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Report On

Specific Absorption Rate Testing of the
Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM
(GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with
Bluetooth, Felica, WLAN and GPS

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This report has been up issued to Issue 2 to correct a typing error





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CONTENTS

Section	Page No
1	
2	3
REPORT SUMMARY	3
1.1 Introduction	4
1.2 Brief Summary of Results	5
1.3 Test Results Summary	5
1.4 Product Information	9
1.5 FCC Power Measurements	11
3	13
TEST DETAILS	13
2.1 SARA 2 SAR Measurement System	14
2.2 CDMA2000 800MHz Head SAR Test Results and Course Area Scans – 2D	20
2.3 CDMA2000 800MHz Head SAR Test Results and Course Area Scans – 2D	24
2.4 CDMA2000 800MHz Body SAR Test Results and Course Area Scans – 2D	25
2.5 PCS 1900MHz Head SAR Test Results and Course Area Scans – 2D	27
2.6 PCS 1900MHz Head SAR Test Results and Course Area Scans – 2D	31
2.7 PCS 1900MHz Body SAR Test Results and Course Area Scans – 2D	32
2.8 WLAN 2450MHz Head SAR Test Results and Course Area Scans – 2D	34
2.9 WLAN 2450MHz Head SAR Test Results and Course Area Scans – 2D	38
2.10 WLAN 2450MHz Body SAR Test Results and Course Area Scans – 2D	39
4	41
TEST EQUIPMENT USED	41
3.1 Test Equipment Used	42
3.2 Test Software	43
3.3 Dielectric Properties of Simulant Liquids	44
3.4 Test Conditions	45
3.5 Measurement Uncertainty	46
5	49
ACCREDITATION, DISCLAIMERS AND COPYRIGHT	49
4.1 Accreditation, Disclaimers and Copyright	50
ANNEX A	A.2
Probe Calibration Report	A.2



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SECTION 1

REPORT SUMMARY

Specific Absorption Rate Testing of the
Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM
(GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and
GPS



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1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Specific Absorption Rate Testing of the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS Mobile Handset to the requirements of OET Bulletin 65 Supplement C Edition 01-01.

Objective	To perform Specific Absorption Rate Testing to determine the Equipment Under Test's (EUT's) compliance with the requirements specified of OET Bulletin 65 Supplement C Edition 01-01, for the series of tests carried out.
Applicant	Sharp Communication Compliance Ltd
Manufacturer	Sharp Corporation
Manufacturing Description	Mobile Handset
Model Number	CDMA SHI15
Power Class	CDMA2000 Class 0 PCS 1900 MHz Class 1
GPRS Class	B
GPRS Multi-slot Class	10
Serial/IMEI Number(s)	004401114000181 004401114000199 004401114000231
Number of Samples Tested	3
Hardware Version	PP2
Software Version	D4232/A4200/A5220
Battery Cell Manufacturer	Sharp Corporation
Battery Model Number	SHI15UAA
Test Specification/Issue/Date	FCC OET65 C:2001
Start of Test	30 May 2012
Finish of Test	31 May 2012
Related Document(s)	FCC 47CFR 2.1093 KDB 248227 – v01r02 (Rev 1.2) KDB 450824 – D01 v01r01(Rev 1.1) KDB 450824 – D02 v01r01 KDB 648474 – D01 v01r05 KDB 941225 – D01 v02 KDB 941225 – D03 v01 IEEE 1528-2003
Name of Engineer(s)	Mark Jenkins



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1.2 BRIEF SUMMARY OF RESULTS

The measurements shown in this report were made in accordance with the procedures specified OET 65(C) – 2001.

The maximum 1g volume averaged SAR found during this Assessment

Max 1g SAR (W/kg)	0.581
The maximum 1g volume averaged SAR level measured for all the tests performed did not exceed the limits for General Population/Uncontrolled Exposure (W/kg) Partial Body of 1.6 W/kg. Level defined in Supplement C (Edition 01-01) to OET Bulletin 65 (97-01).	

1.3 TEST RESULTS SUMMARY

1.3.1 System Performance / Validation Check Results

Prior to formal testing being performed a System Check was performed in accordance with OET 65(C) – 2001 and the results were compared against published data in Standard IEEE 1528-2003. The following results were obtained: -

System performance / Validation results

Date	Dipole Used	Frequency (MHz)	Max 1g SAR (W/kg)*	Percentage Drift on Reference	Max 10g SAR (W/kg)*	Percentage Drift on Reference
31/05/2012	835	835	9.42	-1.52%	6.34	1.89%
30/05/2012	1900	1900	41.52	4.58%	22.07	7.66%
30/05/2012	2450	2450	48.35	-7.72%	23.07	-3.89%

*Normalised to a forward power of 1W



1.3.2 Results Summary Tables

CDMA2000 Head Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS in slider open position.

Position		Channel Number	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Ear	Head							
Left	Cheek	777	848.31	0.490	0.457	0.357	-3.760	Figure 8
Left	15°	777	848.31	0.350	0.299	0.230	1.320	Figure 9
Right	Cheek	777	848.31	0.540	0.499	0.374	-0.050	Figure 10
Right	15°	777	848.31	0.240	0.232	0.180	6.240	Figure 11
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								

CDMA2000 Head Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS in slider closed position.

Position		Channel Number	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Ear	Head							
Right	Cheek	777	848.31	0.290	0.279	0.207	-5.240	Figure 12
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								

CDMA2000 Body Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS.

Position		Channel Number	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Spacing	Direction							
15mm	Front Facing	777	848.31	0.190	0.224	0.161	-9.280	Figure 13
15mm	Rear Facing	777	848.31	0.410	0.461	0.330	-3.720	Figure 14
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								



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PCS 1900MHz Head Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS in slider open position.

Position		Channel Number	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Ear	Head							
Left	Cheek	512	1850.2	0.260	0.269	0.135	0.790	Figure 15
Left	15°	512	1850.2	0.160	0.160	0.098	1.950	Figure 16
Right	Cheek	512	1850.2	0.170	0.171	0.111	3.360	Figure 17
Right	15°	512	1850.2	0.150	0.166	0.088	6.070	Figure 18
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								

PCS 1900MHz Head Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS in slider closed position.

Position		Channel Number	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Ear	Head							
Left	Cheek	512	1850.2	0.300	0.259	0.181	1.310	Figure 19
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								

PCS 1900MHz Body Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS.

Position		Channel Number	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Spacing	Direction							
15mm	Front Facing	512	1850.2	0.290	0.366	0.236	-2.030	Figure 20
15mm	Rear Facing	512	1850.2	0.460	0.581	0.341	-2.110	Figure 21
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								



WLAN 2450MHz Head Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS in slider open position.

Position		Channel Number	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Ear	Head							
Left	Cheek	1	2412	0.040	0.038	0.024	2.800	Figure 22
Left	15°	1	2412	0.020	0.021	0.012	0.000	Figure 23
Right	Cheek	1	2412	0.030	0.031	0.020	0.000	Figure 24
Right	15°	1	2412	0.020	0.015	0.010	-6.120	Figure 25
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								

WLAN 2450MHz Head Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS in slider closed position.

