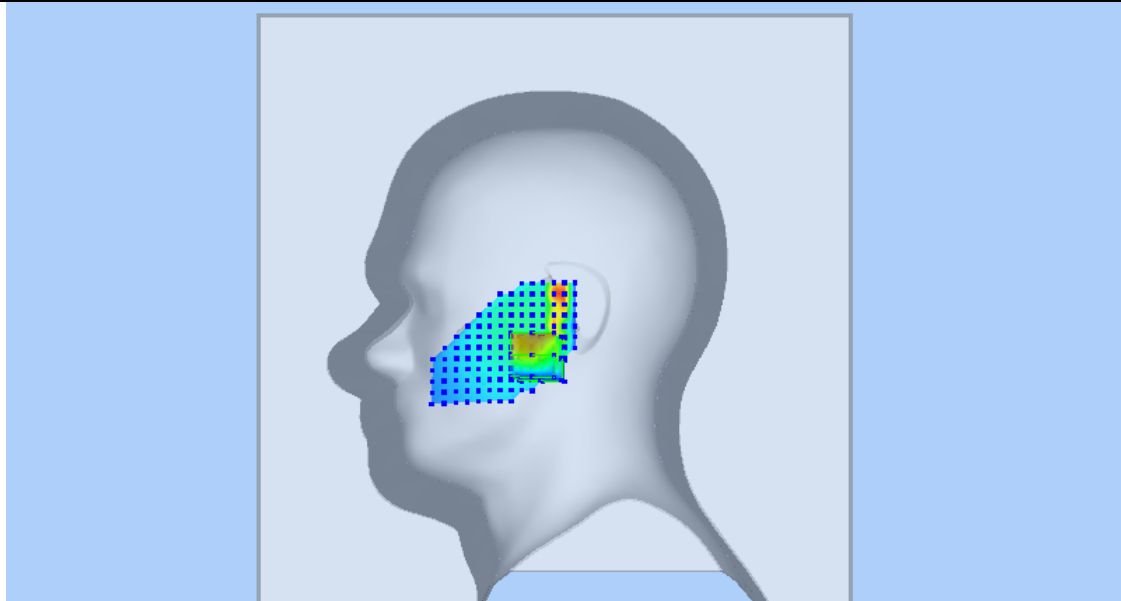
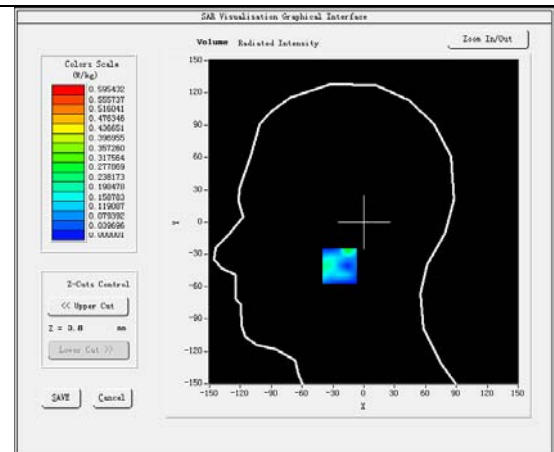
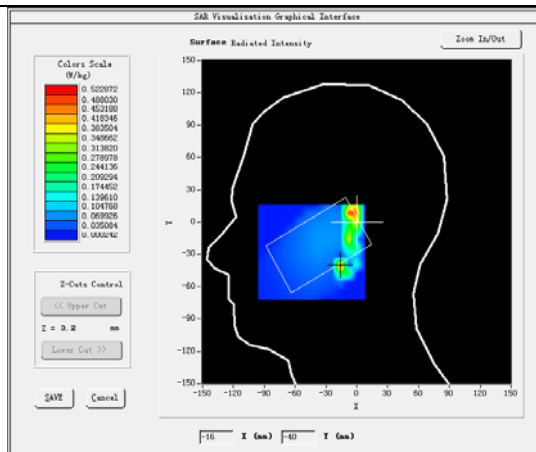


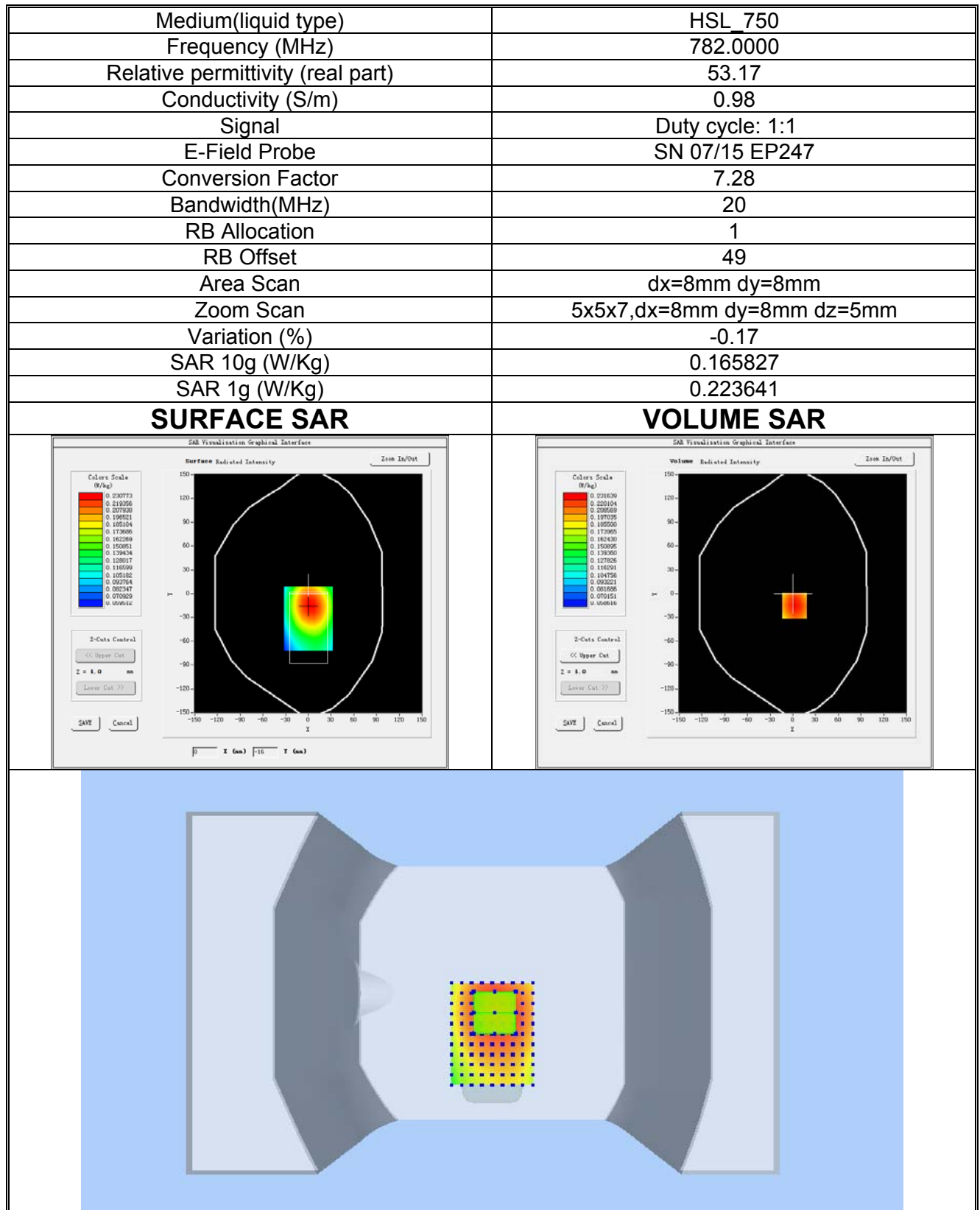
Plot 30:LTE BAND12, Middle channel (Right Head Tilt)**Product Description:**Smart phone**Test Date:** 2019-01-17

