14 SIMULTANEOUS TRANSMISSION ANALYSIS

The test mode as follows:

With Model A1332

Simultaneous Transmission Configurations	Portable Handset Exposure positions		
	Head	Body-worn	PTT
GSM(Voice) + WLAN 2.4GHz(Data)	Yes	Yes	-
WCDMA(Voice/data) + WLAN 2.4GHz(Data)	Yes	Yes	-
GPRS/EDGE(Data) + WLAN 2.4GHz(Data)	-	Yes	-
GSM(Voice) + Bluetooth PTT+BT iphone	-	-	Yes
WCDMA(Voice/data) + Bluetooth PTT+BT iphone	-	-	Yes

With Model A1387

Simultaneous Transmission Configurations	Portable Handset Exposure positions			
	Head	Body-worn	Hotspot	PTT
CMDA2000(Voice) + WLAN 2.4GHz(Data)	Yes	Yes	-	-
GSM(Voice) + WLAN 2.4GHz(Data)	Yes	Yes	-	-
WCDMA(Voice) + WLAN 2.4GHz(Data)	Yes	Yes	-	-
CMDA2000(Data) + WLAN 2.4GHz(Data)	-	-	Yes	-
GPRS/EDGE(Data) + WLAN 2.4GHz(Data)	-	-	Yes	-
WCDMA(Data) + WLAN 2.4GHz(Data)	-	-	Yes	-
DMA2000(Voice/data) + Bluetooth PTT+BT iphone				Yes
GSM(Voice) + Bluetooth PTT+BT iphone				Yes
WCDMA(Voice/data) + Bluetooth PTT+BT iphone				Yes

Note:

1. WLAN 2.4GHz and Bluetooth (iphone) share the same antenna, and cannot transmit simultaneously.
2. EUT will choose either GSM or WCDMA or CDMA2000 according to the network signal condition; therefore, they will not transmit simultaneously.
3. The reported SAR summation is calculated based on the same configuration and test position.
4. For simultaneous transmission SAR, repeat the simultaneous transmission SAR test exclusion analysis in the SAR report for BCG-E2380B and BCG-E2430A by substituting any measured SAR with BT iphone case attached to AT&T iphone.
5. Per KDB 447498 D01v05r01, simultaneous transmission SAR is compliant if,
   a) Scalar SAR summation < 1.6W/kg.
   b) SPLSR = $(\mathrm{SAR1}+\mathrm{SAR2})^{1.5}$ / (min. separation distance, mm), and the peak separation distance is determined from the square root of [$(\mathrm{x1}-\mathrm{x2})^2$ + $(\mathrm{y1}-\mathrm{y2})^2$ +$(\mathrm{z1}-\mathrm{z2})^2$], where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan. If SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary
   c) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg

5. For simultaneous transmission analysis, per KDB 447498 D01v05r01, the 1-g and 10-g SAR test

exclusion threshoilds for 100 MHz to 6GHz at test separation distances ≤ 50mm are determined by.

a) [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] • [$\sqrt{f}$ (GHz)/x] ≤3.0 for 1-g SAR and ≤7.5 10-g extremity SAR

f(GHz) is the RF channel transmit frequency in GHz;
Power and distance are rounded to the nearest mW and mm before calculation;
The result is rounded to one decimal place for comparison;
PPT test distance is 25mm;

Bluetooth				
Tune-up Maximum Power(dBm)	mW	Test Distance (mm)	Frequency(GHz)	Exclusion thresholds
3.5	2.2	25	2.48	0.14

6. Per KDB 447498 D01 v05r01 exclusion thresholds is 0.14 < 3, RF exposure evaluation is not required.
7. BT iphone case is attached to an AT&T iphone, when the BT iphone case is actively operating in PTT mode and transmitting, as long as PTT is supported by a mechanical PTT button only and BT iphone case maximum output power at 25mm (PTT test distance) qualifies for standalone SAR test exclusion in KDB 447498, simultaneous transmission SAR test exclusion analysis is not required.

Model A1332

Head Exposure Conditions

Position	WWAN		WLAN 2.4G	WWAN+WLAN(2.4G)
	WWAN Band	SAR(W/kg)	SAR(W/kg)	Summed SAR(W/kg)
Left Cheek	GSM 850	0.574	0.061	0.635
	WCDMA Ⅴ	0.396	0.061	0.457
	WCDMA Ⅱ	1.256	0.061	1.317
Left Titled	GSM 1900	0.262	0.078	0.340

Body Exposure Conditions

Position	WWAN		WLAN 2.4G	WWAN+WLAN(2.4G)
	WWAN Band	SAR(W/kg)	SAR(W/kg)	Summed SAR(W/kg)
Front Side	GSM 850	1.319	0.071	1.390
	GSM 1900	0.490	0.071	0.561
	WCDMA Ⅱ	0.704	0.071	0.775
Left Side	WCDMA Ⅴ	0.800	0.041	0.841

Model A1387

Head Exposure Conditions

Position	WWAN		WLAN 2.4G	WWAN+WLAN(2.4G)
	WWAN Band	SAR(W/kg)	SAR(W/kg)	Summed SAR(W/kg)
Left Cheek	CDMA2000 Cell	0.191	0.364	0.555
	CDMA2000 PCS	0.594	0.364	0.958
	GSM 850	0.769	0.364	1.134
	GSM 1900	0.553	0.364	0.917
	WCDMA Ⅴ	0.702	0.364	1.066
	WCDMA Ⅱ	0.370	0.365	0.735

Body Exposure Conditions

Position	WWAN		WLAN 2.4G	WWAN+WLAN(2.4G)
	WWAN Band	SAR(W/kg)	SAR(W/kg)	Summed SAR(W/kg)
Front Side	CDMA 2000 PCS	0.918	0.065	0.983
	GSM 850	1.235	0.065	1.300
	WCDMA Ⅴ	0.660	0.065	0.725
Back Side	WCDMA Ⅱ	0.281	0.186	0.467
	GSM 1900	0.636	0.186	0.822

Hotspot Exposure Conditions

Position	WWAN		WLAN 2.4G	WWAN+WLAN(2.4G)
	WWAN Band	SAR(W/kg)	SAR(W/kg)	Summed SAR(W/kg)
Front Side	CDMA 2000 Cell	0.774	0.065	0.839
	CDMA 2000 PCS	0.462	0.065	0.527
	GSM 850	0.742	0.065	0.807
	GSM 1900	0.881	0.065	0.946
	WCDMA Ⅴ	0.904	0.065	0.969
	WCDMA Ⅱ	0.502	0.065	0.567

We can get that the maximum scalar SAR summation value is 1.390W/Kg according to the analysis from above data, it less than 1.6W/Kg, so simultaneous transmission SAR is compliant per KDB 447498 D01v05r01.

15 Measurement Uncertainty

Table 23:Measurement Uncertainty according to IEEE 1528

No.	Uncertainty Component	Type	Uncertainty Value (%)	Probability Distribution	k	ci	Standard Uncertainty (%) ui(%)	Degree of freedom Veff or vi
	Measurement System							
1	－Probe Calibration	B	6	N	1	1	3.5	∞
2	－Axial isotropy	B	4.7	R	1.732	1	2.7	∞
3	－Hemispherical Isotropy	B	9.4	R	1.732	1	5.4	∞
4	－Boundary Effect	B	11.0	R	1.732	1	6.4	∞
5	－Linearity	B	4.7	R	1.732	1	2.7	∞
6	－System Detection Limits	B	1.0	R	1.732	1	0.6	∞
7	－Readout Electronics	B	1.0	N	1	1	1.00	∞
8	－Response Time	B	0.00	R	1.732	1	0.00	∞
9	－Integration Time	B	0.00	R	1.732	1	0.00	∞
10	－RF Ambient Conditions	B	3.0	R	1.732	1	1.73	∞
11	－Probe Position Mechanical tolerance	B	0.4	R	1.732	1	0.2	∞
12	－Probe Position with respect to Phantom Shell	B	2.9	R	1.732	1	1.7	∞
13	－Extrapolation, Interpolation and Integration Algorithms for Max. SAR evaluation	B	3.9	R	1.732	1	2.3	∞

	Uncertainties of the DUT							
14	－Position of the DUT	A	4.8	N	1	1	4.8	5
15	－Holder of the DUT	A	7.1	N	1	1	7.1	5
16	－Output Power Variation –SAR drift measurement	B	5.0	R	1.732	1	2.9	∞
	Phantom and Tissue Parameters							
17	－Phantom Uncertainty(shape and thickness tolerances)	B	1.0	R	1.732	1	0.6	∞
18	－Liquid Conductivity Target –tolerance	B	5.0	R	1.732	0.6	1.7	∞
19	－Liquid Conductivity –measurement Uncertainty)	B	0.23	N	1	1	0.23	9
20	－Liquid Permittivity Target tolerance	B	5.0	R	1.732	0.6	1.7	∞
21	－Liquid Permittivity –measurement uncertainty	B	0.46	N	1	1	0.46	∞
Combined Standard Uncertainty				RSS			12.92	35.15
Expanded uncertainty (Confidence interval of 95 %)				K=2			25.84	

Table 24:Measurement Uncertainty for Body Worn Test according to IEC 62209-2

No.	Uncertainty Component	Type	Uncertainty Value (%)	Probability Distribution	k	ci	Standard Uncertainty (%) ui(%)	Degree of freedom Veff or vi
	Measurement System							
1	－Probe Calibration	B	6	N	1	1	3.5	∞
2	－Isotropy	B	14.1	R	1.732	1	4.1	∞
3	－Hemispherical Isotropy	B	9.4	R	1.732	1	5.4	∞
4	－Boundary Effect	B	11.0	R	1.732	1	6.4	∞
5	－Linearity	B	4.7	R	1.732	1	2.7	∞
6	－System Detection Limits	B	1.0	R	1.732	1	0.6	∞
7	－Readout Electronics	B	1.0	N	1	1	1.00	∞
8	－Response Time	B	0.00	R	1.732	1	0.00	∞
9	－Integration Time	B	0.00	R	1.732	1	0.00	∞
10	－RF Ambient Conditions	B	3.0	R	1.732	1	1.73	∞
11	－Probe Position Mechanical tolerance	B	0.4	R	1.732	1	0.2	∞
12	－Probe Position with respect to Phantom Shell	B	2.9	R	1.732	1	1.7	∞
13	－Post-processing	B	5.0	R	1.732	1	2.9	∞
14	－Probe modulation response	B	0.4	R	1.732	1	0.2	∞

	Uncertainties of the DUT							
15	－Position of the DUT	A	4.8	N	1	1	4.8	5
16	－Holder of the DUT	A	7.1	N	1	1	7.1	5
17	－Power Scaling	B	1.0	R	1.732	1	0.6	∞
18	－Output Power Variation –SAR drift measurement	B	5.0	R	1.732	1	2.9	∞
	Phantom and Tissue Parameters							
19	－Phantom Uncertainty(shape and thickness tolerances)	B	1.0	R	1.732	1	0.6	∞
20	－Liquid Conductivity Target –tolerance	B	5.0	R	1.732	0.6	1.7	∞
21	－Liquid Conductivity –measurement Uncertainty)	B	0.23	N	1	1	0.23	9
22	－Liquid Permittivity Target tolerance	B	5.0	R	1.732	0.6	1.7	∞
23	－Liquid Permittivity –measurement uncertainty	B	0.46	N	1	1	0.46	∞
24	－liquid temperature uncertainty	B	1	N	1	1	1	∞
Combined Standard Uncertainty				RSS			13.12	44.15
Expanded uncertainty (Confidence interval of 95 %)				K=2			26.24	

16 MAIN TEST INSTRUMENTS

No	EQUIPMENT	TYPE	Series No.	Due Date
1	System Simulator	E5515C	GB 47200710	2014-02-23
2	SAR Probe	SATIMO	SN_0913_EP169	2014/04/05
3	Dipole	SID835	SN_0913_DIP0G900-217	2014/04/05
4	Dipole	SID1900	SN_0913_DIP1G900-218	2014/04/05
5	Vector Network Analyzer	ZVB8	A0802530	2014/06/13
6	Signal Generator	SMR27	A0304219	2014/06/10
7	Amplifier	Nucletudes	143060	2014/04/05
8	Power Meter	NRVS	A0802531	2014/06/10
9	Power Sensor	NRV-Z4	100069	2014/06/10
10	Multimeter	Keithley-2000	4014020	2014/04/05
11	Device Holder	MSH80	SN 09/13 MSH80	2014/04/05
12	SAM Phantom	SAM97	SN 09/13 SAM97	2014/04/05