Position		Channel Number	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Ear	Head							
Left	Cheek	1	2412	0.150	0.164	0.089	-1.870	Figure 26
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								

WLAN 2450MHz Body Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS.

Position		Channel Number	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Spacing	Direction							
15mm	Front Facing	1	2412	0.030	0.037	0.022	0.000	Figure 27
15mm	Rear Facing	1	2412	0.040	0.054	0.035	0.000	Figure 28
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								



1.4 PRODUCT INFORMATION

1.4.1 Technical Description

The equipment under test (EUT) was a Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM (GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and GPS. A full technical description can be found in the manufacturer's documentation.

1.4.2 Test Configuration and Modes of Operation

The testing was performed with standard batteries supplied and manufactured by Sharp Corporation. Each battery was fully charged before each measurement and there were no external connections.

For head SAR assessment, testing was performed with the device in the declared normal position of operation for CDMA2000 800MHz, PCS 1900MHz and WLAN 2.4GHz frequency bands at maximum power. The device was placed against a Specific Anthropomorphic Mannequin (SAM) phantom as specified in the CENELEC standard EN 62209-1: 2006. The phantom was filled with simulant liquid appropriate to the frequency band. The dielectric properties were measured and found to be in accordance with the requirements for the dielectric properties specified in OET 65(C) – 2001. Testing was performed at both the left and right ear of the phantom at both handset positions stated in the applied specification.

For body SAR assessment, the device was tested for typical body-worn operation in accordance with the requirements of OET65(c) with the exception of SAR limits applied, these were obtained from ICNIRP (1998). Flat phantom dimensions are 210mmx210mmx210mm and with a sidewall thickness of 6.0mm. The phantom was filled to a depth of 150mm with the appropriate body simulant liquid. The dielectric properties were in accordance with the requirements specified in Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01). SAR testing was performed with the body of the device placed at 15mm separation from the phantom.

Testing was performed in each position at the frequency that gave the highest output power for each band. No SAR level was found to be within -3dB of the applicable limit (-3dB equates to ≤ 0.802 W/kg in this instance) therefore no additional testing was required at the remaining frequencies / channels of the bands. WLAN testing was achieved using the devices internal software, customer supplied software and settings supplied by the customer.. The worse case data rate for WLAN testing was obtain from data provided by TUV Product Service determined by the testing of the handset. The worst case was deemed as the data rate which produced the highest level of conducted average power. This was 1Mbps for 802.11b.

Simultaneous transmission SAR testing for Head/Body for CDMA2000 800MHz and WLAN was not required because the antenna separation distance is greater than 5cm and the maximum SAR levels obtained for both transmitters is less than 0.8W/kg.

Simultaneous transmission SAR testing for Head/Body for CDMA2000 800MHz and BT was not required because the antenna separation distance is greater than 5cm and the Bluetooth conducted output power is less than 24mW.

Simultaneous transmission SAR testing for Head/Body for WLAN and BT was not required because the antenna separation distance is less than 2.5cm and the Bluetooth conducted output power is less than 24mW.

Stand alone SAR testing for Bluetooth was not required due to the output power being less than the threshold.



The following configurations and procedures for SAR testing were used:

HEAD SAR:

SAR for the head exposure configurations is measured in RC3 with the EUT configured to transmit at full rate using Loopback Service Option SO55.

SAR for RC1 is not required when the maximum average output of each channel is less than 0.25dB higher than that measured in RC3. If SAR for RC1 is required, then SAR is measured on the maximum output channel in RC1 using the exposure configuration that results in the highest SAR for that channel in RC3

BODY SAR:

SAR for the body exposure configuration is measured in RC3 with the EUT configured using TDSO32, to transmit at full rate on FCH with all other code channels disabled.

SAR for multiple code channels (FCH + SCH) is not required when the maximum average output of each RF channel is less than 0.25dB higher than that measured with FCH only. If SAR for multiple code channels is required then SAR is measured on the maximum output channel (FCH + SCHn) with FCH at full rate and SCH0 enabled at 9600bps, using the exposure configuration that results in the highest SAR with FCH only for that channel. When multiple code channels are enabled, the DUT may shift by more than 0.5dB and lead to higher SAR drifts and SCH dropouts.

Body SAR in RC1 is not required when the maximum average output of each channel is less than 0.25dB higher than that measured in RC3. If SAR for RC1 is required, then SAR is measured on the maximum output channel in RC1; with Loopback Service Option SO55, at full rate, using the body exposure configuration that results in the highest SAR that channel in RC3.

Included in this report are descriptions of the test method; the equipment used and an analysis of the test uncertainties applicable and diagrams indicating the locations of maximum SAR for each test position along with photographs indicating the positioning of the handset against the body as appropriate



1.5 FCC POWER MEASUREMENTS

1.5.1 Method

Conducted power measurements were made using a power meter.

1.5.2 Conducted Power Measurements

CDMA2000 800MHz

Head

TUV Sample No.	Mode	Modulation	Frequency	Conducted Carrier Power (dBm)
75	S055, RC1	64-RAY Orthogonal	824.70	22.81
			836.52	22.88
			848.31	22.94

TUV Sample No.	Mode	Modulation	Frequency	Conducted Carrier Power (dBm)
75	S055, RC3	64-RAY Orthogonal	824.70	22.81
			836.52	22.86
			848.31	22.95

Body

TUV Sample No.	Mode	Modulation	Frequency	Conducted Carrier Power (dBm)
75	TDS032,	BPSK	824.70	22.81
	FCH		836.52	22.79
	RC3		848.31	22.96

TUV Sample No.	Mode	Modulation	Frequency	Conducted Carrier Power (dBm)
75	TDS032,	BPSK	824.70	22.81
	FCH +SCH		836.52	22.80
	RC3		848.31	22.96



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WLAN

Mode	Modulation	Frequency	Conducted Carrier Power (dBm) IMEI	Radiated Carrier Power(dBm) IMEI 004401113851006	Peak to Average Ratio (dB)	Corrected Radiated Carrier Power for SAR Report (dBm)
802.11 1 Mbps	DSSS	2412	18.05	17.39	3.37	14.02
		2437	17.86	16.47	3.43	13.04
		2462	17.86	16.59	3.48	13.11

PCS

Head

TUV Sample No.	Mode	Modulation	Frequency (MHz)	Conducted Carrier Power (dBm)
65	Voice	GMSK	1850.2	20.33
			1880.0	20.33
			1909.8	20.33

Body

TUV Sample No.	Mode	Modulation	Frequency (MHz)	Conducted Carrier Power (dBm)
65	GPRS	GMSK	1850.2	23.09
			1880.0	23.07
			1909.8	22.75



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SECTION 2

TEST DETAILS

Specific Absorption Rate Testing of the
Sharp CDMA SHI15 Dual-band CDMA (BC0, BC6) and Tri-band GSM
(GSM900/DCS1800/PCS1900) Dual mode Cellular Phone with Bluetooth, Felica, WLAN and
GPS Mobile Handset



2.1 SARA 2 SAR MEASUREMENT SYSTEM

2.1.1 Robot System Specification

The SAR measurement system being used is the IndexSAR SARA2 system, which consists of a Mitsubishi RV-E2 6-axis robot arm and controller, IndexSAR probe and amplifier and SAM phantom Head Shape. The robot is used to articulate the probe to programmed positions inside the phantom head to obtain the SAR readings from the DUT.