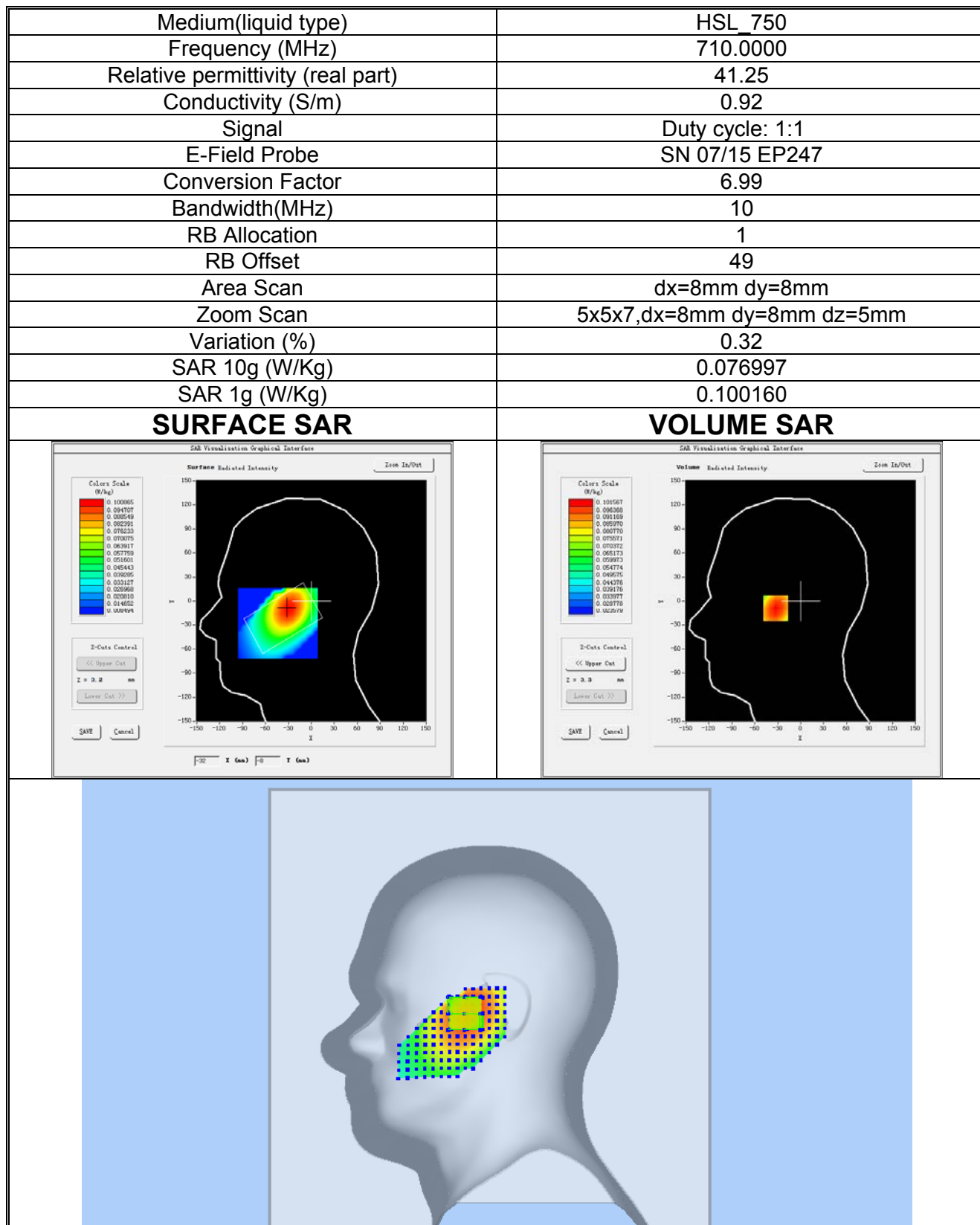
Plot 31:LTE BAND12, Middle channel (Body-worn/Hotspot, Back Surface)**Product Description:**Smart phone**Test Date:** 2019-01-07

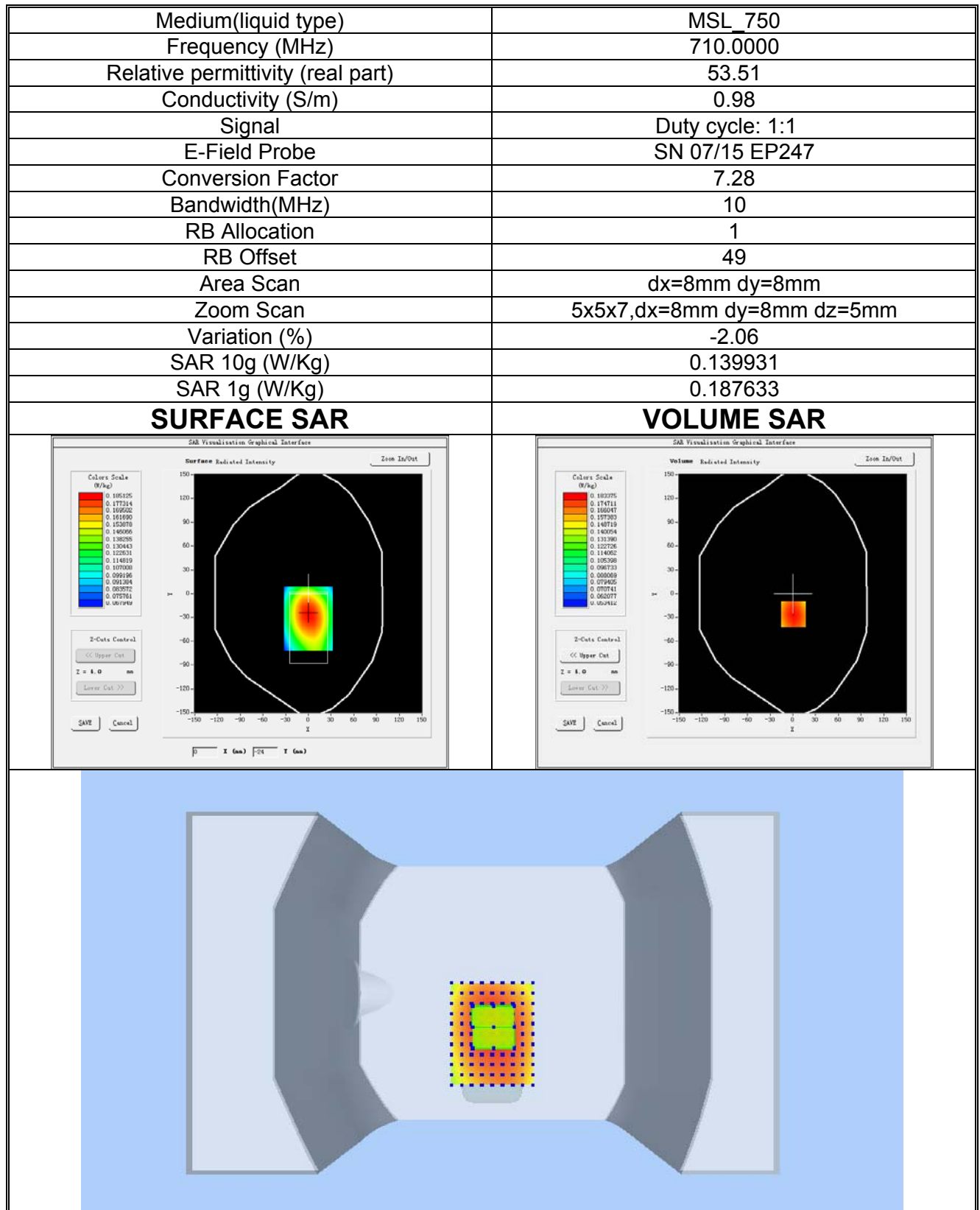
Plot 32:LTE BAND13, Middle channel (Right Head Tilt)**Product Description:**Smart phone**Test Date:** 2019-01-17