ANNEX A

of

CCIC-SET

CONFORMANCE TEST REPORT FOR

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS

SET2013-05214

Kodiak Networks

CARBONADO

Type Name: Carbonado smart PTT case for iPhone

Hardware Version: V2.0

Software Version: V2.0

TEST LAYOUT

This Annex consists of 4 pages

Date of Report: 2013-09-06

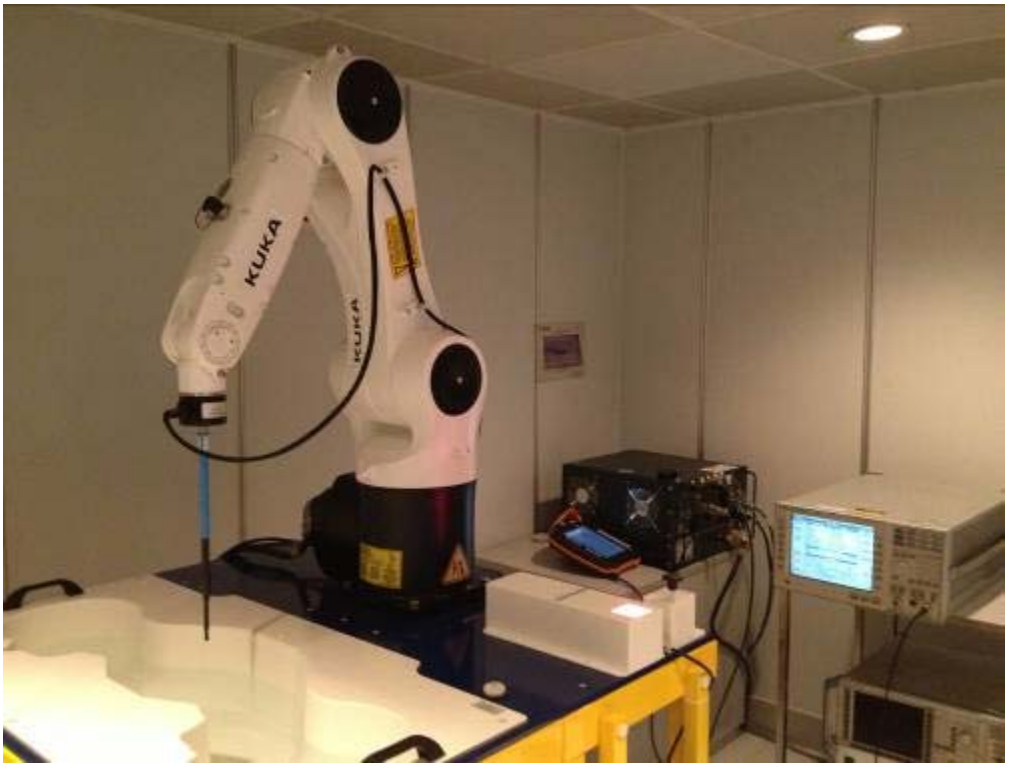


Fig.1 COMO SAR Test System

SAR Test setup For iphone with BT iPhone case

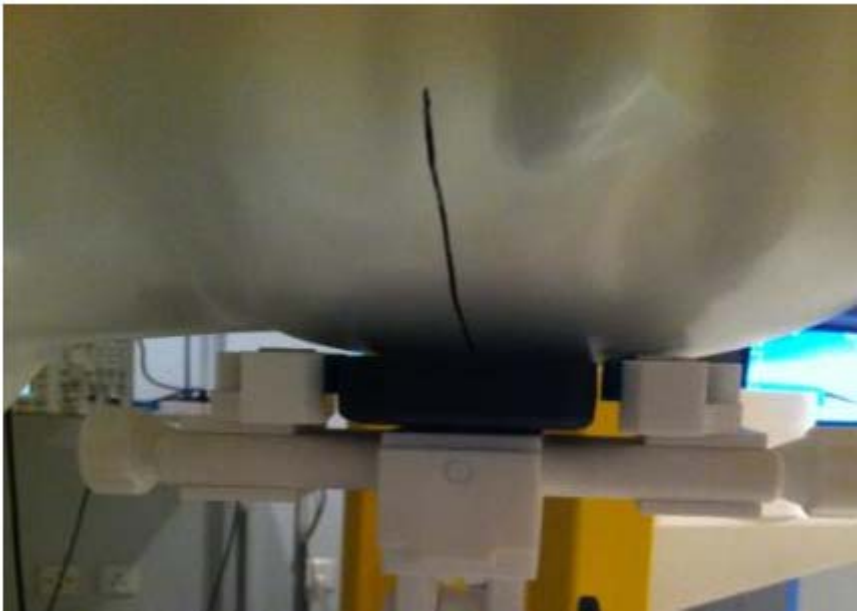


Fig.2 Left_Cheek

Fig.3 Left_Tilt

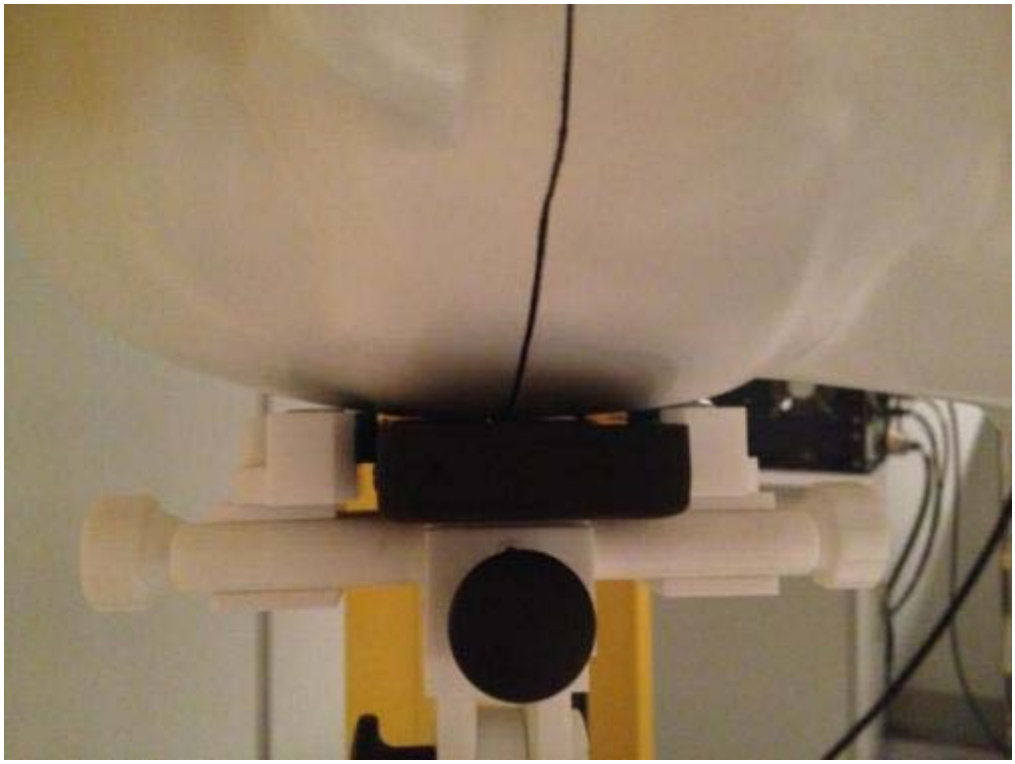


Fig.4 Right_Cheek

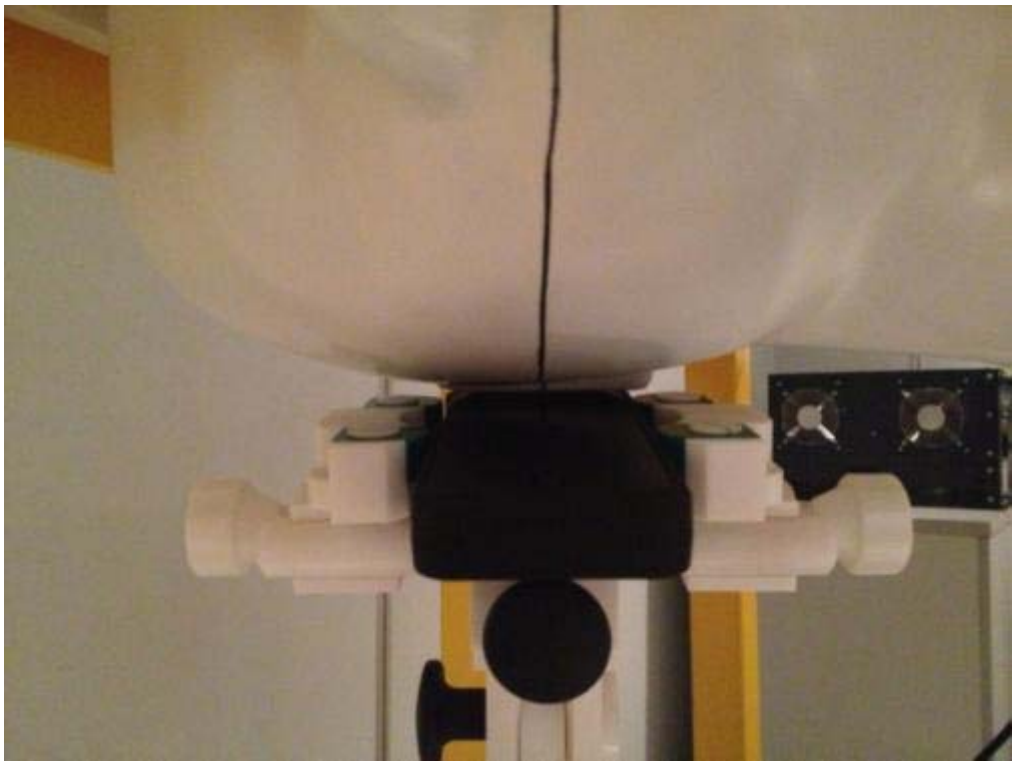