Schematic diagram of the SAR measurement system

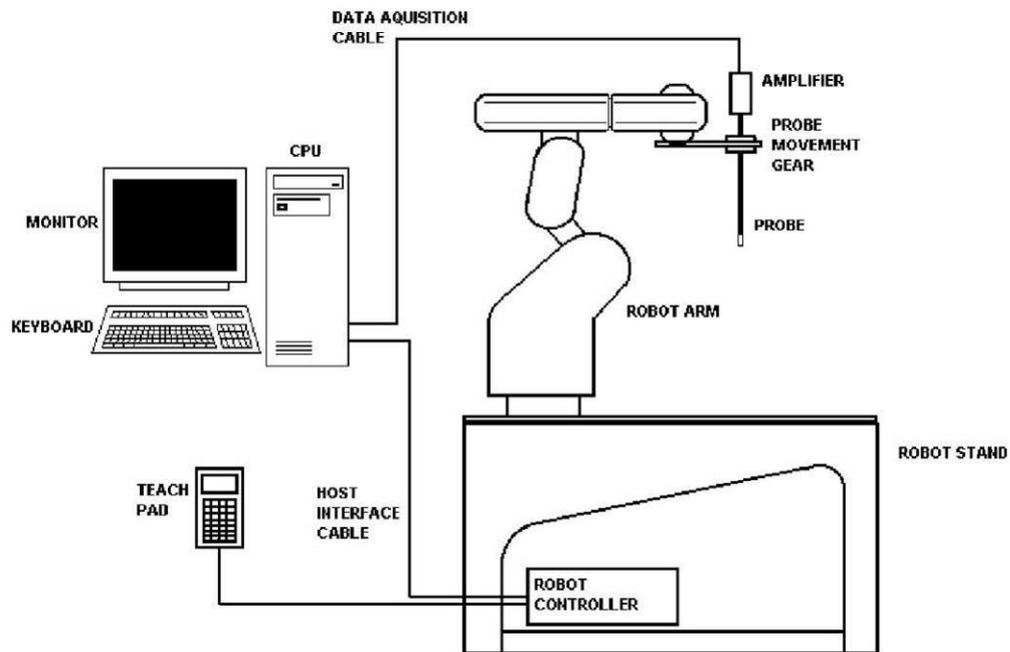


Figure 1

The system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

The position and digitised shape of the phantom heads are made available to the software for accurate positioning of the probe and reduction of set-up time.

The SAM phantom heads are individually digitised using a Mitutoyo CMM machine to a precision of 0.001mm. The data is then converted into a shape format for the software, providing an accurate description of the phantom shell.

In operation, the system first does an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom. When the maximum SAR point has been found, the system will then carry out a 3D scan centred at that point to determine volume averaged SAR level.



2.1.2 Probe and Amplifier Specification

IXP-050 IndexSAR isotropic immersible SAR probe

The probes are constructed using three orthogonal dipole sensors arranged on an interlocking, triangular prism core. The probes have built-in shielding against static charges and are contained within a PEEK cylindrical enclosure material at the tip. Probe calibration is described in the following section.

IFA-010 Fast Amplifier

Technical description of IndexSAR IFA-010 Fast probe amplifier

A block diagram of the fast probe amplifier electronics is shown below.

Block diagram of the fast probe amplifier electronic

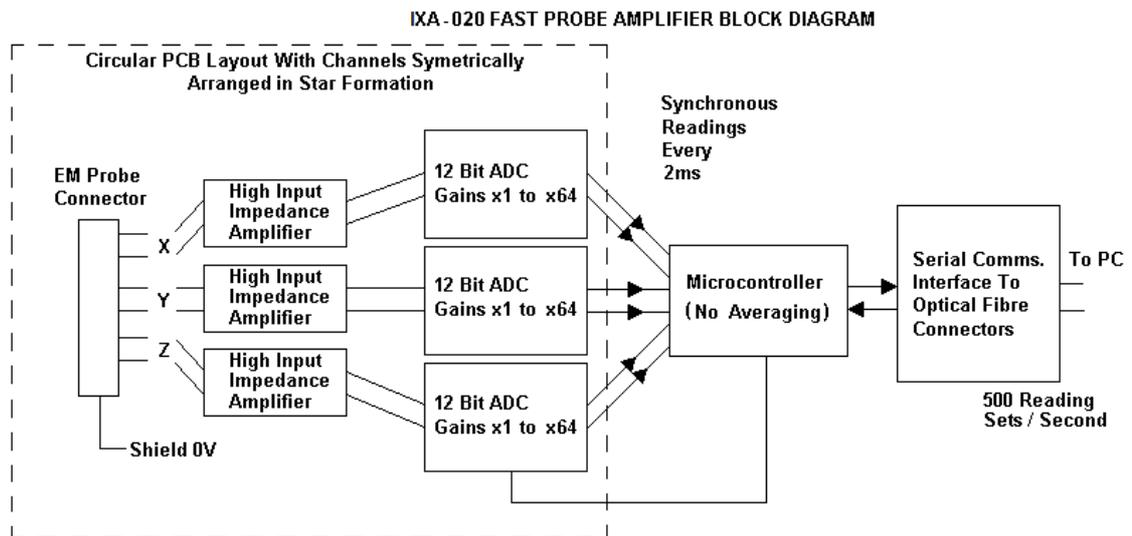


Figure 2

This amplifier has a time constant of approx. $50\mu\text{s}$, which is much faster than the SAR probe response time. The overall system time constant is therefore that of the probe ($<1\text{ms}$) and reading sets for all three channels (simultaneously) are returned every 2ms to the PC. The conversion period is approx. $1\mu\text{s}$ at the start of each 2ms period. This enables the probe to follow pulse modulated signals of periods $\gg 2\text{ms}$. The PC software applies the linearisation procedure separately to each reading, so no linearisation corrections for the averaging of modulated signals are needed in this case. It is important to ensure that the probe reading frequency and the pulse period are not synchronised and the behaviour with pulses of short duration in comparison with the measurement interval need additional consideration.

Phantoms

The Flat phantom used is a rectangular Perspex Box IndexSAR item IXB-070. Dimensions 210w 210d 210h (mm). This phantom is used with IndexSAR side bench IXM-030.

The Specific Anthropomorphic Mannequin (SAM) Upright Phantom is fabricated using moulds generated from the CAD files as specified by CENELEC EN 62209-1: 2006. It is mounted via a rotation base to a supporting table, which also holds the robotic positioner. The phantom and robot alignment is assured by both mechanical and laser registration systems.