Medium(liquid type)	HSL_750
Frequency (MHz)	782.0000
Relative permittivity (real part)	41.25
Conductivity (S/m)	0.92
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	6.99
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	49
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	4.75
SAR 10g (W/Kg)	0.139005
SAR 1g (W/Kg)	0.189576
SURFACE SAR	VOLUME SAR



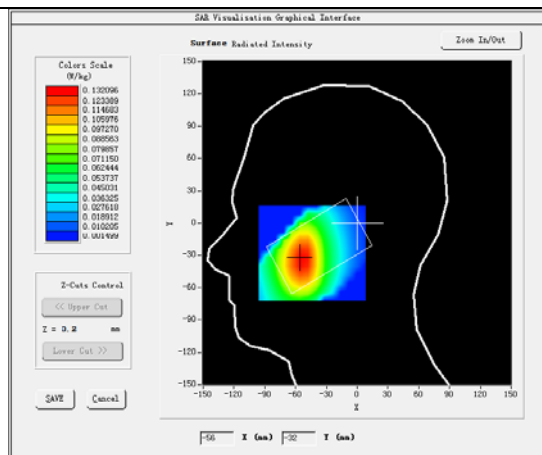
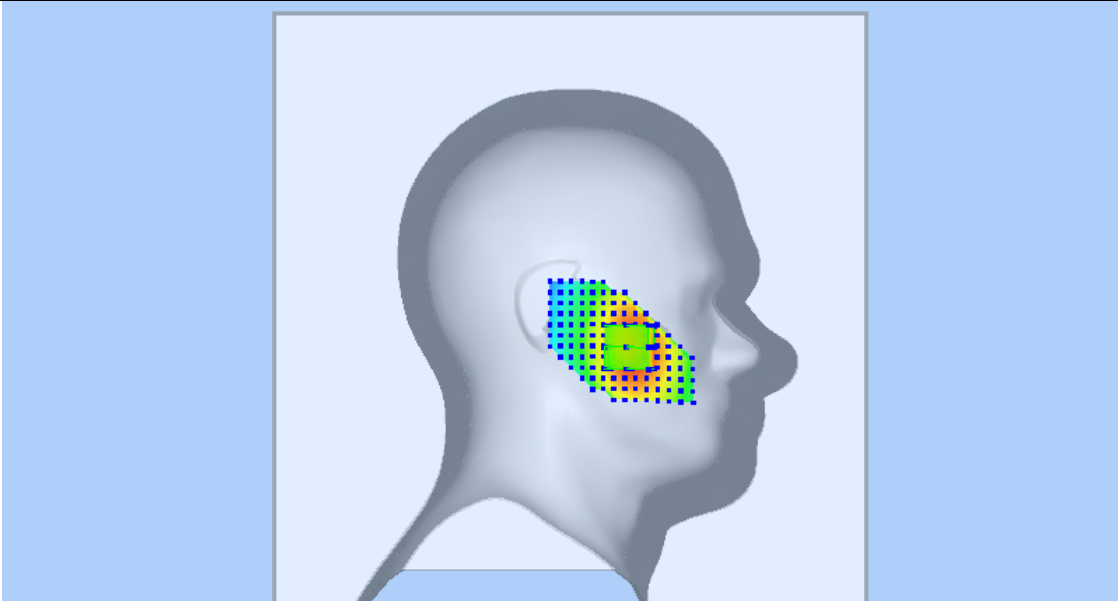
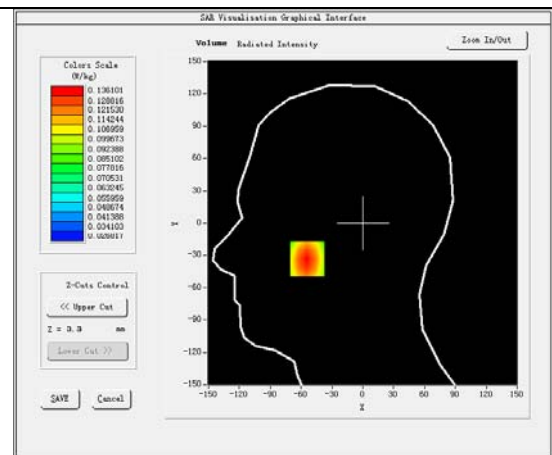
Plot 33:LTE BAND13, Middle channel (Body-worn/Hotspot, Back Surface)**Product Description:**Smart phone**Test Date:** 2019-01-07

Plot 34:LTE BAND17, Middle channel (Right Head Tilt)**Product Description:**Smart phone**Test Date:** 2019-01-17

Plot 35:LTE BAND17, Middle channel (Body-worn/Hotspot, Back Surface)**Product Description:**Smart phone**Test Date:** 2019-01-17

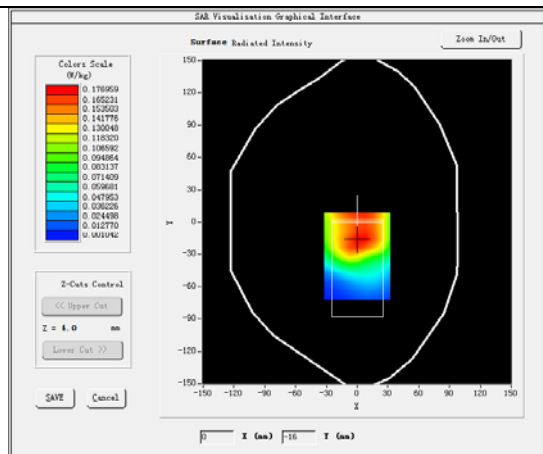
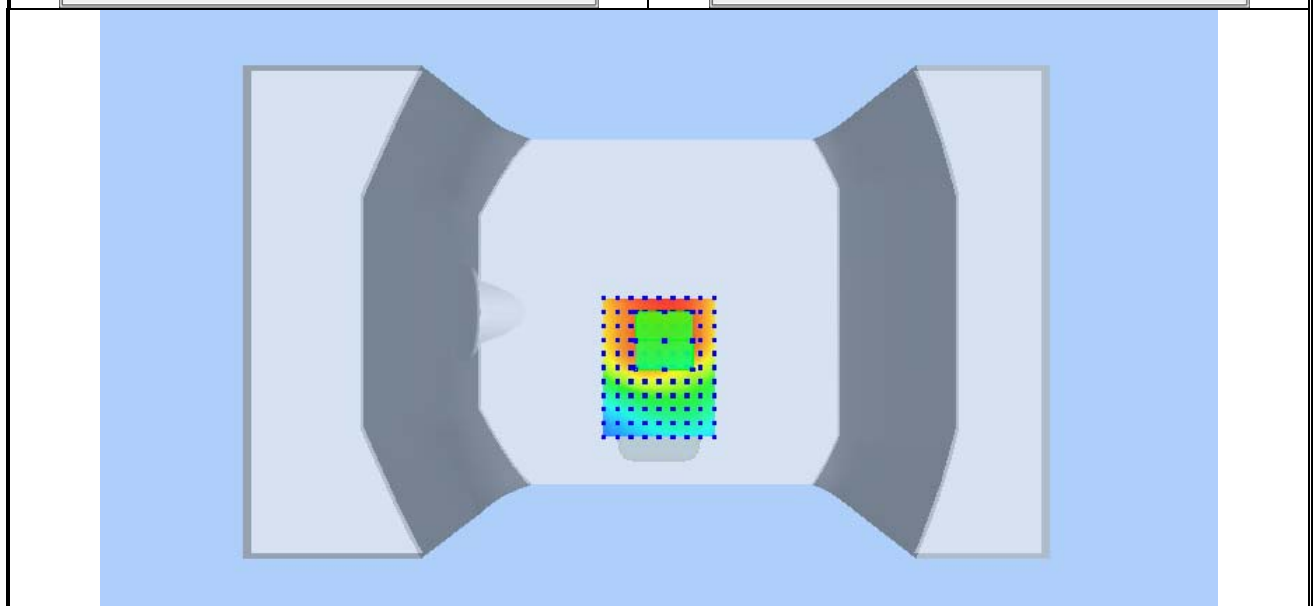
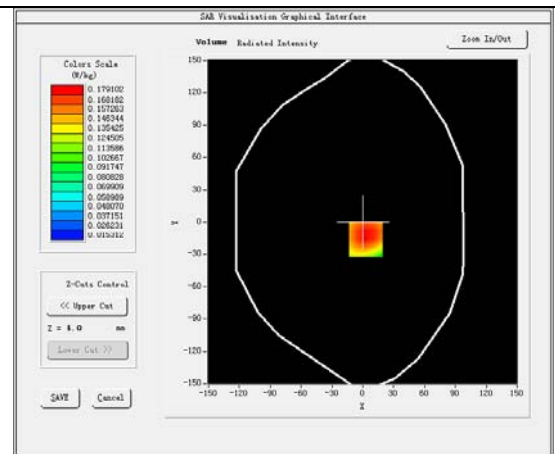
Plot 36: LTE BAND26, Middle channel (Left Head Cheek)**Product Description: Smart Phone****Test Date: 2019-01-07**