Fig.5 Right_Tilt

Fig.6 Face Upward

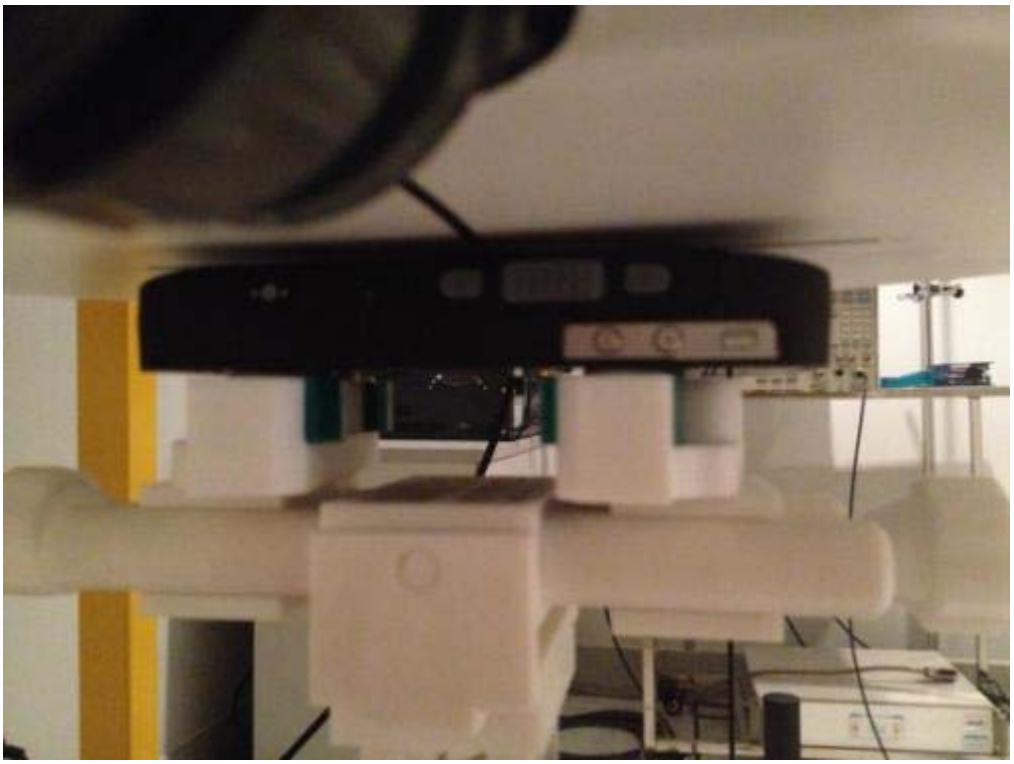


Fig.7 Back Upward with Model A1332

Fig.8 Back Upward with Model A1387

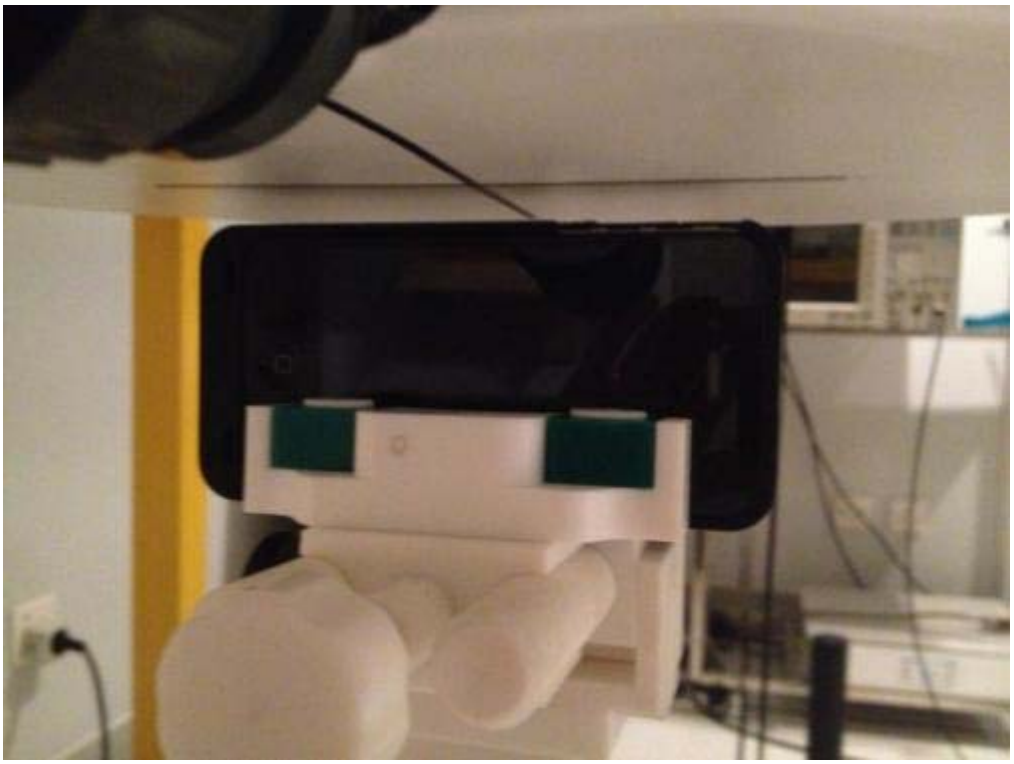


Fig.9 Left Side

SAR Test setup For Model A1332 without BT iPhone case

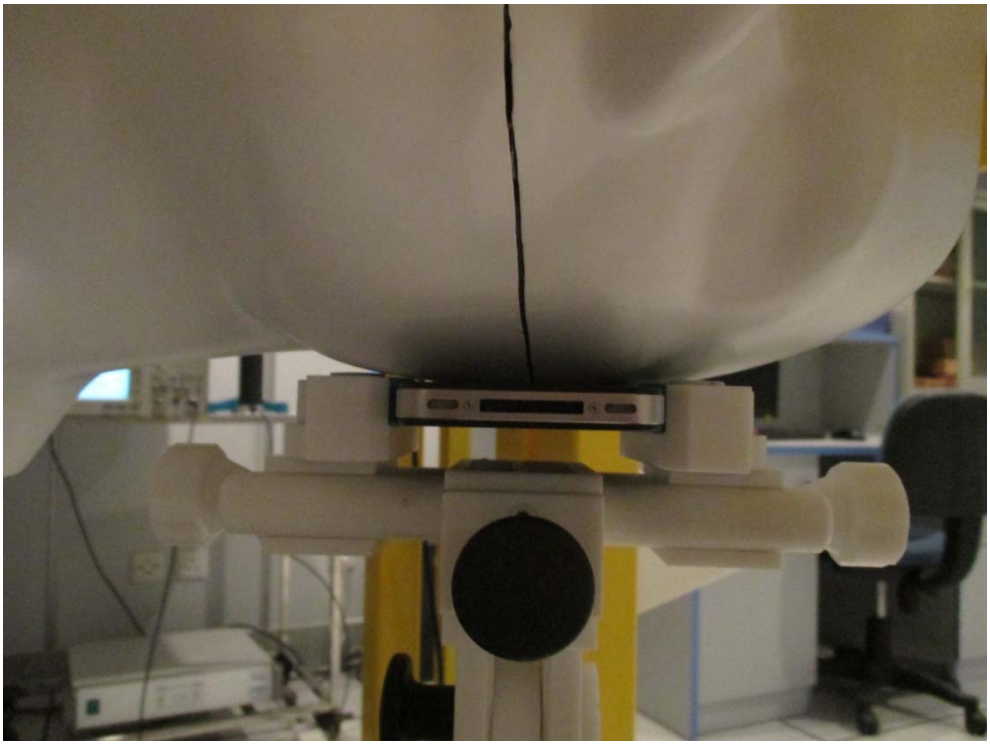


Fig.10 Left Check

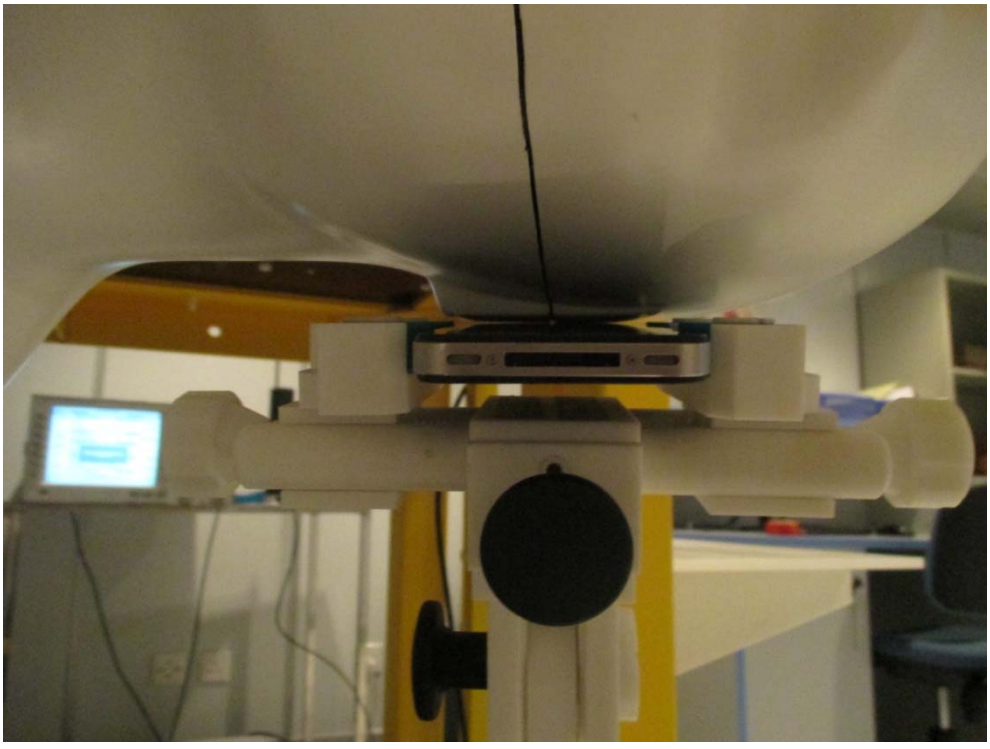


Fig.11 Left Tilt

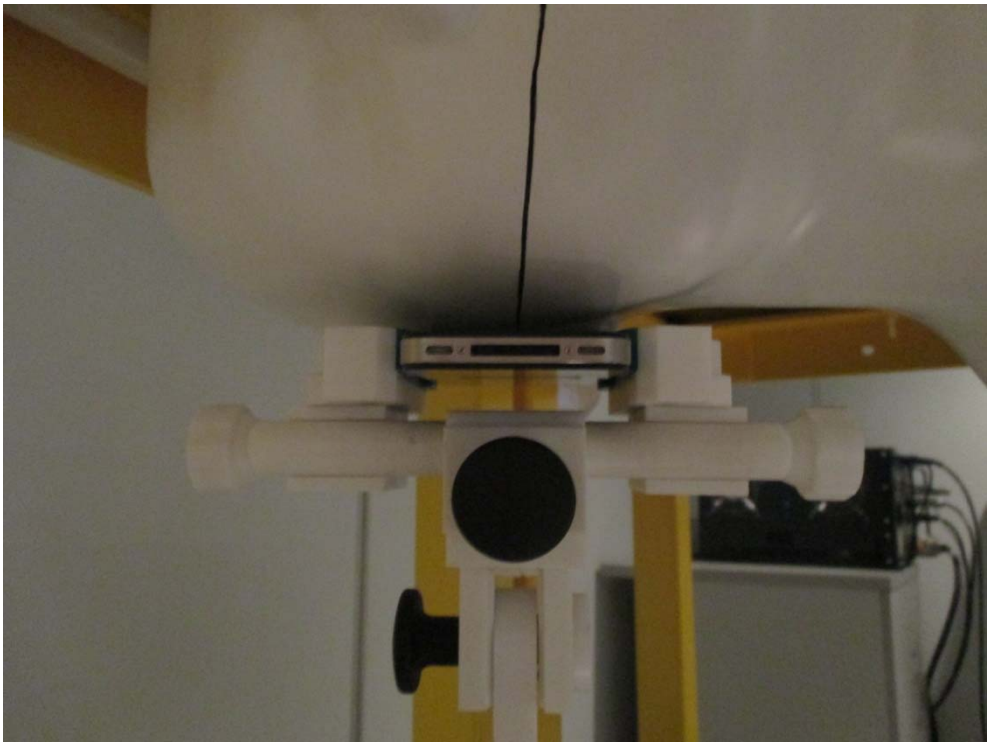


Fig.12 Right cheek

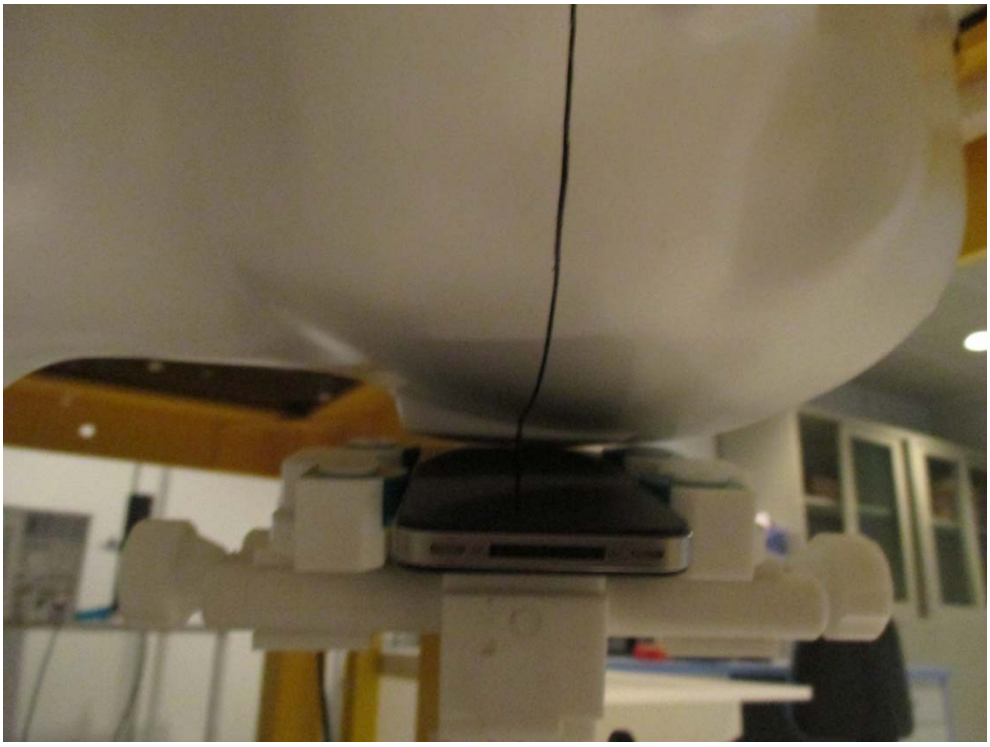


Fig.13 Right Tilt

Fig.14 Face Upward

Fig.15 Face Downward

Fig.16 Face Upward (with headset)

Fig.17 Face Downward (with headset)