2.1.3 SAR Measurement Procedure

Principal components of the SAR measurement test bench



Figure 3

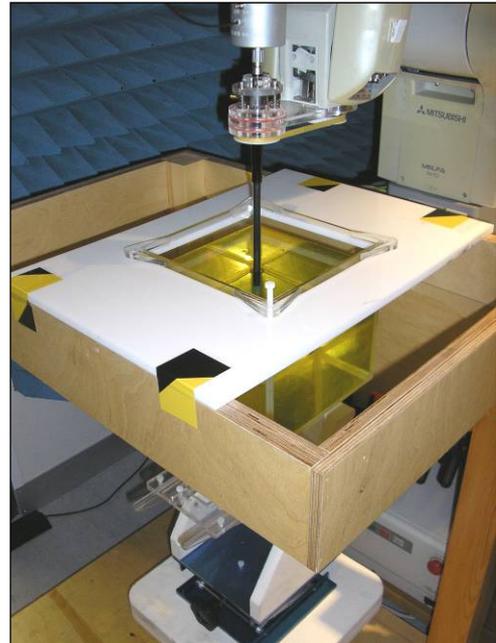


Figure 4

The major components of the test bench are shown in the pictures above. A test set and dipole antenna control the handset via an air link and a low-mass phone holder can position the phone at either ear. Graduated scales are provided to set the phone in the 15 degree position. The upright phantom head holds approx. 7 litres of simulant liquid. The phantom is filled and emptied through a 45mm diameter penetration hole in the top of the head.

After an area scan has been done at a fixed distance of 8mm from the surface of the phantom on the source side, a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power drift during measurement to be assessed.

SARA2 Interpolation and Extrapolation schemes

SARA2 software contains support for both 2D cubic B-spline interpolation as well as 3D cubic B-spline interpolation. In addition, for extrapolation purposes, a general n^{th} order polynomial fitting routine is implemented following a singular value decomposition algorithm presented in [4]. A 4th order polynomial fit is used by default for data extrapolation, but a linear-logarithmic fitting function can be selected as an option. The polynomial fitting procedures have been tested by comparing the fitting coefficients generated by the SARA2 procedures with those obtained using the polynomial fit functions of Microsoft Excel when applied to the same test input data.



Interpolation of 2D area scan

The 2D cubic B-spline interpolation is used after the initial area scan at fixed distance from the phantom shell wall. The initial scan data are collected with approx. 115mm spatial resolution and spline interpolation is used to find the location of the local maximum to within a 1mm resolution for positioning the subsequent 3D scanning.

Extrapolation of 3D scan

For the 3D scan, data are collected on a spatially regular 3D grid having (by default) 6.4 mm steps in the lateral dimensions and 3.5 mm steps in the depth direction (away from the source). SARA2 enables full control over the selection of alternative step sizes in all directions.

The digitised shape of the head is available to the SARA2 software, which decides which points in the 3D array are sufficiently well within the shell wall to be 'visited' by the SAR probe. After the data collection, the data are extrapolated in the depth direction to assign values to points in the 3D array closer to the shell wall. A notional extrapolation value is also assigned to the first point outside the shell wall so that subsequent interpolation schemes will be applicable right up to the shell wall boundary.

Interpolation of 3D scan and volume averaging

The procedure used for defining the shape of the volumes used for SAR averaging in the SARA2 software follow the method of adapting the surface of the 'cube' to conform with the curved inner surface of the phantom (see Appendix C.2.2.1 in EN 62209-1: 2006). This is called, here, the conformal scheme.

For each row of data in the depth direction, the data are extrapolated and interpolated to less than 1mm spacing and average values are calculated from the phantom surface for the row of data over distances corresponding to the requisite depth for 10g and 1g cubes. This results in two 2D arrays of data, which are then cubic B-spline interpolated to sub mm lateral resolution. A search routine then moves an averaging square around through the 2D array and records the maximum value of the corresponding 1g and 10g volume averages. For the definition of the surface in this procedure, the digitised position of the headshell surface is used for measurement in head-shaped phantoms. For measurements in rectangular, box phantoms, the distance between the phantom wall and the closest set of gridded data points is entered into the software.

For measurements in box-shaped phantoms, this distance is under the control of the user. The effective distance must be greater than 2.5mm as this is the tip-sensor distance and to avoid interface proximity effects, it should be at least 5mm. A value of 6 or 8mm is recommended. This distance is called **dbe** in EN 62209-1: 2006.

For automated measurements inside the head, the distance cannot be less than 2.5mm, which is the radius of the probe tip and to avoid interface proximity effects, a minimum clearance distance of x mm is retained. The actual value of **dbe** will vary from point to point depending upon how the spatially-regular 3D grid points fit within the shell. The greatest separation is when a grid point is just not visited due to the probe tip dimensions. In this case the distance could be as large as the step-size plus the minimum clearance distance (i.e with $x=5$ and a step size of 3.5, **dbe** will be between 3.5 and 8.5mm).

The default step size (**dstep** in EN 62209-1: 2006) used is 3.5mm, but this is under user-control. The compromise is with time of scan, so it is not practical to make it much smaller or scan times become long and power-drop influences become larger.



Product Service

The robot positioning system specification for the repeatability of the positioning (**dss** in EN 62209-1: 2006) is +/- 0.04mm.

The phantom shell is made by an industrial moulding process from the CAD files of the SAM shape, with both internal and external moulds. For the upright phantoms, the external shape is subsequently digitised on a Mitutoyo CMM machine (Euro C574) to a precision of 0.001mm. Wall thickness measurements made non-destructively with an ultrasonic sensor indicate that the shell thickness (**dph**) away from the ear is 2.0 +/- 0.1mm. The ultrasonic measurements were calibrated using additional mechanical measurements on available cut surfaces of the phantom shells.

For the upright phantom, the alignment is based upon registration of the rotation axis of the phantom on its 253mm-diameter baseplate bearing and the position of the probe axis when commanded to go to the axial position. A laser alignment tool is provided (procedure detailed elsewhere). This enables the registration of the phantom tip (**dmis**) to be assured to within approx. 0.2mm. This alignment is done with reference to the actual probe tip after installation and probe alignment. The rotational positioning of the phantom is variable – offering advantages for special studies, but locating pins ensure accurate repositioning at the principal positions (LH and RH ears).



2.1.4 Head Test Positions

This recommended practice specifies exactly two test positions for the handset against the head phantom, the “Cheek” position and the “tilted” position. These two test positions are defined in the following sub-clauses. The handset should be tested in both positions on the left and right sides of the SAM phantom. In each test position the centre of the earpiece of the device is placed directly at the entrance of the auditory canal. The angles mentioned in the test positions used are referenced to the line connecting both auditory canal openings. The plane this line is on is known as the reference plane. Testing is performed on the right and left-hand sides of the generic phantom head.

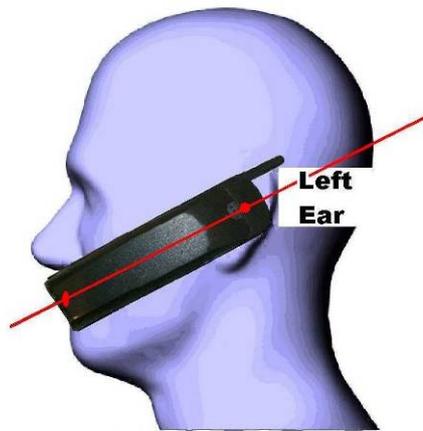


Figure 5. – Side View of Mobile next to head showing alignment.