Medium(liquid type)	HSL_850
Frequency (MHz)	836.5000
Relative permittivity (real part)	41.15
Conductivity (S/m)	0.92
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	6.93
Bandwidth(MHz)	10
RB Allocation	1
RB Offset	49
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-1.09
SAR 10g (W/Kg)	0.092002
SAR 1g (W/Kg)	0.130505

SURFACE SAR**VOLUME SAR**

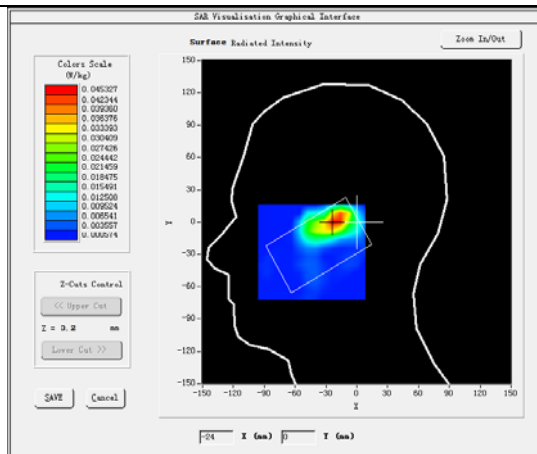
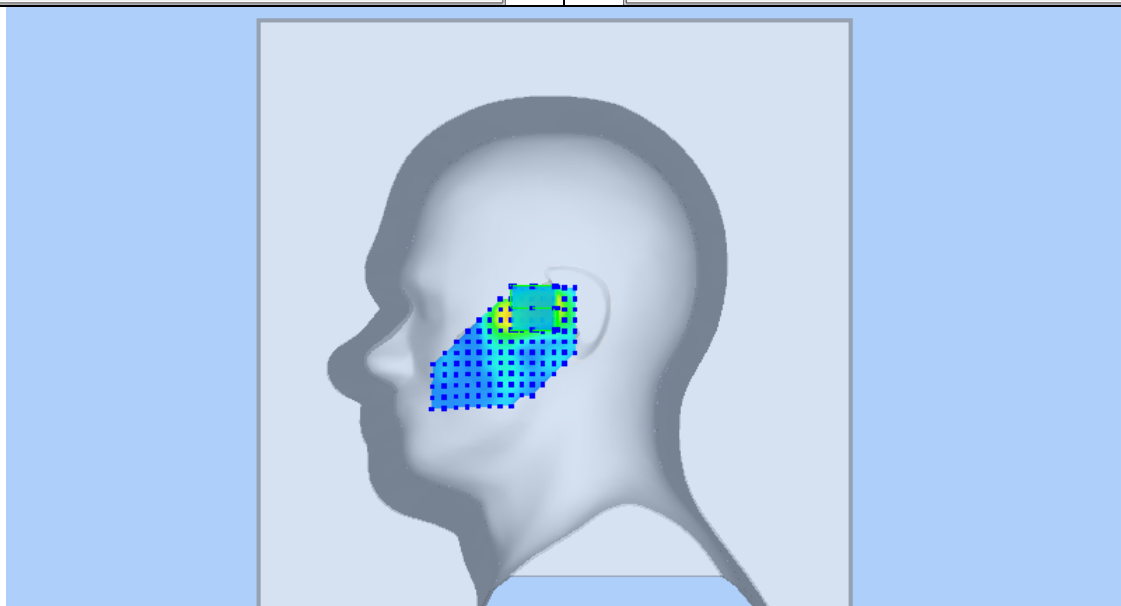
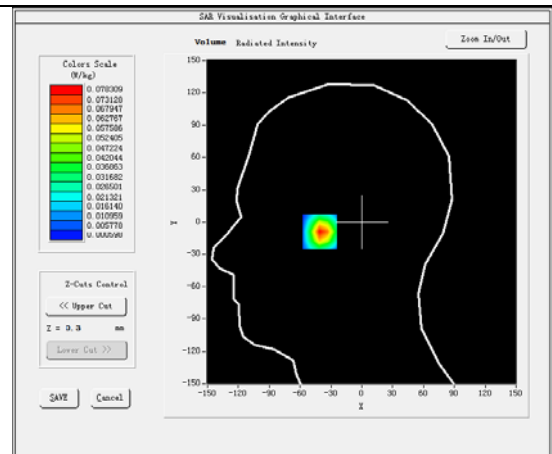
Plot 37: LTE BAND26, Middle channel (Body-worn, Back Surface)**Product Description: Smart Phone****Test Date: 2019-01-07**