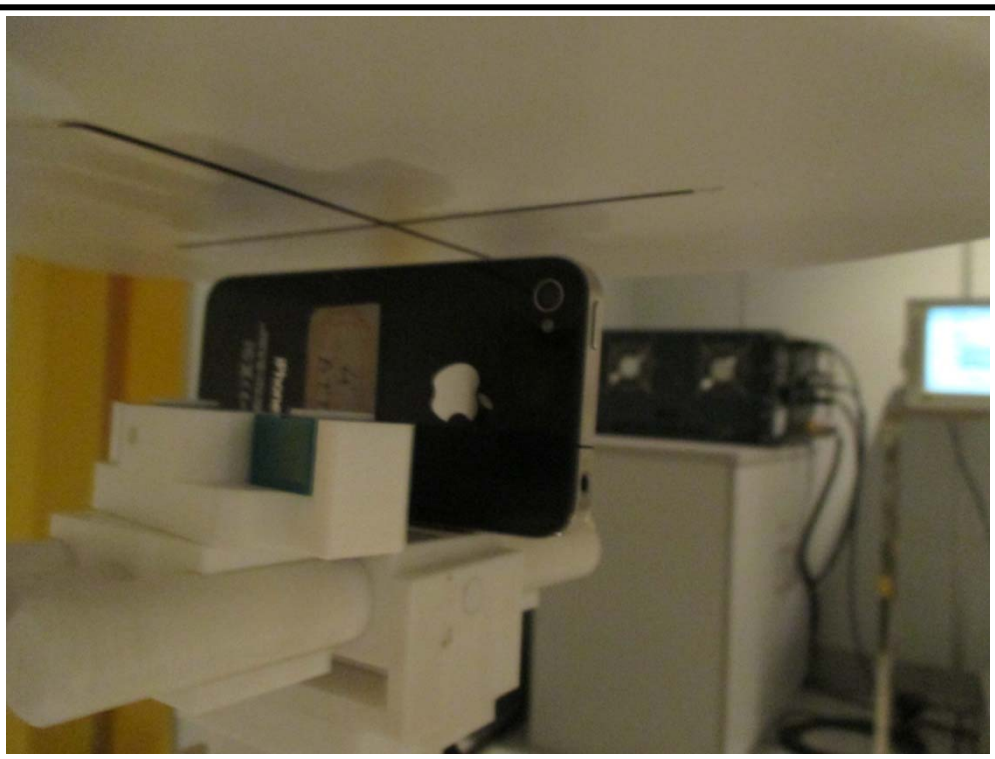


Fig.18 Right Side

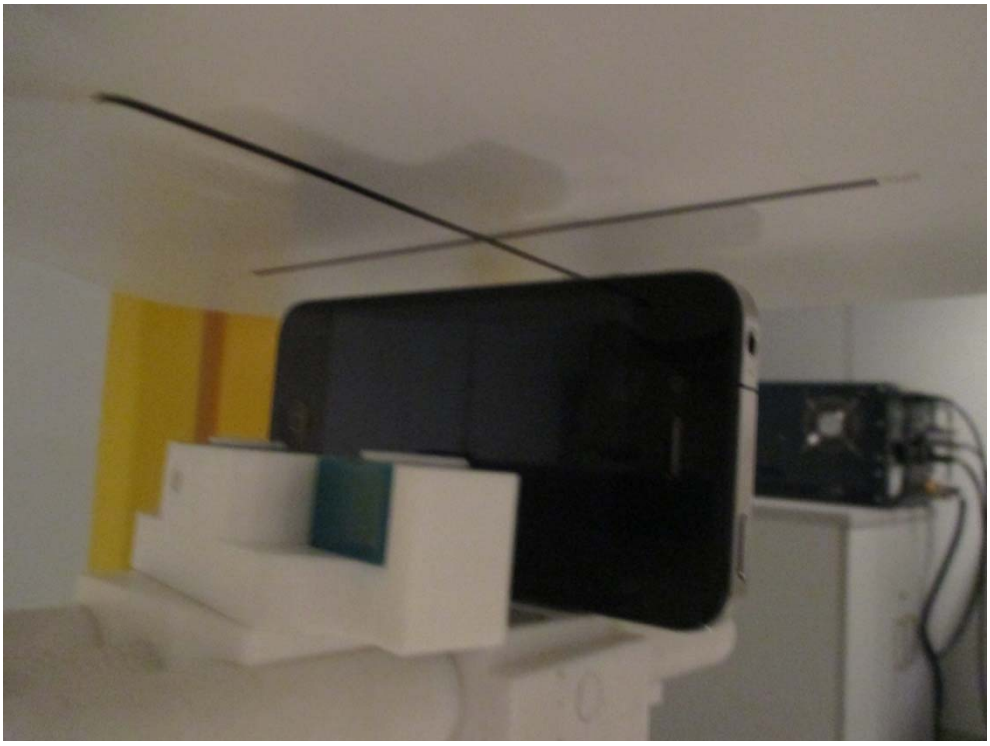


Fig.19 Left Side

Fig.20 Top Side

Fig.21 Bottom Side

SAR Test setup For Model A1387 without BT iPhone case

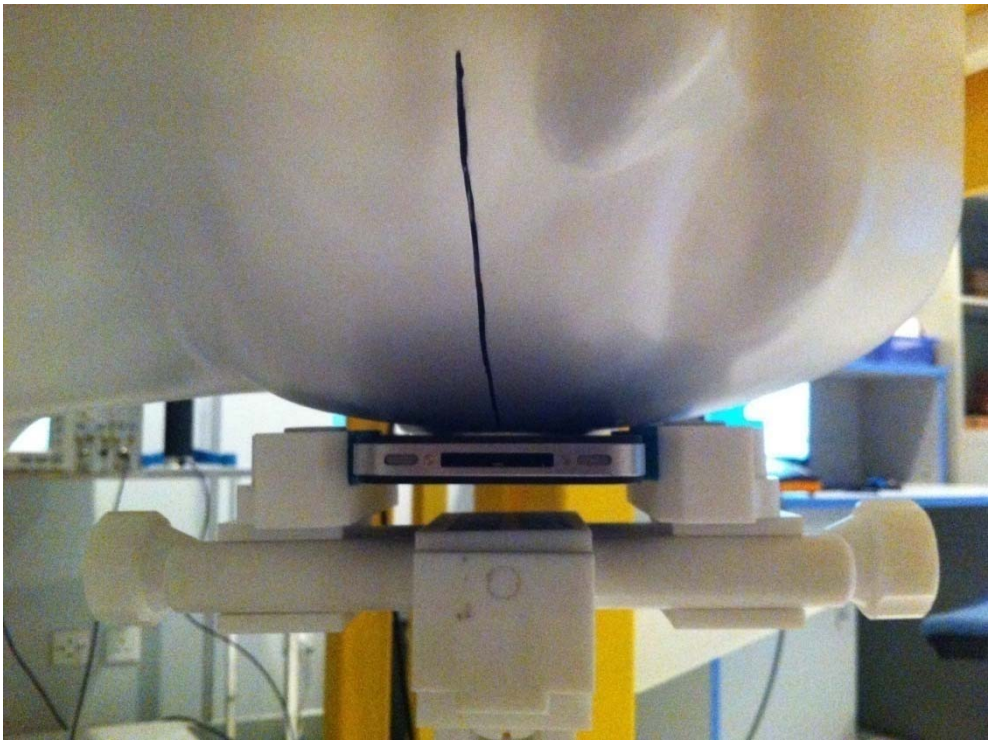


Fig.22 Left Check

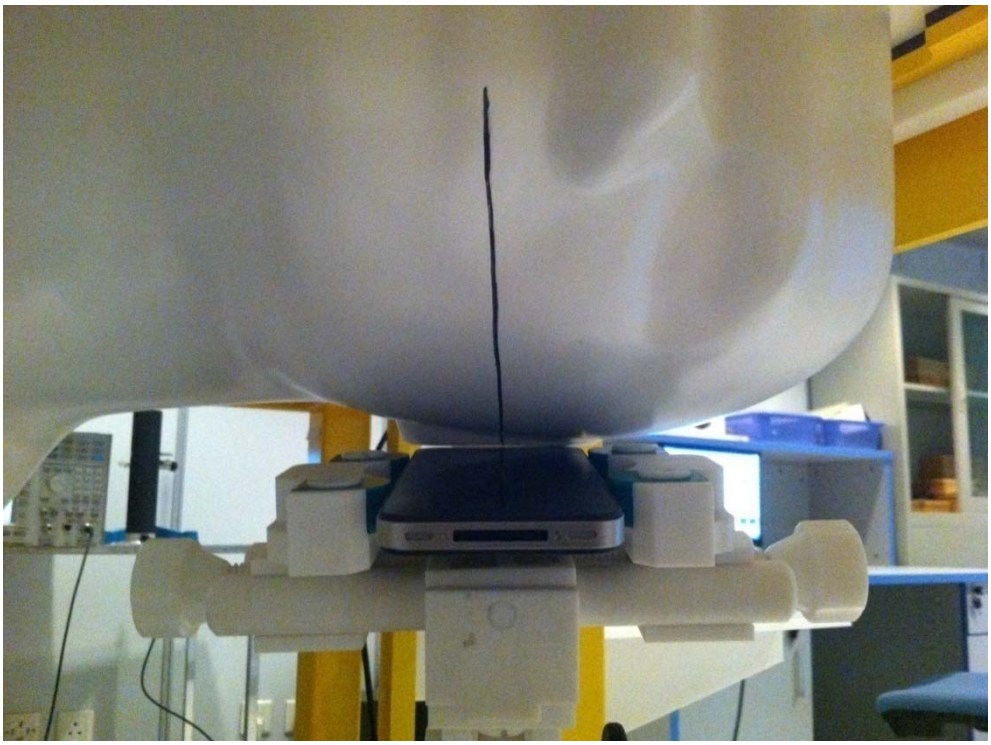


Fig.23 Left Tilt

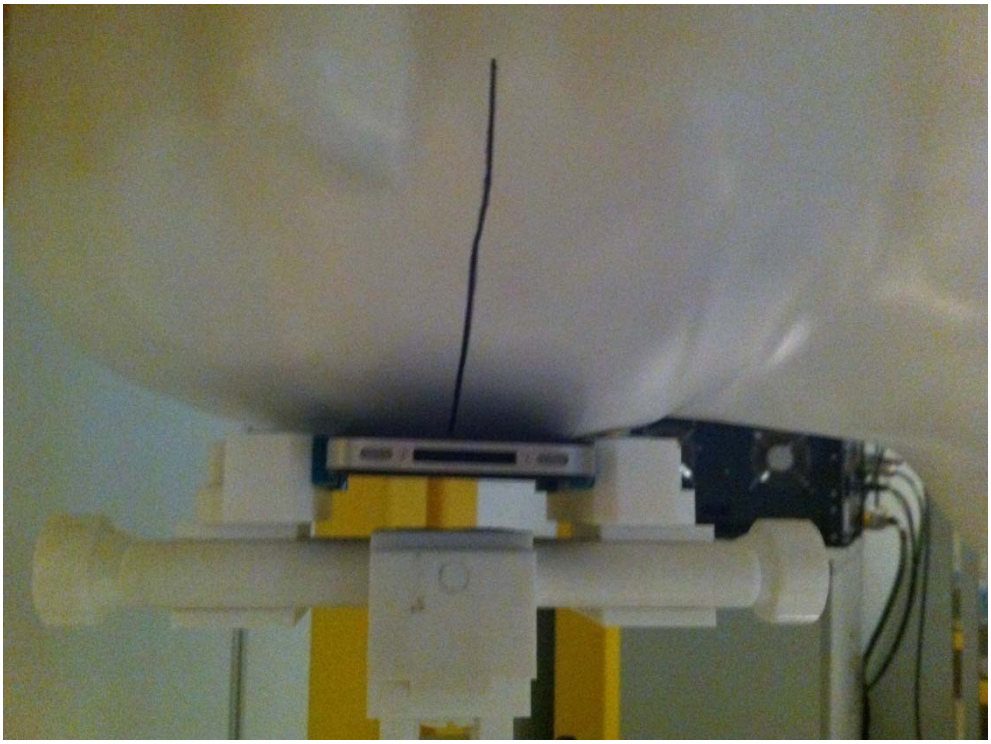


Fig.24 Right cheek

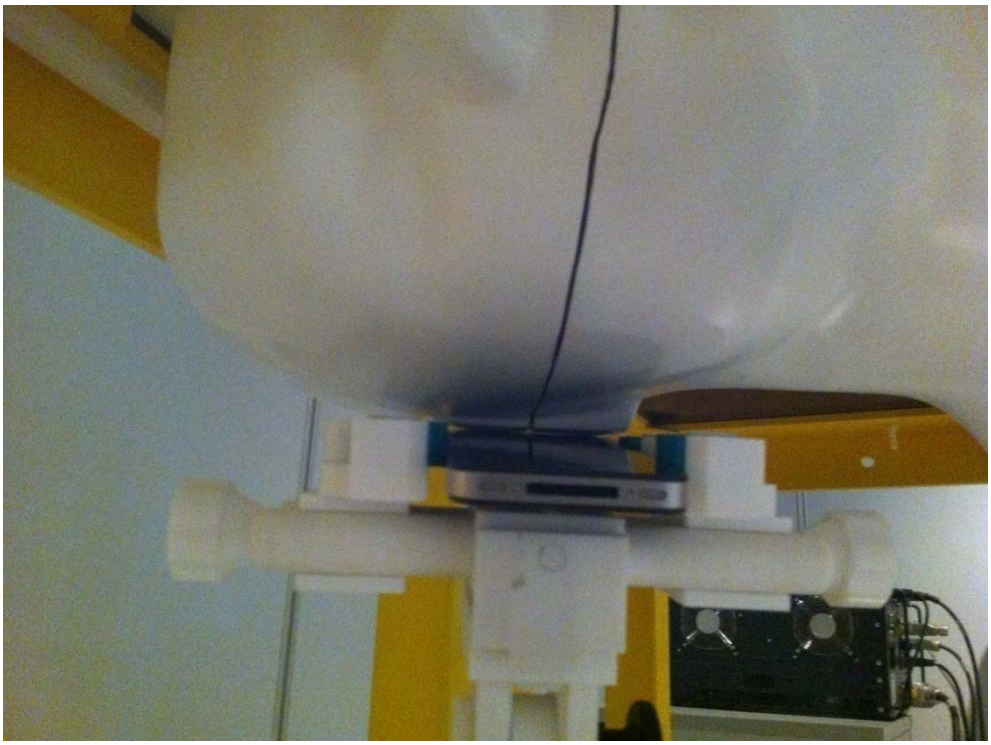


Fig.25 Right Tilt

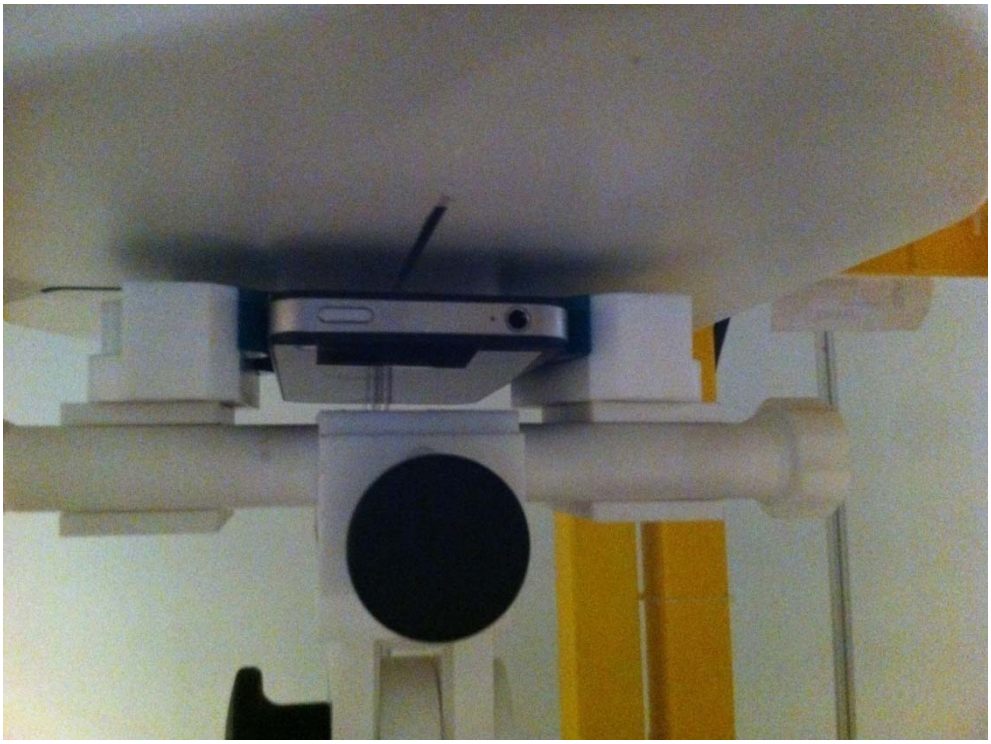


Fig.25 Face Upward

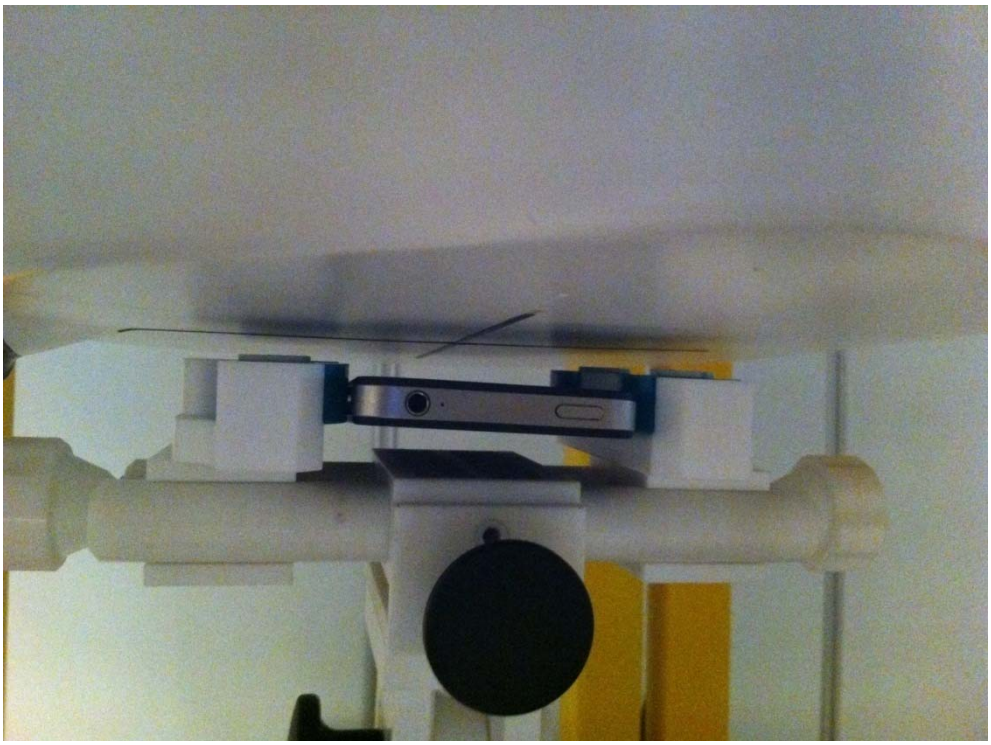


Fig.26 Face Downward

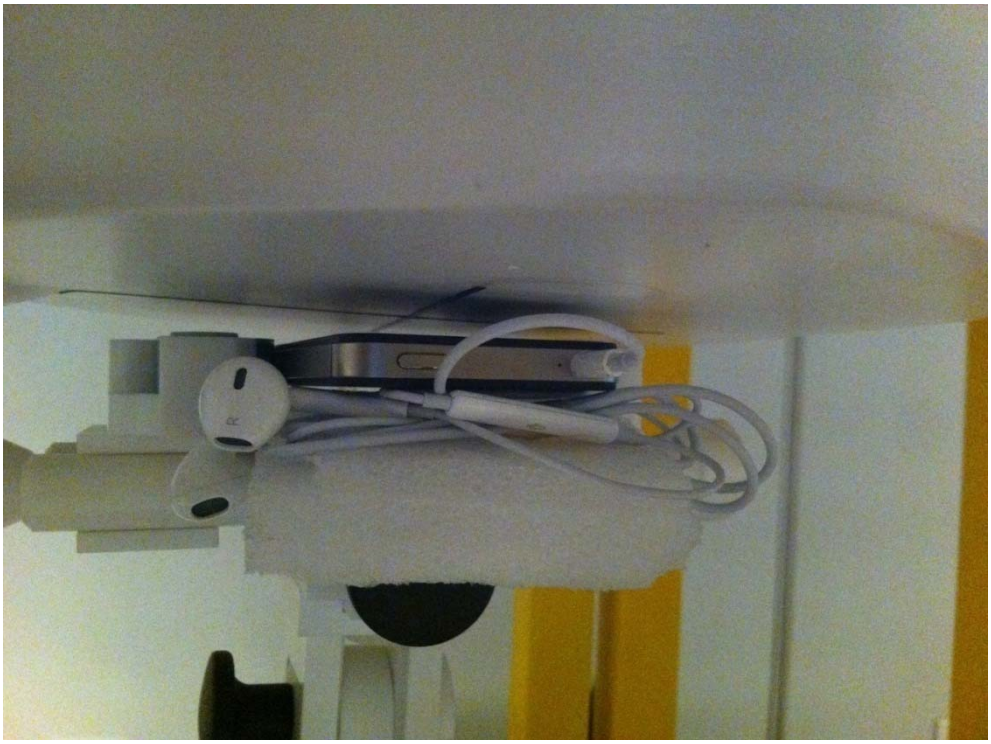


Fig.27 Face Upward (with headset)

Fig.28 Face Downward (with headset)

Fig.29 Left Side

Fig.30 Right Side

Fig.31 Top Side

Fig.32 Bottom Side

ANNEX B

of

CCIC-SET

CONFORMANCE TEST REPORT FOR

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS

SET2013-05214

CARBONADO

Type Name: Carbonado smart PTT case for iPhone

Hardware Version: V2.0

Software Version: V2.0

Sample Photographs

This Annex consists of 5 pages

Date of Report: 2013-09-06

1. Appearance