The Cheek Position

The Cheek Position is where the mobile is in the reference plane and the line between the mobile and the line connecting both auditory canal openings is reduced until any part of the mobile touches any part of the generic twin phantom head.

The 15° Position

The 15° Position is where the mobile is in the reference Cheek position and the phone is kept in contact with the auditory canal at the earpiece; the bottom of the phone is then tilted away from the phantom mouth by 15°.

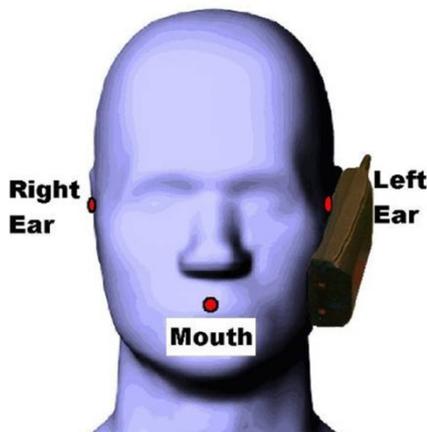


Figure 6. – Cheek Position.

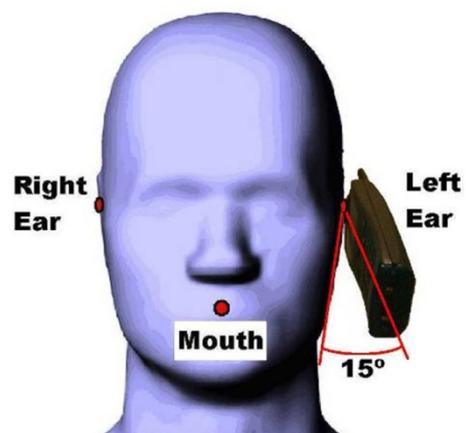


Figure 7. – 15° Tilt Position.



2.2 CDMA2000 800MHz HEAD SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 10:42:12	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	34.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	835Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	43.39
RELATIVE HUMIDITY:	39.00%	CONDUCTIVITY:	0.912
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	330°	MAX SAR Y-AXIS LOCATION:	-11.10mm
DUT POSITION:	Left-Cheek	MAX SAR Z-AXIS LOCATION:	-157.45mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	21.620
TEST FREQUENCY:	848.31MHz	SAR 1g:	0.457 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.357 W/kg
CONVERSION FACTORS:	0.204 / 0.193 / 0.195	SAR START:	0.310 W/kg
TYPE OF MODULATION:	64-RAY Orthogonal	SAR END:	0.298 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-3.760 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/05/2012
INPUT POWER LEVEL:	23dBm	EXTRAPOLATION:	poly4

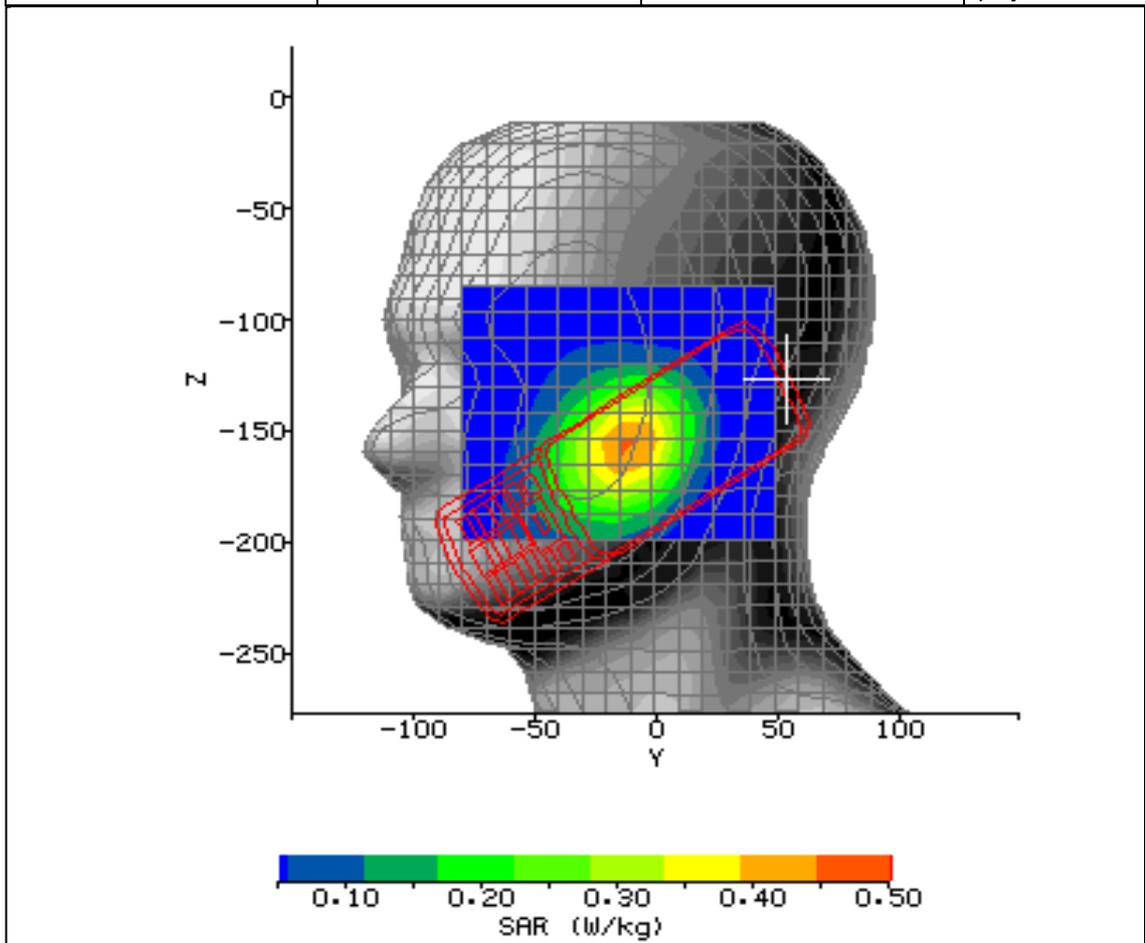


Figure 8: SAR Head Testing Results for the Sharp CDMA SHI15 at 848.31MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 11:05:27	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	35.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	835Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	43.39
RELATIVE HUMIDITY:	39.00%	CONDUCTIVITY:	0.912
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	330°	MAX SAR Y-AXIS LOCATION:	0.60mm
DUT POSITION:	Left-15°	MAX SAR Z-AXIS LOCATION:	-144.80mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	16.360
TEST FREQUENCY:	848.31MHz	SAR 1g:	0.299 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.230 W/kg
CONVERSION FACTORS:	0.204 / 0.193 / 0.195	SAR START:	0.193 W/kg
TYPE OF MODULATION:	64-RAY Orthogonal	SAR END:	0.196 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	1.320 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/05/2012
INPUT POWER LEVEL:	23dBm	EXTRAPOLATION:	poly4