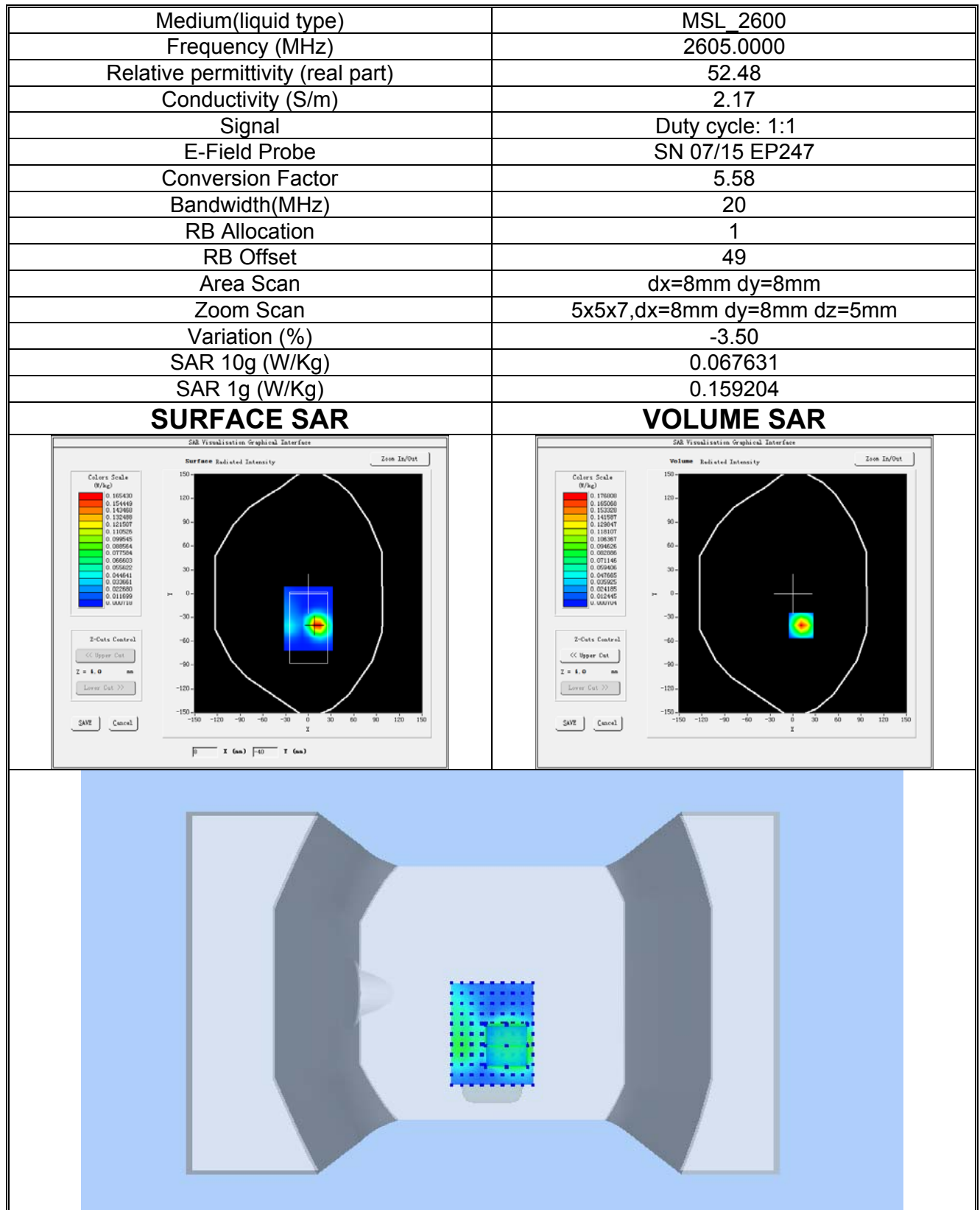
Medium(liquid type)	MSL_850
Frequency (MHz)	836.5000
Relative permittivity (real part)	55.03
Conductivity (S/m)	0.99
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	7.13
Bandwidth(MHz)	10
RB Allocation	1
RB Offset	49
Sensor-Surface	4mm
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.13
SAR 10g (W/Kg)	0.111973
SAR 1g (W/Kg)	0.173931