Appearance and size (obverse with Model)

Appearance and size (reverse with Model)

Appearance and size (obverse without Model)

Appearance and size (reverse without Model)

5. Position of antennas

ANNEX C

of

CCIC-SET

CONFORMANCE TEST REPORT FOR

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS

SET2013-05214

CARBONADO

Type Name: Carbonado smart PTT case for iPhone

Hardware Version： V2.0

Software Version： V2.0

System Performance Check Data

This Annex consists of 2 pages

Date of Report：2013-09-06

System Performance Check (Head, 835MHz)

Type: Phone measurement (Complete)

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm

Date of measurement: 8/28/2013

Measurement duration: 12 minutes 57 seconds

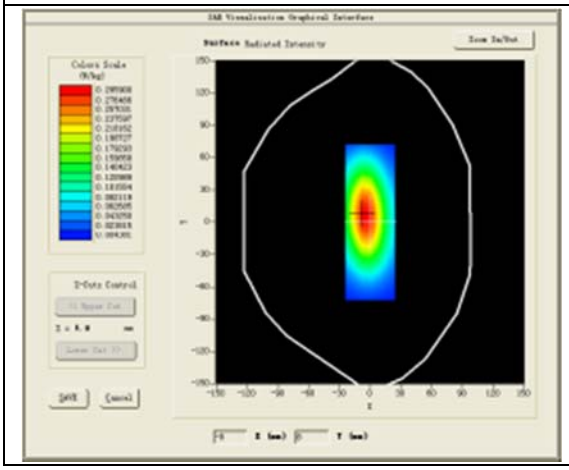
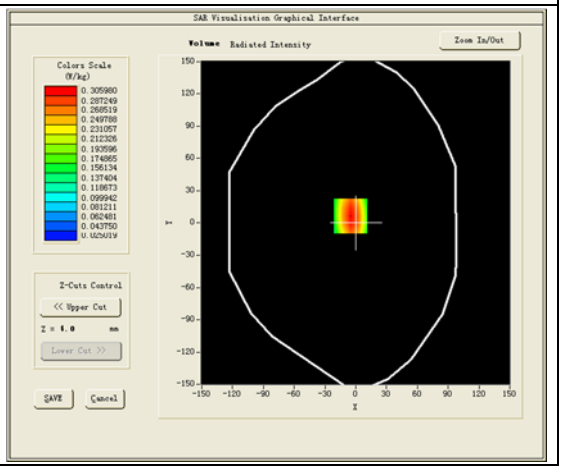
A. Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Flat Plane
Device Position	Dipole
Band	835MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

Frequency (MHz)	835.000000
Relative permittivity (real part)	41.28
Relative permittivity	15.07
Conductivity (S/m)	0.94
Power drift (%)	-0.160000
Crest factor:	1:1