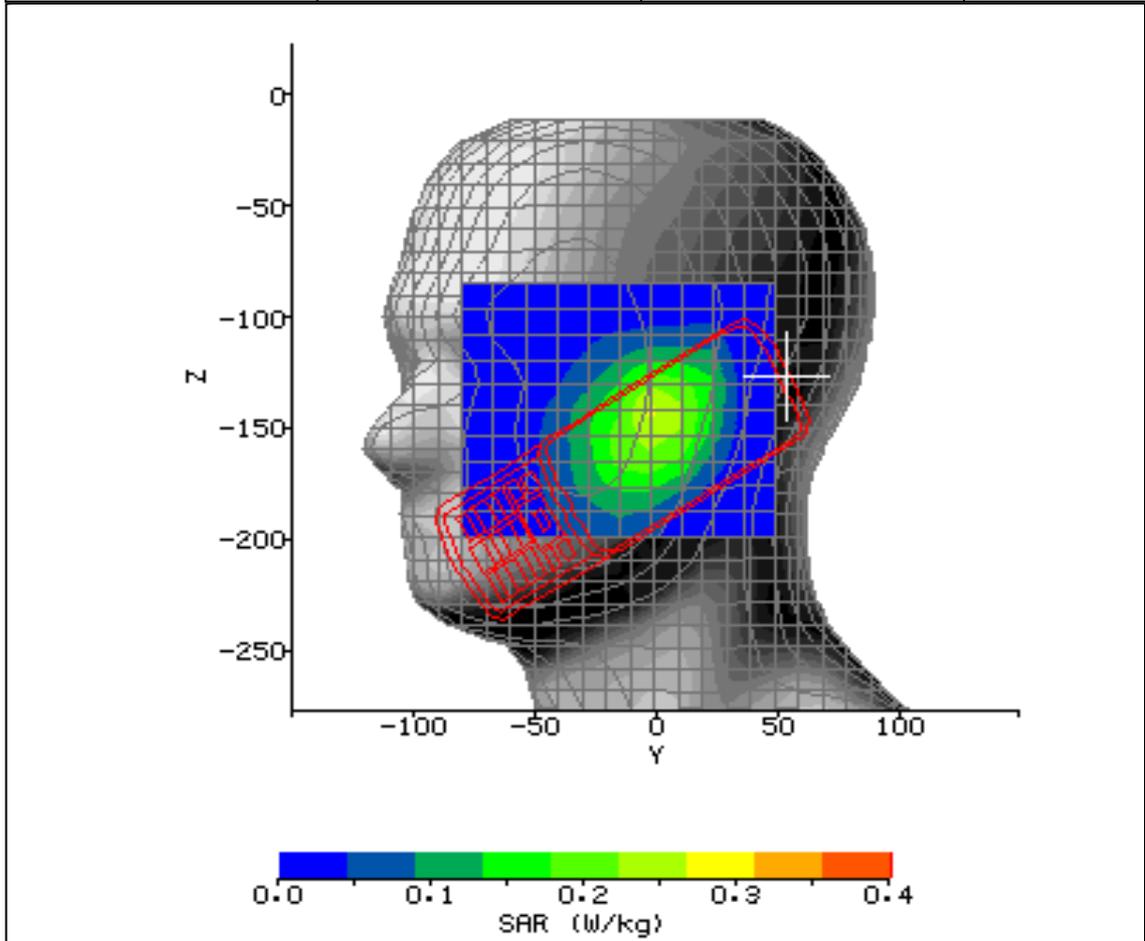


Figure 9: SAR Head Testing Results for the Sharp CDMA SHI15 at 848.31MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 11:40:35	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	36.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	835Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	43.39
RELATIVE HUMIDITY:	39.00%	CONDUCTIVITY:	0.912
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	210°	MAX SAR Y-AXIS LOCATION:	9.80mm
DUT POSITION:	Right-Cheek	MAX SAR Z-AXIS LOCATION:	-159.75mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	22.020
TEST FREQUENCY:	848.31MHz	SAR 1g:	0.499 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.374 W/kg
CONVERSION FACTORS:	0.204 / 0.193 / 0.195	SAR START:	0.325 W/kg
TYPE OF MODULATION:	64-RAY Orthogonal	SAR END:	0.325 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.050 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/05/2012
INPUT POWER LEVEL:	23dBm	EXTRAPOLATION:	poly4