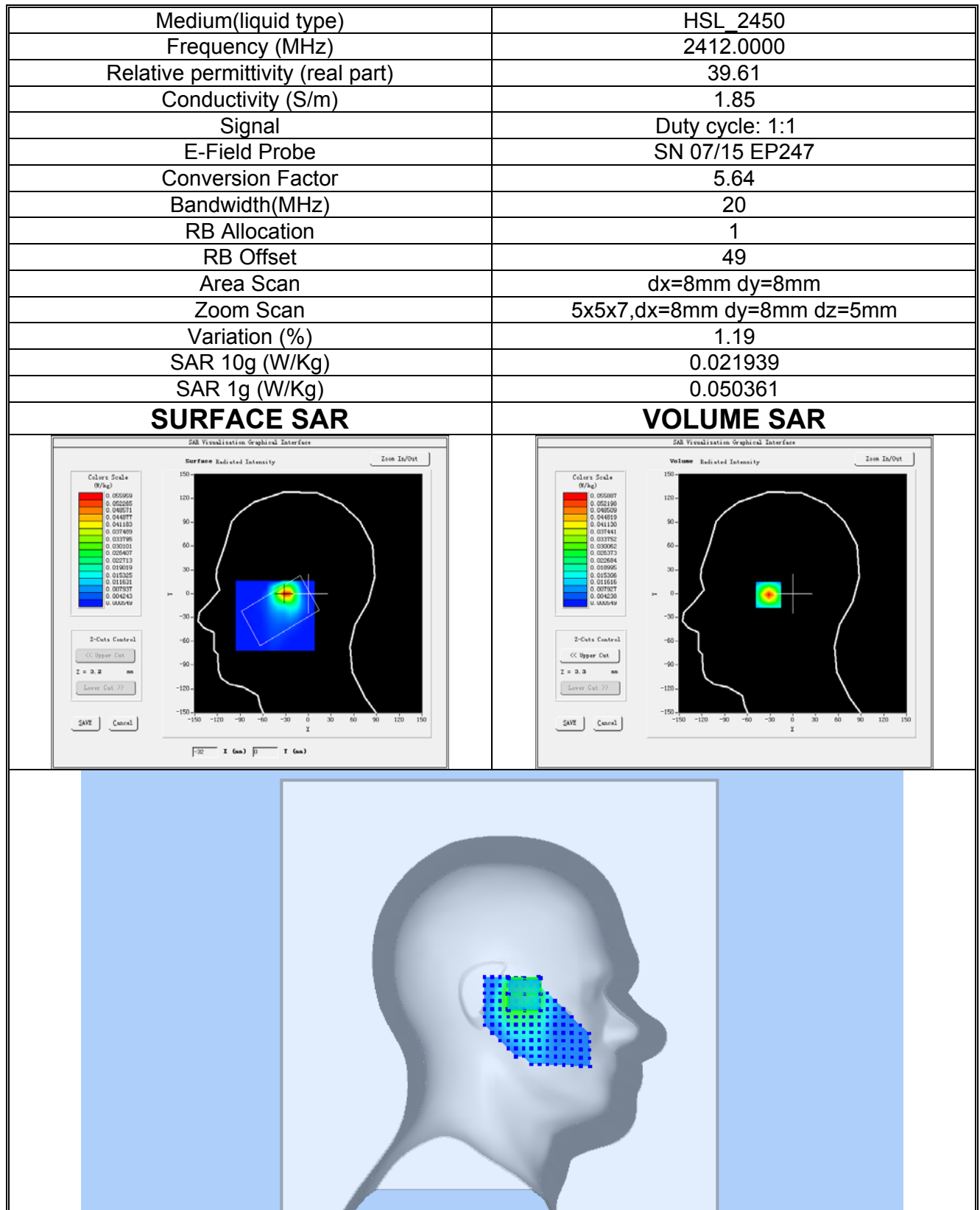
SURFACE SAR**VOLUME SAR**

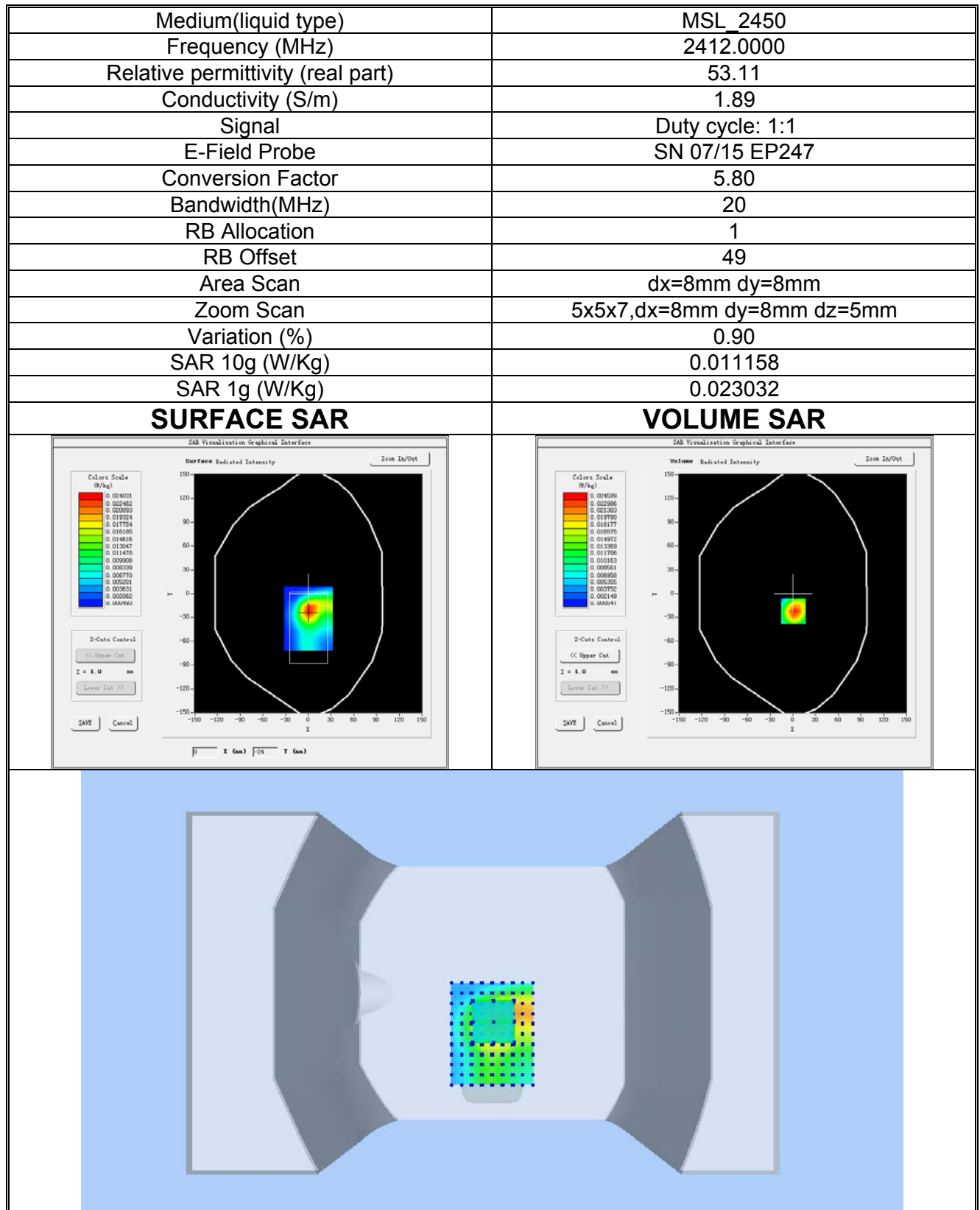
Plot 38:LTE BAND41, Middle channel (Right Head Tilt)**Product Description:**Smart phone**Test Date:** 2019-01-09

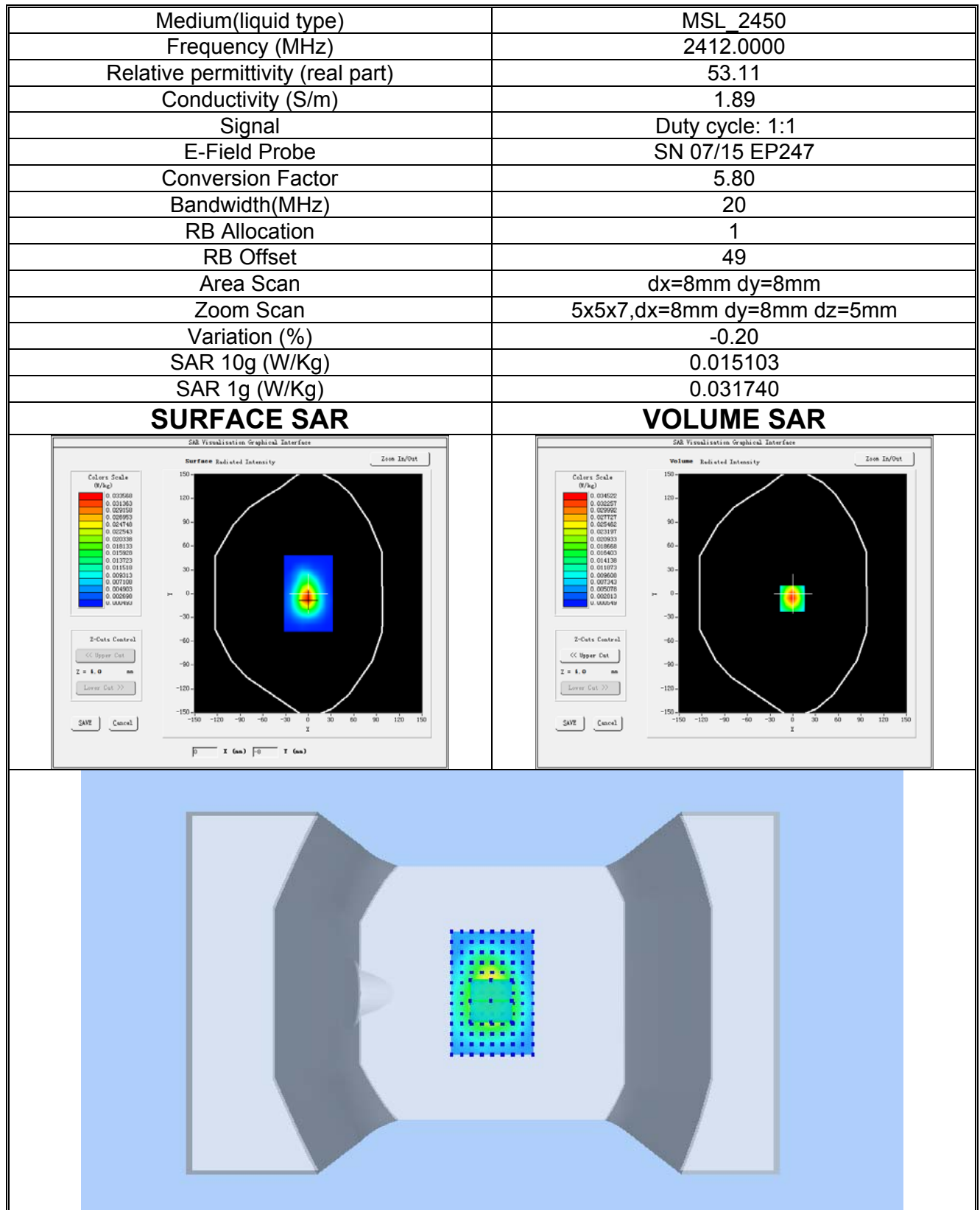
Medium(liquid type)	HSL_2600
Frequency (MHz)	2605.0000
Relative permittivity (real part)	39.59
Conductivity (S/m)	1.97
Signal	Duty cycle: 1:1
E-Field Probe	SN 07/15 EP247
Conversion Factor	5.37
Bandwidth(MHz)	20
RB Allocation	1
RB Offset	49
Area Scan	dx=8mm dy=8mm
Zoom Scan	5x5x7,dx=8mm dy=8mm dz=5mm
Variation (%)	-0.51
SAR 10g (W/Kg)	0.019275
SAR 1g (W/Kg)	0.044369