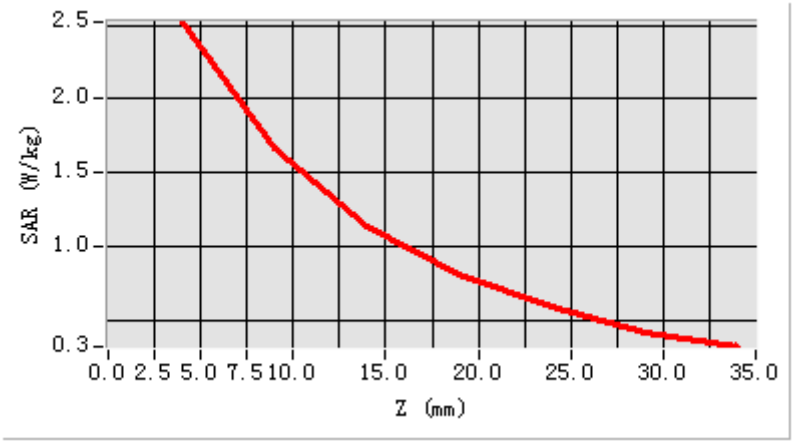
SURFACE SAR	VOLUME SAR
	

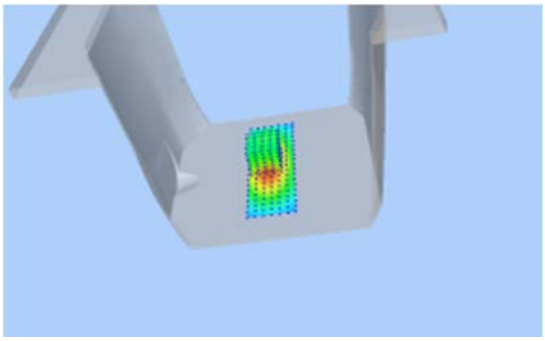
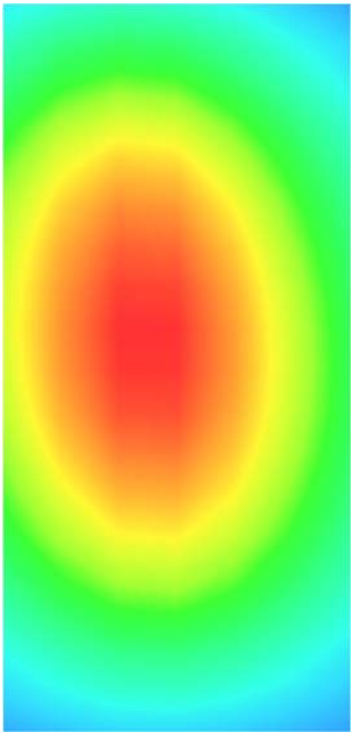
Maximum location: X=-5.00, Y=6.00

SAR 10g (W/Kg)	1.801556
SAR 1g (W/Kg)	2.469344

Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0000	2.5212	1.6625	1.1452	0.8068	0.5876	0.4154



3D sceen shot	Hot spot position
	

System Performance Check (Head, 1900MHz)

Type: Phone measurement (Complete)

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm

Date of measurement: 8/28/2013

Measurement duration: 14 minutes 51 seconds

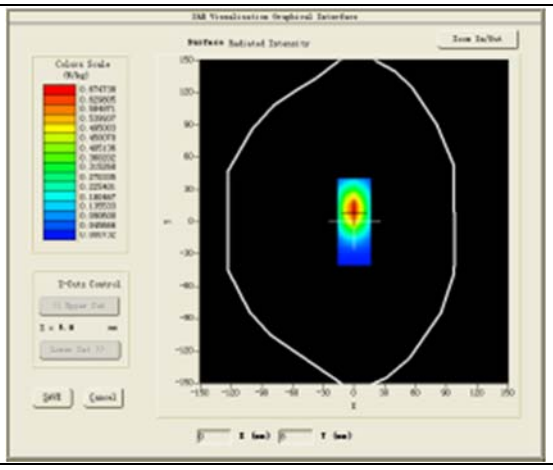
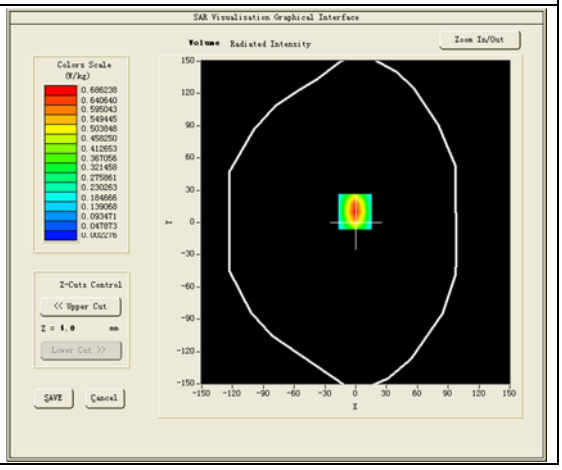
A. Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Flat Plane
Device Position	Dipole
Band	1900MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

Frequency (MHz)	1900.000000
Relative permittivity (real part)	39.88
Relative permittivity	15.07
Conductivity (S/m)	1.42
Power drift (%)	-0.420000
Crest factor:	1:1

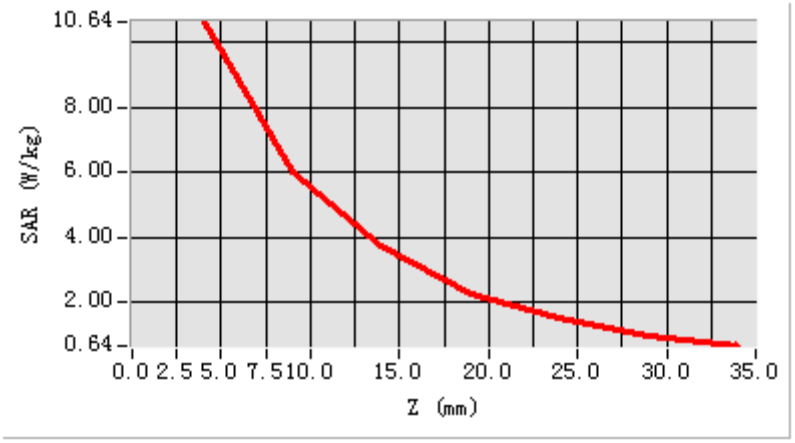
SURFACE SAR	VOLUME SAR
	

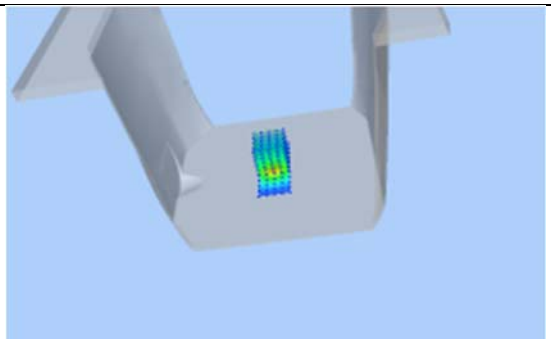
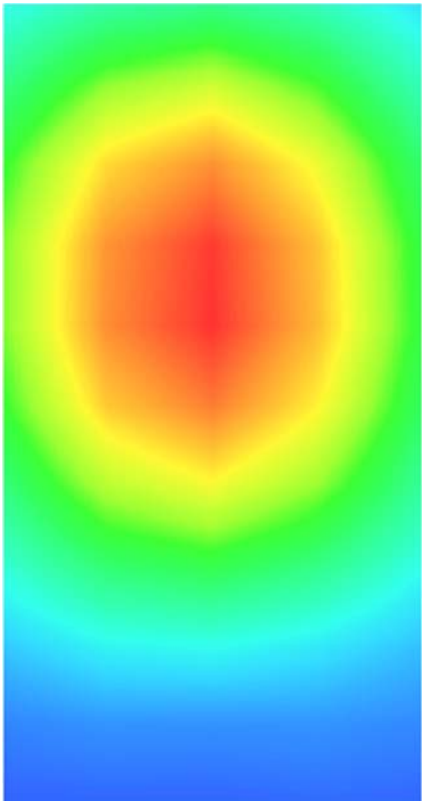
Maximum location: X=0.00, Y=8.00

SAR 10g (W/Kg)	5.156024
SAR 1g (W/Kg)	9.789668

Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0000	10.6419	6.0043	3.7297	2.2606	1.5119	0.9792



3D sceen shot	Hot spot position
	

System Performance Check (Head, 2450MHz)

Type: Phone measurement (Complete)

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm

Date of measurement: 8/28/2013

Measurement duration: 15 minutes 24 seconds

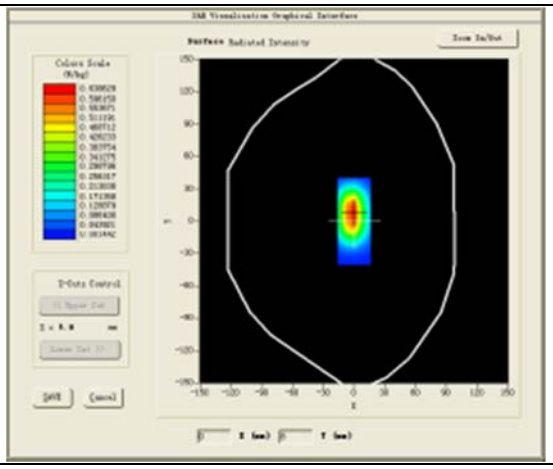
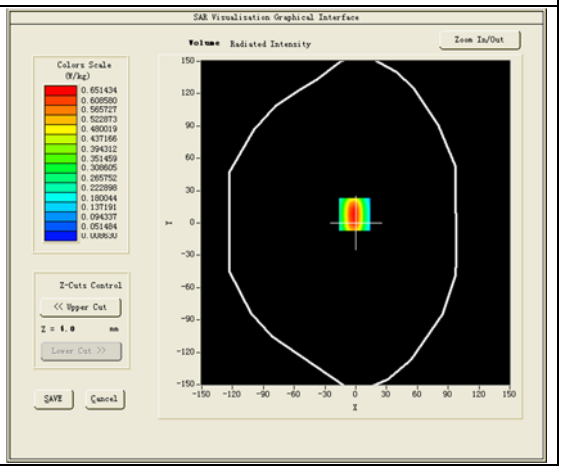
A. Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Device Position	Dipole
Band	2450MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

Frequency (MHz)	2450.000000
Relative permittivity (real part)	38.96
Relative permittivity	13.19
Conductivity (S/m)	1.79
Power Drift (%)	0.160000
Crest factor:	1:1

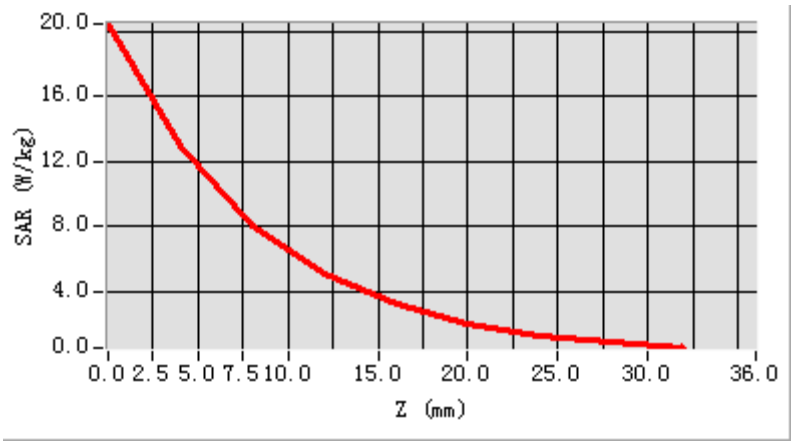
SURFACE SAR	VOLUME SAR
	

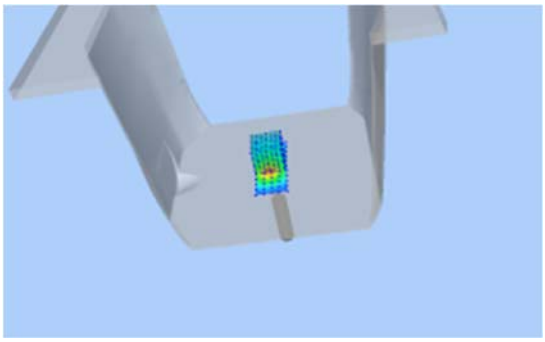
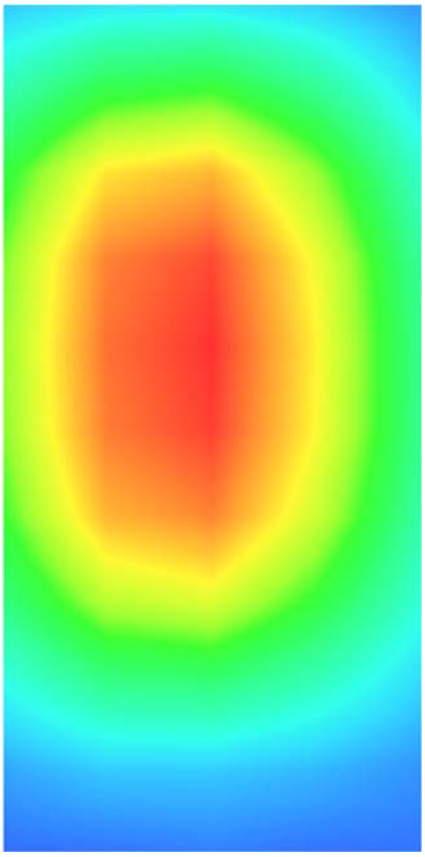
Maximum location: X=0.00, Y=8.00