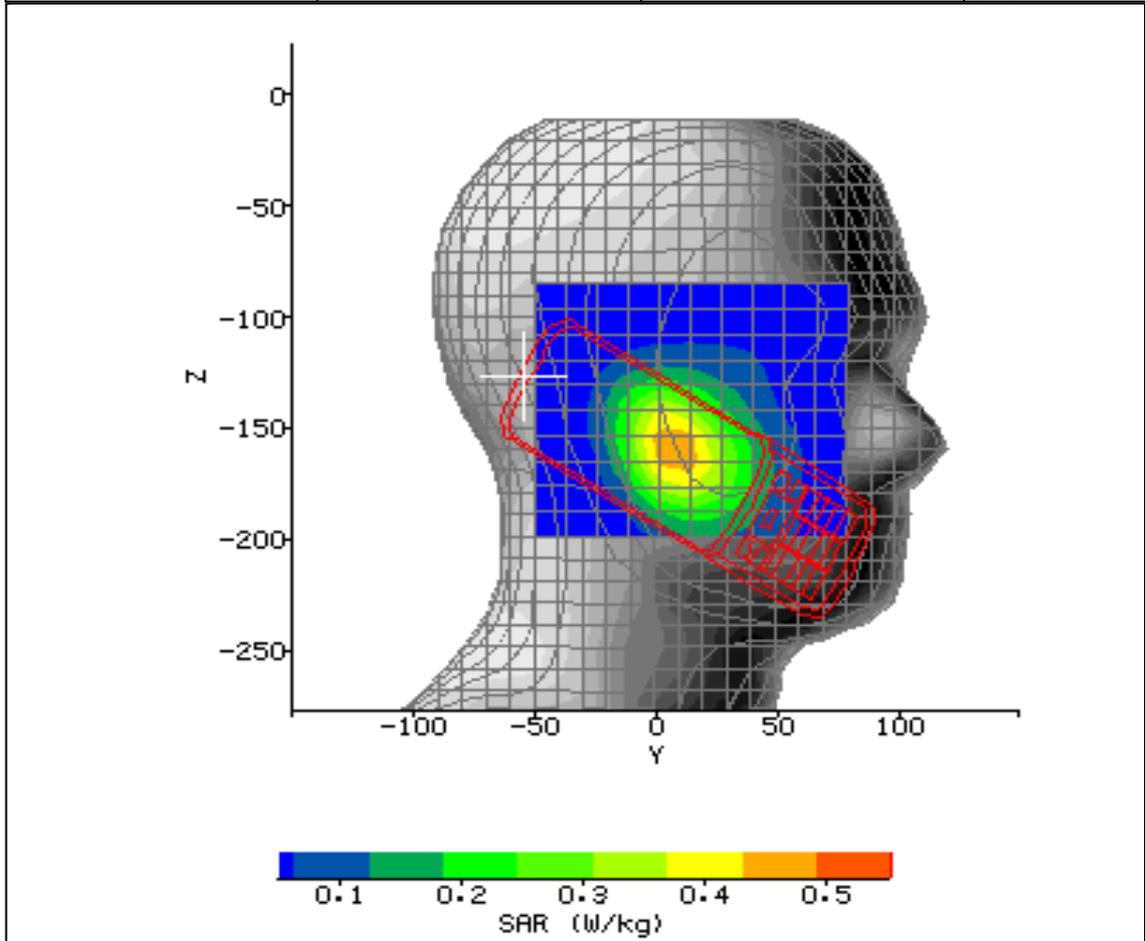


Figure 10: SAR Head Testing Results for the Sharp CDMA SHI15 at 848.31MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 12:04:42	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	37.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	835Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	43.39
RELATIVE HUMIDITY:	39.00%	CONDUCTIVITY:	0.912
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	210°	MAX SAR Y-AXIS LOCATION:	-3.20mm
DUT POSITION:	Right-15°	MAX SAR Z-AXIS LOCATION:	-148.25mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	14.930
TEST FREQUENCY:	848.31MHz	SAR 1g:	0.232 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.180 W/kg
CONVERSION FACTORS:	0.204 / 0.193 / 0.195	SAR START:	0.167 W/kg
TYPE OF MODULATION:	64-RAY Orthogonal	SAR END:	0.177 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	6.240 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/05/2012
INPUT POWER LEVEL:	23dBm	EXTRAPOLATION:	poly4

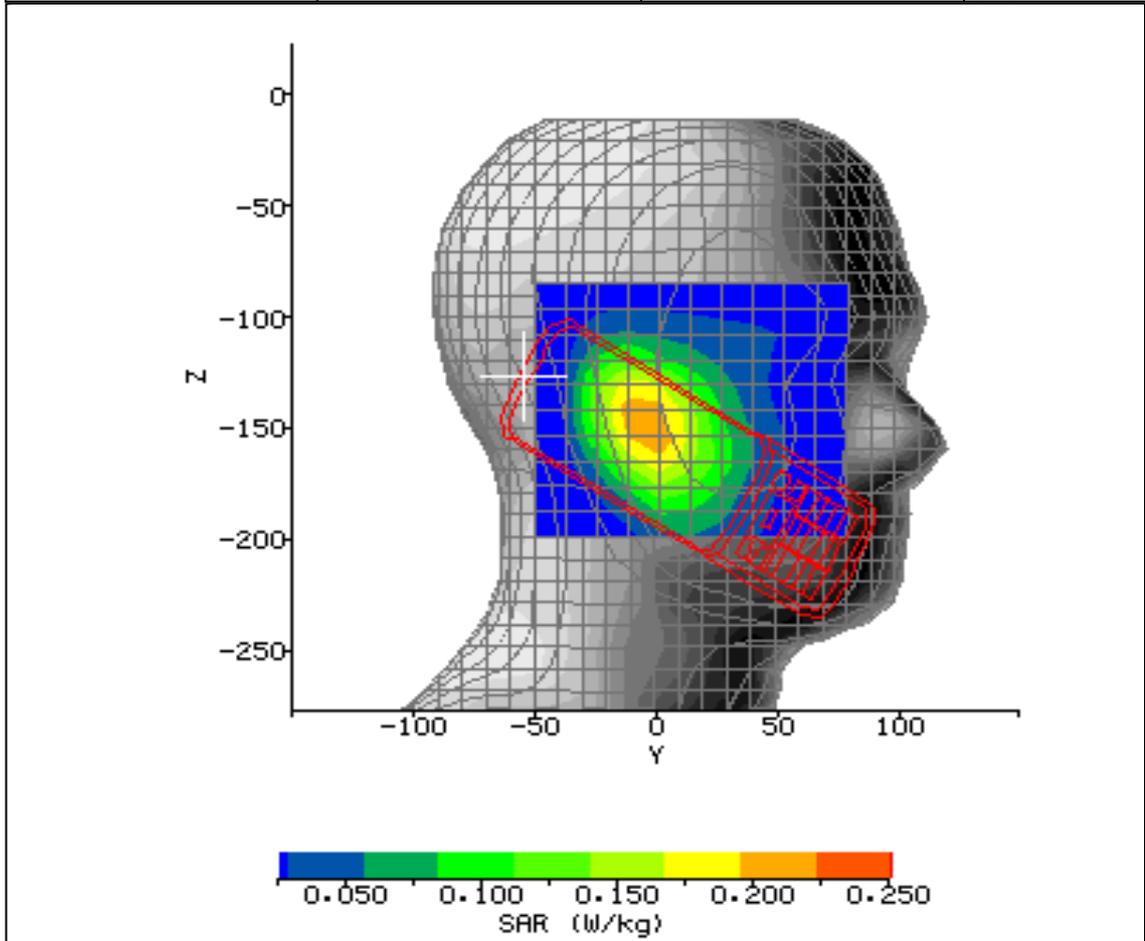


Figure 11: SAR Head Testing Results for the Sharp CDMA SHI15 at 848.31MHz.



2.3 CDMA2000 800MHz HEAD SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 12:29:40	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	38.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	835Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	43.39
RELATIVE HUMIDITY:	39.00%	CONDUCTIVITY:	0.912
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	210°	MAX SAR Y-AXIS LOCATION:	8.50mm
DUT POSITION:	Right-Cheek, Slider Closed	MAX SAR Z-AXIS LOCATION:	-156.30mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	16.250
TEST FREQUENCY:	848.31MHz	SAR 1g:	0.279 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.207 W/kg
CONVERSION FACTORS:	0.204 / 0.193 / 0.195	SAR START:	0.186 W/kg
TYPE OF MODULATION:	64-RAY Orthogonal	SAR END:	0.176 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-5.240 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/05/2012
INPUT POWER LEVEL:	23dBm	EXTRAPOLATION:	poly4