SURFACE SAR**VOLUME SAR**

Plot 39:LTE BAND41, Middle channel (Body-worn/Hotspot, Back Surface)**Product Description:**Smart phone**Test Date:** 2019-01-09

Plot 40:802.11b, Low channel (Left Head Tilt)**Product Description:**Smart phone**Test Date:** 2019-02-20

Plot 41:802.11b, Low channel (Body-worn, Back Surface)**Product Description:**Smart phone**Test Date:** 2019-02-20

Plot 42:802.11b, Low channel (Hotspot,Top edge)**Product Description:Smart phone****Test Date: 2019-02-20**

16 Calibration Reports-Probe and Dipole



COMOSAR E-Field Probe Calibration Report

Ref: ACR.154.5.18.SATU.A

**WALTEK SERVICES (SHENZHEN) CO.,
LTD**

**1/F, FUKANGTAI BUILDING, WEST BAIMA
ROAD, SONGGANG STREET, BAOAN DISTRICT
SHENZHEN (518105), CHINA**

**MVG COMOSAR DOSIMETRIC E-FIELD PROBE
SERIAL NO.: SN 07/15 EP247**

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



09/07/2018

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.154.5.18.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	9/7/2018	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	9/7/2018	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	9/7/2018	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Waltek Services (Shenzhen)Co.,Ltd

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	9/7/2018	Initial release

Page: 2/9

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.154.5.18.SATU.A

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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.154.5.18.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 EP247
Product Condition (new / used)	Used
Frequency Range of Probe	0.7GHz-3GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.224 MΩ Dipole 2: R2=0.234 MΩ Dipole 3: R3=0.229 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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COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.154.5.18.SATU.A

3.2 SENSITIVITY

The sensitivity factors of the three dipoles were determined using a two step calibration method (air and tissue simulating liquid) using waveguides as outlined in the standards.

3.3 LOWER DETECTION LIMIT

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

3.4 ISOTROPY

The axial isotropy was evaluated by exposing the probe to a reference wave from a standard dipole with the dipole mounted under the flat phantom in the test configuration suggested for system validations and checks. The probe was rotated along its main axis from 0 - 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.154.5.18.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 %

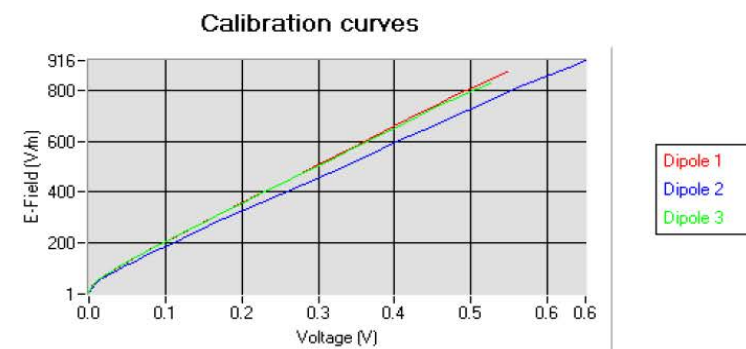
5.1 SENSITIVITY IN AIR

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 ($\mu\text{V}/(\text{V}/\text{m})^2$)
4.48	5.48	3.88

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
105	103	114

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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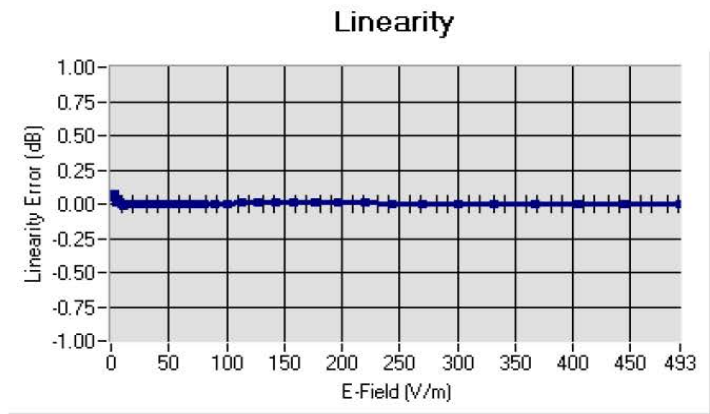
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Ref. ACR.154.5.18.SATU.A

5.2 LINEARITY



Linearity: $\pm 1.62\%$ ($\pm 0.07\text{dB}$)

5.3 SENSITIVITY IN LIQUID

Liquid	Frequency (MHz $\pm$ 100MHz)	Permittivity	Epsilon(S/m)	ConvF
HL750	750	41.90	0.89	6.99
BL750	750	55.50	0.96	7.28
HL850	850	42.59	0.90	6.93
BL850	850	53.19	0.97	7.13
HL900	900	42.05	0.98	6.18
BL900	900	56.41	1.08	6.41
HL1800	1800	41.82	1.38	5.84
BL1800	1800	53.00	1.52	6.06
HL1900	1900	40.38	1.41	6.35
BL1900	1900	53.93	1.55	6.55
HL2000	2000	40.12	1.43	5.76
BL2000	2000	53.65	1.54	5.88
HL2450	2450	38.34	1.80	5.64
BL2450	2450	52.70	1.94	5.80
HL2600	2600	38.16	1.93	5.37
BL2600	2600	51.55	2.21	5.58

LOWER DETECTION LIMIT: 7mW/kg



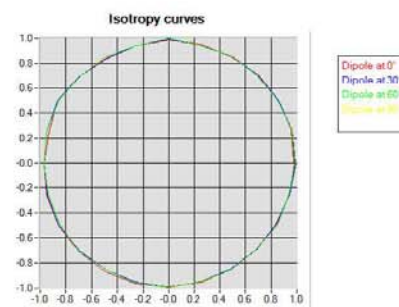
COMOSAR E-FIELD PROBE CALIBRATION REPORT

Ref: ACR.154.5.18.SATU.A

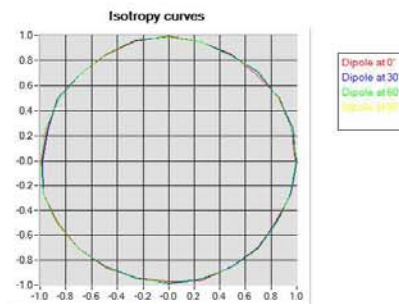
5.4 ISOTROPY

HL900 MHz

- Axial isotropy: 0.04 dB
- Hemispherical isotropy: 0.05 dB

**HL1800 MHz**

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



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COMOSAR E-FIELD PROBE CALIBRATION REPORT

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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	02/2016	02/2019
Reference Probe	MVG	EP 94 SN 37/08	10/2017	10/2018
Multimeter	Keithley 2000	1188656	12/2016	12/2019
Signal Generator	Agilent E4438C	MY49070581	12/2016	12/2019
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	12/2016	12/2019
Power Sensor	HP ECP-E26A	US37181460	12/2016	12/2019
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	11-661-9	8/2018	8/2021

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SAR Reference Dipole Calibration Report

Ref : ACR.93.2.18.SATU.A

WALTEK SERVICES(SHENZHEN) CO.,LTD
1/F., FUKANGTAI BUILDING, WEST BAIMA ROAD,
SONGGANG STREET
BAOAN DISTRICT, SHENZHEN GUANGDONG
518105, CHINA
MVG COMOSAR REFERENCE DIPOLE
FREQUENCY: 750 MHZ
SERIAL NO.: SN 09/15 DIP 0G750-357

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



Calibration Date: 02/28/2018

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.93.2.18.SATU.A

	<i>Name</i>	<i>Function</i>	<i>Date</i>	<i>Signature</i>
<i>Prepared by :</i>	Jérôme LUC	Product Manager	3/14/2018	<i>JS</i>
<i>Checked by :</i>	Jérôme LUC	Product Manager	3/14/2018	<i>JS</i>
<i>Approved by :</i>	Kim RUTKOWSKI	Quality Manager	3/14/2018	<i>Kim Rutkowski</i>

	<i>Customer Name</i>
<i>Distribution :</i>	Waltek Services (Shenzhen)Co., Ltd

<i>Issue</i>	<i>Date</i>	<i>Modifications</i>
A	3/14/2018	Initial release

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.93.2.18.SATU.A

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SAR REFERENCE DIPOLE CALIBRATION REPORT

Ref: ACR.93.2.18.SATU.A

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, FCC KDBs and CEI/IEC 62209 standards for reference dipoles used for SAR measurement system validations and the measurements that were performed to verify that the product complies with the fore mentioned standards.