SAR 10g (W/Kg)	5.914682
SAR 1g (W/Kg)	13.160218

Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	20.3890	13.160218	3.8625	0. 8019	0.2333



3D sceen shot	Hot spot position
	

System Performance Check (Body, 835MHz)

Type: Phone measurement (Complete)

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm

Date of measurement: 8/29/2013

Measurement duration: 13 minutes 12 seconds

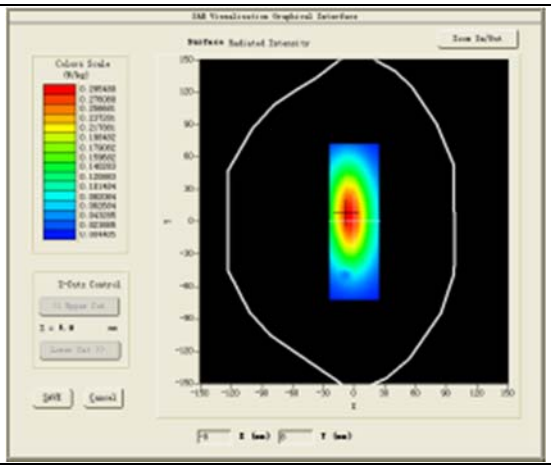
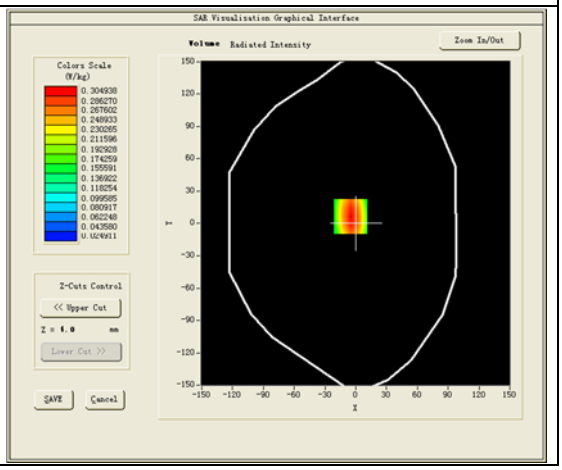
A. Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Flat Plane
Device Position	Dipole
Band	835MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

Frequency (MHz)	835.000000
Relative permittivity (real part)	55.38
Relative permittivity	21.72
Conductivity (S/m)	0.99
Power drift (%)	0.120000
Crest factor:	1:1

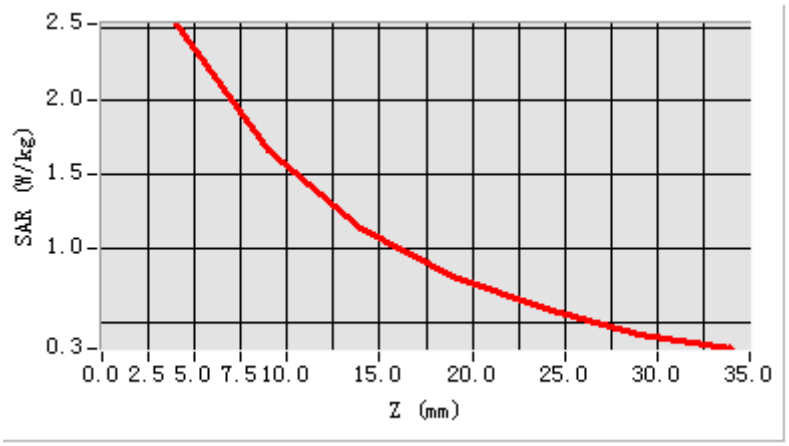
SURFACE SAR	VOLUME SAR
	

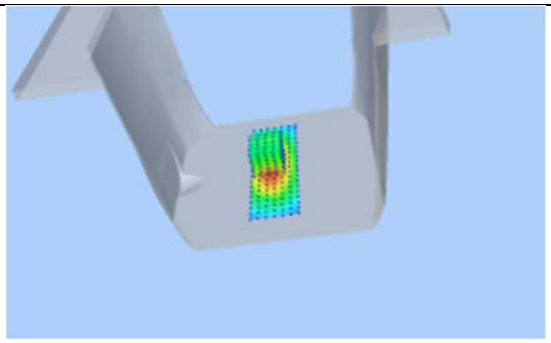
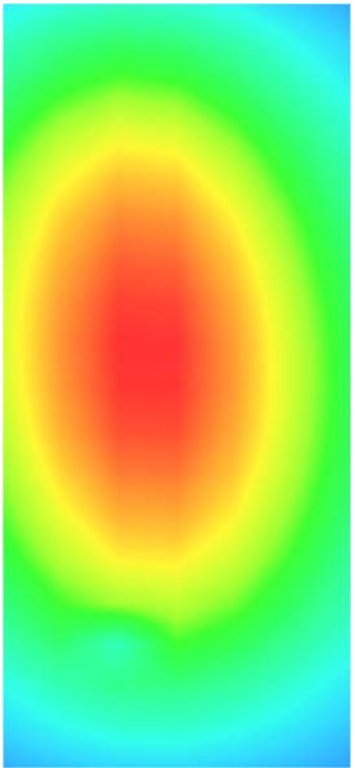
Maximum location: X=-8.00, Y=8.00

SAR 10g (W/Kg)	1.743219
SAR 1g (W/Kg)	2.430218

Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00	24.00	29.00
SAR (W/Kg)	0.0000	2.5209	1.6629	1.1437	0.8075	0.5889	0.4143



3D sceen shot	Hot spot position
	

System Performance Check (Body, 1900MHz)

Type: Phone measurement (Complete)

Area scan resolution: dx=8mm,dy=8mm

Zoom scan resolution: dx=8mm, dy=8mm, dz=5mm

Date of measurement: 8/29/2013

Measurement duration: 14 minutes 12 seconds

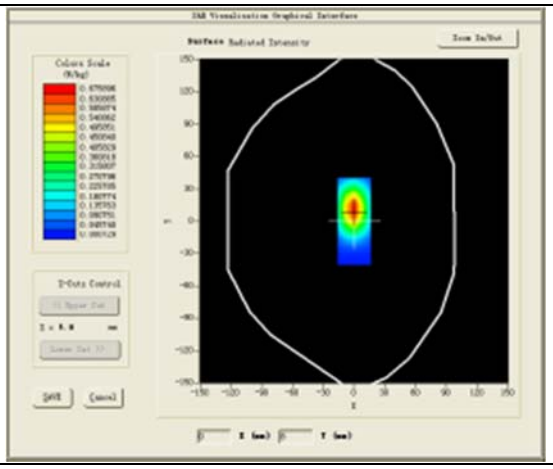
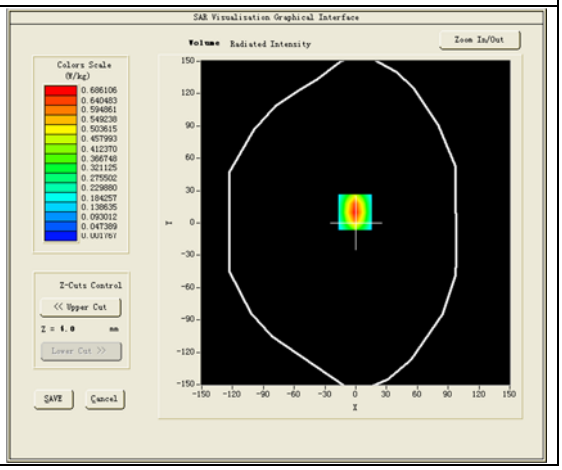
A. Experimental conditions.

Phantom File	surf_sam_plan.txt
Phantom	Validation plane
Device Position	Dipole
Band	1900MHz
Channels	
Signal	CW

B. SAR Measurement Results

Band SAR

Frequency (MHz)	1900.000000
Relative permittivity (real part)	53.67
Relative permittivity	13.02
Conductivity (S/m)	1.51
Power Drift (%)	0.220000
Crest factor:	1:1

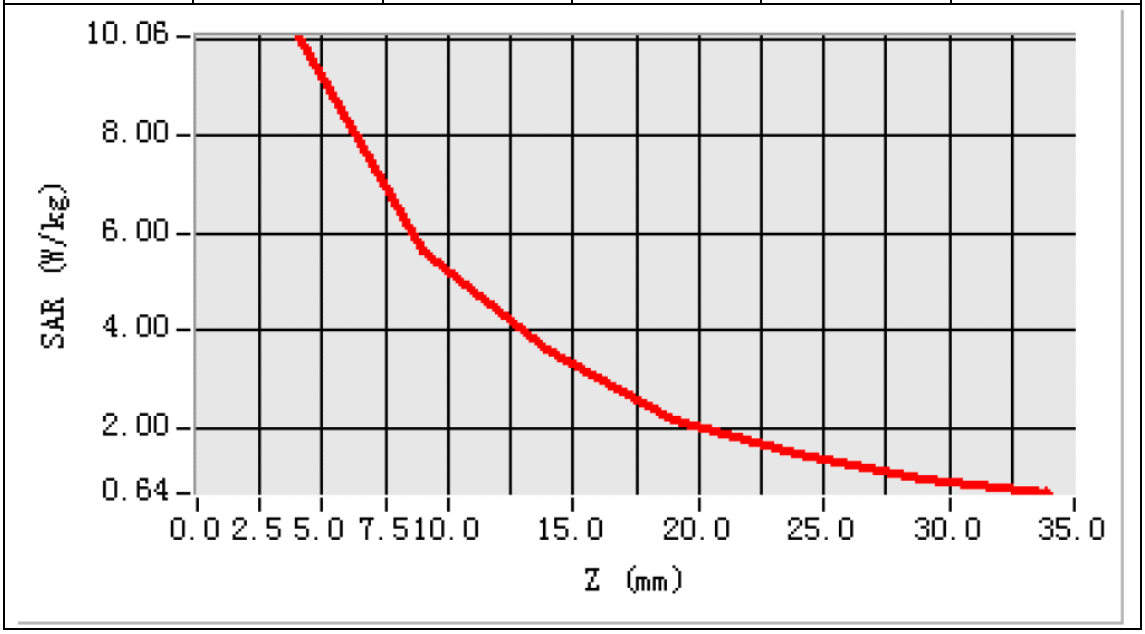
SURFACE SAR	VOLUME SAR
	

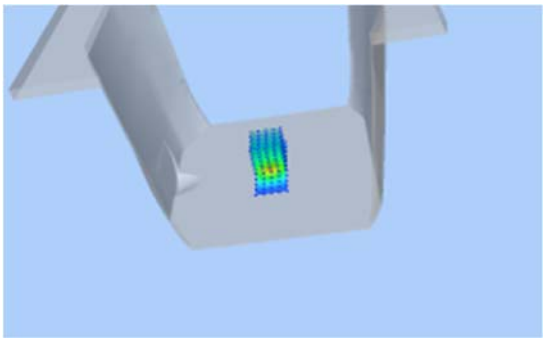
Maximum location: X=0.00, Y=8.00

SAR 10g (W/Kg)	5.201543
SAR 1g (W/Kg)	9.986241

Z Axis Scan

Z (mm)	0.00	4.00	9.00	14.00	19.00
SAR (W/Kg)	0.0000	10.0613	5.7282	3. 6529	2.0314



3D sceen shot	Hot spot position
	

ANNEX D

of

CCIC-SET

CONFORMANCE TEST REPORT FOR

HUMAN EXPOSURE TO ELECTROMAGNETIC FIELDS

SET2013-05214

CARBONADO

Type Name: Carbonado smart PTT case for iPhone

Hardware Version： V2.0

Software Version： V2.0

Calibration Certificate of Probe and Dipoles

This Annex consists of 3 pages

Date of Report：2013-09-06

Probe Calibration Ceriticate

COMOSAR E-Field Probe Calibration Report

Ref : ACR.96.2.13.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO.,LTD

ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI. TOWN SHENZHEN,P.R.CHINA

SATIMO COMOSAR DOSIMETRIC E-FIELD PROBE

SERIAL NO.: SN 09/13 EP169

Calibrated at SATIMO US

2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED
Calibration CERT #2246.02

04/05/13

Summary:

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

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	4/5/2013	
Checked by :	Jérôme LUC	Product Manager	4/5/2013	
Approved by :	Kim RUTKOWSKI	Quality Manager	4/5/2013	

	Customer Name
Distribution :	Shenzhen EMC-united Co., Ltd

Issue	Date	Modifications
A	4/5/2013	Initial release

TABLE OF CONTENTS

1 DEVICE UNDER TEST

Device Under Test	
Device Type	COMOSAR DOSIMETRIC E FIELD PROBE
Manufacturer	Satimo
Model	SSE5
Serial Number	SN 09/13 EP169
Product Condition (new / used)	new
Frequency Range of Probe	0.7 GHz-3GHz
Resistance of Three Dipoles at Connector	Dipole 1: R1=0.223 MΩ Dipole 2: R2=0.233 MΩ Dipole 3: R3=0.222 MΩ

A yearly calibration interval is recommended.