2 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR 750 MHz REFERENCE DIPOLE
Manufacturer	MVG
Model	SID750
Serial Number	SN 09/15 DIP 0G750-357
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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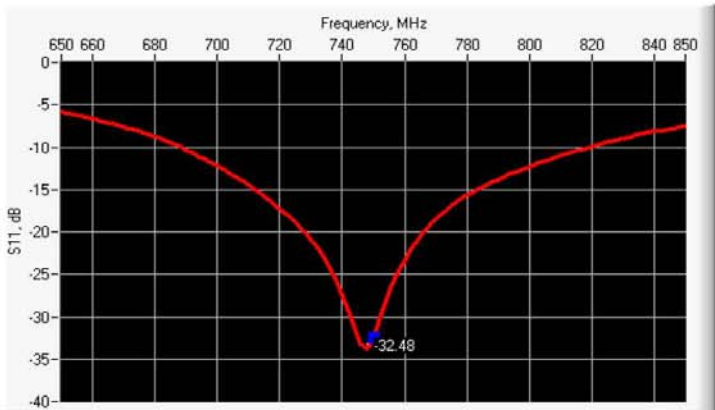
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10 g	20.1 %
------	--------

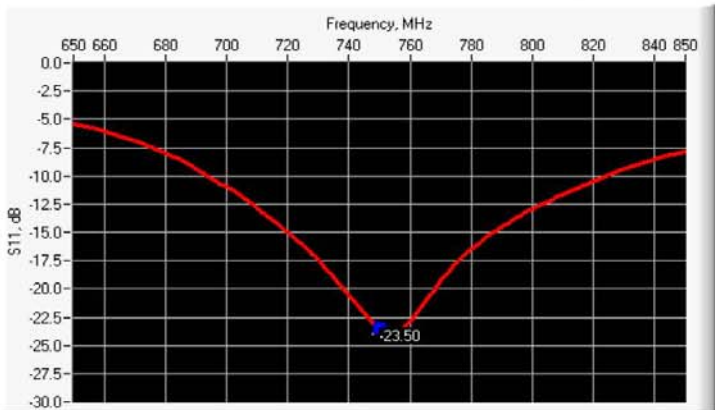
6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS AND IMPEDANCE IN HEAD LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-32.48	-20	51.6 Ω + 1.7 jΩ

6.2 RETURN LOSS AND IMPEDANCE IN BODY LIQUID



Frequency (MHz)	Return Loss (dB)	Requirement (dB)	Impedance
750	-23.50	-20	48.8 Ω + 6.6 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 %.	



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450	290.0 ±1 %.		166.7 ±1 %.		6.35 ±1 %.	
750	176.0 ±1 %.	PASS	100.0 ±1 %.	PASS	6.35 ±1 %.	PASS
835	161.0 ±1 %.		89.8 ±1 %.		3.6 ±1 %.	
900	149.0 ±1 %.		83.3 ±1 %.		3.6 ±1 %.	
1450	89.1 ±1 %.		51.7 ±1 %.		3.6 ±1 %.	
1500	80.5 ±1 %.		50.0 ±1 %.		3.6 ±1 %.	
1640	79.0 ±1 %.		45.7 ±1 %.		3.6 ±1 %.	
1750	75.2 ±1 %.		42.9 ±1 %.		3.6 ±1 %.	
1800	72.0 ±1 %.		41.7 ±1 %.		3.6 ±1 %.	
1900	68.0 ±1 %.		39.5 ±1 %.		3.6 ±1 %.	
1950	66.3 ±1 %.		38.5 ±1 %.		3.6 ±1 %.	
2000	64.5 ±1 %.		37.5 ±1 %.		3.6 ±1 %.	
2100	61.0 ±1 %.		35.7 ±1 %.		3.6 ±1 %.	
2300	55.5 ±1 %.		32.6 ±1 %.		3.6 ±1 %.	
2450	51.5 ±1 %.		30.4 ±1 %.		3.6 ±1 %.	
2600	48.5 ±1 %.		28.8 ±1 %.		3.6 ±1 %.	
3000	41.5 ±1 %.		25.0 ±1 %.		3.6 ±1 %.	
3500	37.0 ±1 %.		26.4 ±1 %.		3.6 ±1 %.	
3700	34.7 ±1 %.		26.4 ±1 %.		3.6 ±1 %.	

7 VALIDATION MEASUREMENT

The IEEE Std. 1528, FCC KDBs and CEI/IEC 62209 standards state that the system validation measurements must be performed using a reference dipole meeting the fore mentioned return loss and mechanical dimension requirements. The validation measurement must be performed against a liquid filled flat phantom, with the phantom constructed as outlined in the fore mentioned standards. Per the standards, the dipole shall be positioned below the bottom of the phantom, with the dipole length centered and parallel to the longest dimension of the flat phantom, with the top surface of the dipole at the described distance from the bottom surface of the phantom.

7.1 HEAD LIQUID MEASUREMENT

Frequency MHz	Relative permittivity (ϵ_r')		Conductivity (σ) S/m	
	required	measured	required	measured
300	45.3 ±5 %		0.87 ±5 %	
450	43.5 ±5 %		0.87 ±5 %	
750	41.9 ±5 %	PASS	0.89 ±5 %	PASS
835	41.5 ±5 %		0.90 ±5 %	
900	41.5 ±5 %		0.97 ±5 %	
1450	40.5 ±5 %		1.20 ±5 %	
1500	40.4 ±5 %		1.23 ±5 %	
1640	40.2 ±5 %		1.31 ±5 %	
1750	40.1 ±5 %		1.37 ±5 %	

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

7.2 SAR MEASUREMENT RESULT WITH HEAD LIQUID

The IEEE Std. 1528 and CEI/IEC 62209 standards state that the system validation measurements should produce the SAR values shown below (for phantom thickness of 2 mm), within the uncertainty for the system validation. All SAR values are normalized to 1 W forward power. In bracket, the measured SAR is given with the used input power.

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: ϵ_{ps} : 40.0 σ : 0.93
Distance between dipole center and liquid	15.0 mm
Area scan resolution	$dx=8mm/dy=8mm$
Zoon Scan Resolution	$dx=8mm/dy=8mm/dz=5mm$
Frequency	750 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

Frequency MHz	1 g SAR (W/kg/W)		10 g SAR (W/kg/W)	
	required	measured	required	measured
300	2.85		1.94	
450	4.58		3.06	
750	8.49	8.78 (0.88)	5.55	5.72 (0.57)
835	9.56		6.22	
900	10.9		6.99	
1450	29		16	
1500	30.5		16.8	
1640	34.2		18.4	
1750	36.4		19.3	
1800	38.4		20.1	

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