2 PRODUCT DESCRIPTION

2.1 GENERAL INFORMATION

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

Figure 1 – *Satimo 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%

5 CALIBRATION MEASUREMENT RESULTS

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

5.1 SENSITIVITY IN AIR

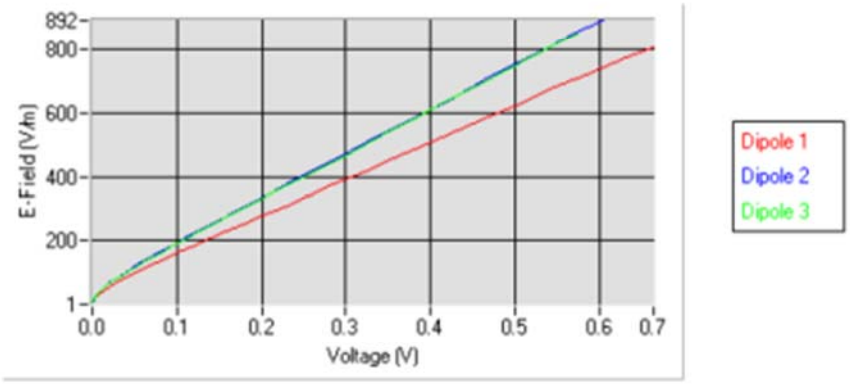
Normx dipole 1 (μV/(V/m)^2)	Normy dipole 2 (μV/(V/m)^2)	Normz dipole 3 (μV/(V/m)^2)
7.21	6.08	5.72

DCP dipole 1 (mV)	DCP dipole 2 (mV)	DCP dipole 3 (mV)
93	93	90

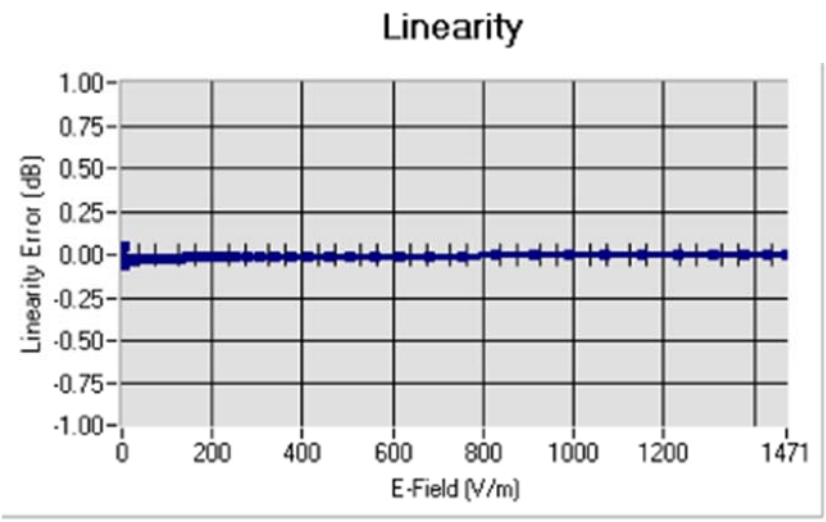
Calibration curves ei=f(V) (i=1,2,3) allow to obtain H-field value using the formula:

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

Calibration curves



5.2 LINEARITY



Linearity: +/-1.42% (+/-0.06dB)

5.3 SENSITIVITY IN LIQUID

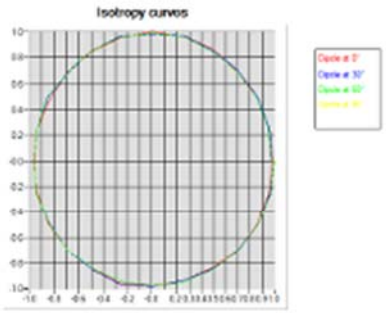
Liquid	Frequency (MHz +/- 100MHz)	Permittivity	Epsilon (S/m)	ConvF
HL850	835	42.56	0.88	5.52
BL850	835	55.26	0.96	5.67
HL900	900	41.79	0.96	5.19
BL900	900	55.98	1.04	5.32
HL1800	1750	40.17	1.38	4.79
BL1800	1750	52.05	1.48	4.95
HL1900	1880	39.80	1.43	5.48
BL1900	1880	52.55	1.50	5.64
HL2000	1950	38.93	1.44	4.82
BL2000	1950	53.12	1.51	5.01
HL2450	2450	38.64	1.82	4.80
BL2450	2450	52.02	1.94	4.90

LOWER DETECTION LIMIT: 9mW/kg

5.4 ISOTROPY

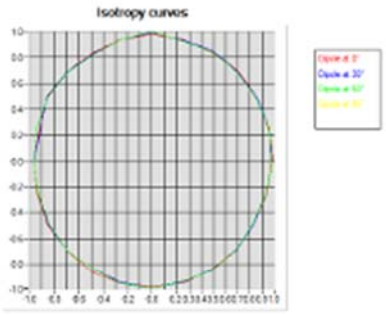
HL900 MHz

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



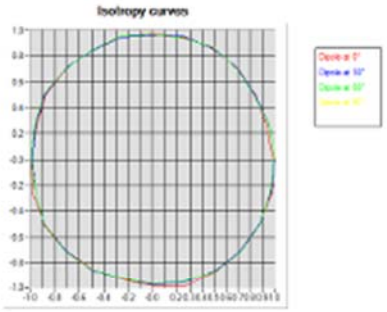
HL1800 MHz

- Axial isotropy: 0.05 dB
- Hemispherical isotropy: 0.07 dB



HL2450 MHz

- Axial isotropy: 0.06 dB
- Hemispherical isotropy: 0.09 dB



6 LIST OF EQUIPMENT

Equipment Summary Sheet				
Equipment Description	**Manufacturer / Model**	**Identification No.**	**Current Calibration Date**	**Next Calibration Date**
Flat Phantom	Satimo	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	02/2013	02/2016
Reference Probe	Satimo	EP 94 SN 37/08	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Multimeter	Keithley 2000	1188656	11/2010	11/2013
Signal Generator	Agilent E4438C	MY49070581	12/2010	12/2013
Amplifier	Aethercomm	SN 046	Characterized prior to test. No cal required.	Characterized prior to test. No cal required.
Power Meter	HP E4418A	US38261498	11/2010	11/2013
Power Sensor	HP ECP-E26A	US37181460	11/2010	11/2013
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	3/2012	3/2014

SID835 Dipole Calibration Ceriticate

SAR Reference Dipole Calibration Report

Ref : ACR.96.3.13.SATU.A

CCIC SOUTHERN ELECTRONIC PRODUCT TESTING (SHENZHEN) CO.,LTD

ELECTRONIC TESTING BUILDING,SHAHE ROAD, XILI TOWN SHENZHEN,P.R.CHINA

SATIMO COMOSAR REFERENCE DIPOLE

FREQUENCY: 835 MHZ

Calibrated at SATIMO US

2105 Barrett Park Dr. - Kennesaw, GA 30144

ACCREDITED

Calibration CERT #2246.02

04/05/13

Summary:

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

	Name	Function	Date	Signature
Prepared by :	Jérôme LUC	Product Manager	4/5/2013	
Checked by :	Jérôme LUC	Product Manager	4/5/2013	
Approved by :	Kim RUTKOWSKI	Quality Manager	4/5/2013	

	Customer Name
Distribution :	Shenzhen EMC-united Co., Ltd

Issue	Date	Modifications
A	4/5/2013	Initial release

TABLE OF CONTENTS

1 INTRODUCTION

This document contains a summary of the requirements set forth by the IEEE 1528, OET 65 Bulletin C 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	Satimo
Model	SID835
Serial Number	SN 09/13 DIP0G835-217
Product Condition (new / used)	new

A yearly calibration interval is recommended.

3 PRODUCT DESCRIPTION

3.1 GENERAL INFORMATION

Satimo's COMOSAR Validation Dipoles are built in accordance to the IEEE 1528, OET 65 Bulletin C and CEI/IEC 62209 standards. The product is designed for use with the COMOSAR test bench only.

Figure 1 – *Satimo COMOSAR Validation Dipole*

4 MEASUREMENT METHOD

The IEEE 1528, OET 65 Bulletin C 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

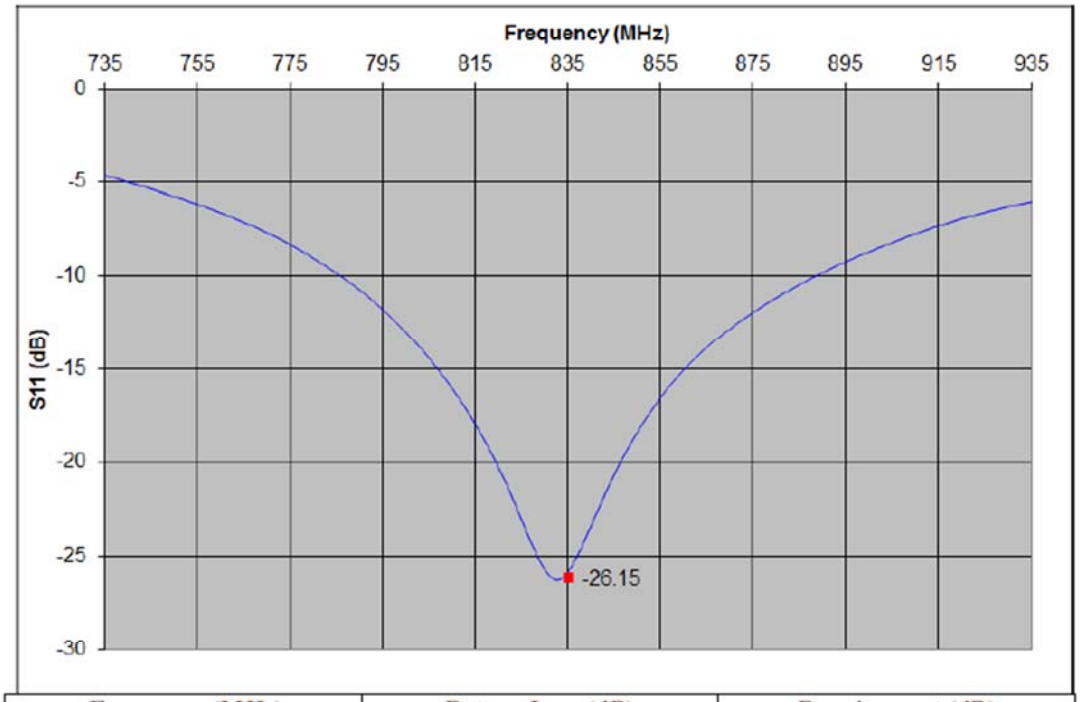
5.3 VALIDATION MEASUREMENT

The guidelines outlined in the IEEE 1528, OET 65 Bulletin C, CENELEC EN50361 and CEI/IEC 62209 standards were followed to generate the measurement uncertainty for validation measurements.

Scan Volume	Expanded Uncertainty
1 g	16.19 %
10 g	15.86 %

6 CALIBRATION MEASUREMENT RESULTS

6.1 RETURN LOSS



Frequency (MHz)	Return Loss (dB)	Requirement (dB)
835	-26.15	-20

6.2 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 %.		100.0 ±1 %.		6.35 ±1 %.	
835	161.0 ±1 %.	PASS	89.8 ±1 %.	PASS	3.6 ±1 %.	PASS
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, OET 65 Bulletin C 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 MEASUREMENT CONDITION

Software	OPENSAR V4
Phantom	SN 20/09 SAM71
Probe	SN 18/11 EPG122
Liquid	Head Liquid Values: eps' : 42.6 sigma : 0.88
Distance between dipole center and liquid	15.0 mm
Area scan resolution	dx=8mm/dy=8mm
Zoon Scan Resolution	dx=8mm/dy=8m/dz=5mm
Frequency	835 MHz
Input power	20 dBm
Liquid Temperature	21 °C
Lab Temperature	21 °C
Lab Humidity	45 %

7.2 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 %		0.89 ±5 %	
835	41.5 ±5 %	PASS	0.90 ±5 %	PASS
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 %	
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 %	

7.3 MEASUREMENT RESULT

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.

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		5.55	
835	9.56	9.72 (0.97)	6.22	6.28 (0.63)
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	
1900	39.7		20.5	
1950	40.5		20.9	
2000	41.1		21.1	
2100	43.6		21.9	
2300	48.7		23.3	
2450	52.4		24	
2600	55.3		24.6	
3000	63.8		25.7	
3500	67.1		25	