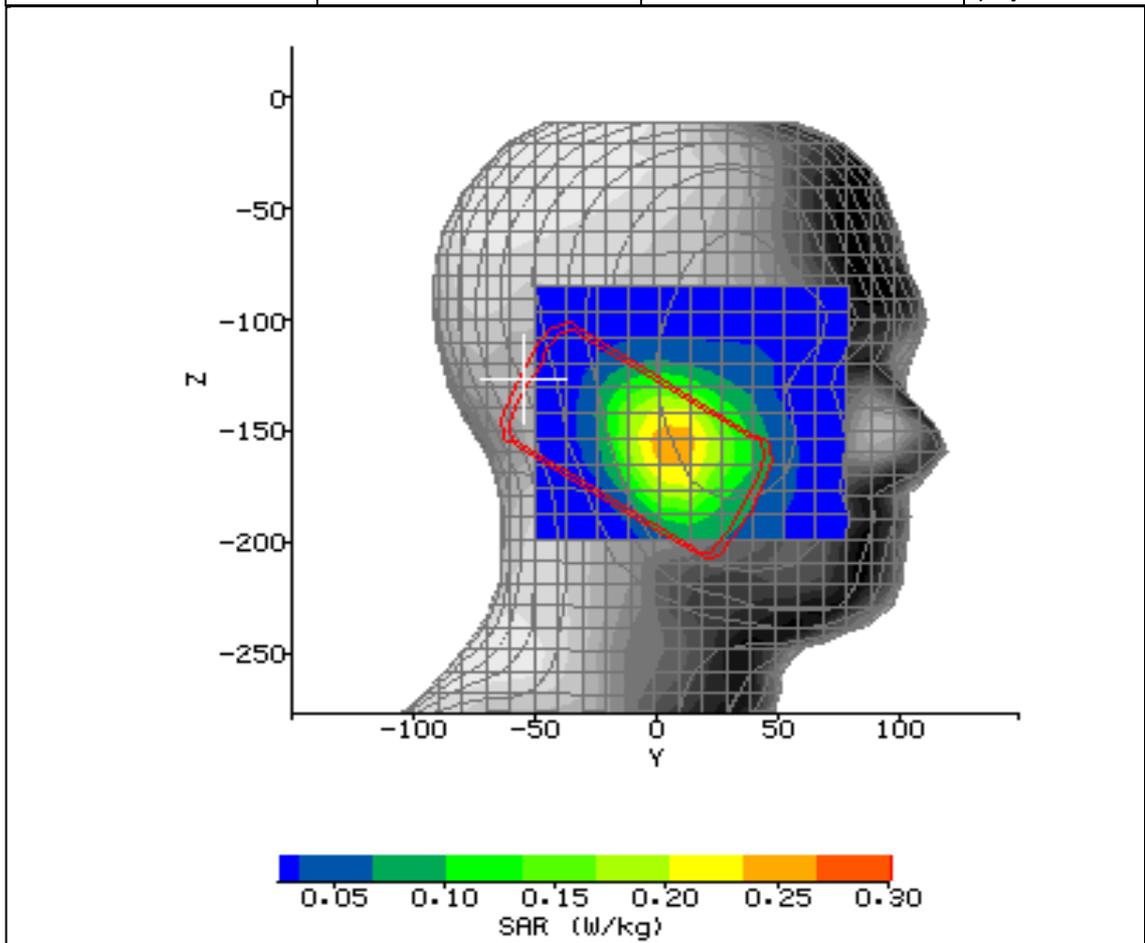


Figure 12: SAR Head Testing Results for the Sharp CDMA SHI15 at 848.31MHz.



2.4 CDMA2000 800MHz BODY SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 13:31:05	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	39.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	835Body
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	57.02
RELATIVE HUMIDITY:	39.00%	CONDUCTIVITY:	1.000
PHANTOM S/NO:	HeadBox1.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	N/A	MAX SAR X-AXIS LOCATION:	7.00mm
DUT POSITION:	15mm-Front Facing	MAX SAR Y-AXIS LOCATION:	4.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	13.210
TEST FREQUENCY:	848.31MHz	SAR 1g:	0.224 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.161 W/kg
CONVERSION FACTORS:	0.206 / 0.195 / 0.199	SAR START:	0.078 W/kg
TYPE OF MODULATION:	BPSK	SAR END:	0.071 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-9.280 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/05/2012
INPUT POWER LEVEL:	23dBm	EXTRAPOLATION:	poly4

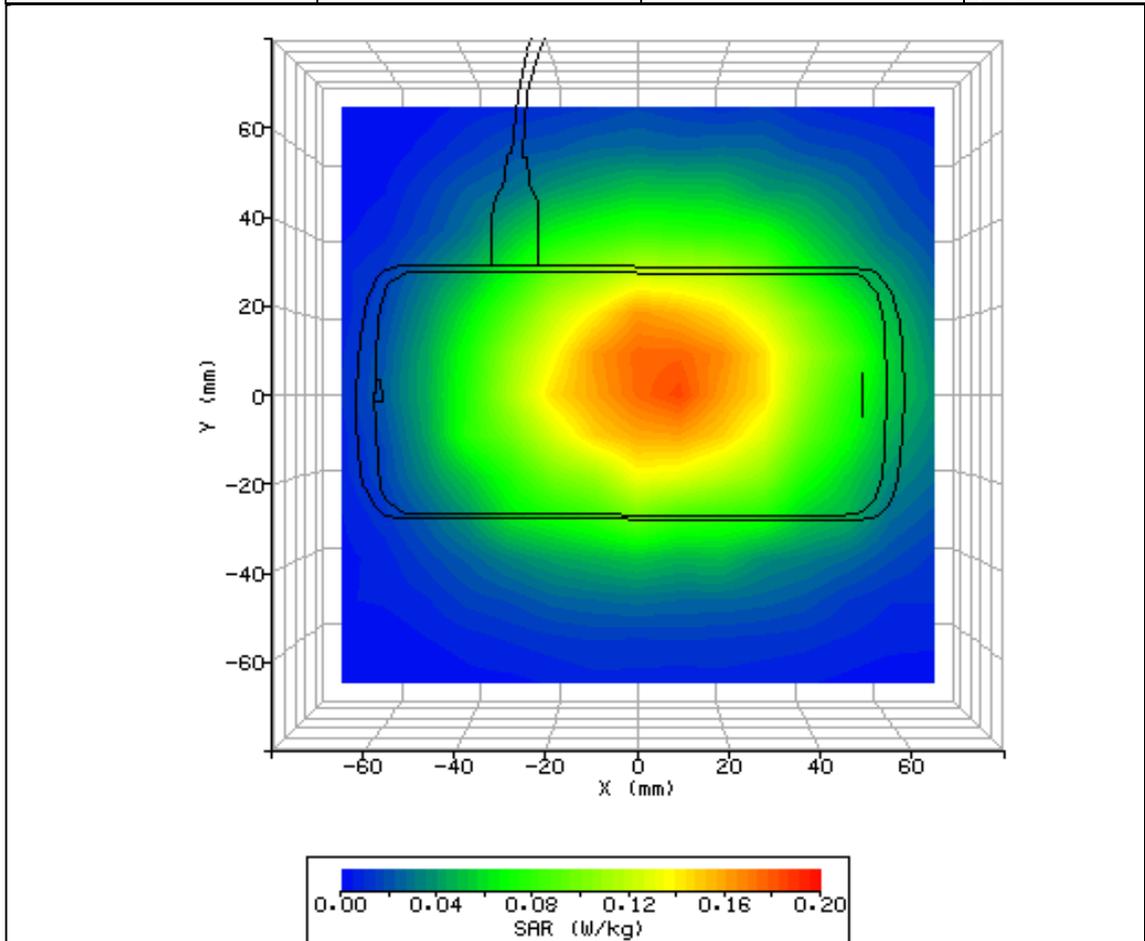


Figure 13: SAR Body Testing Results for the Sharp CDMA SHI15 at 848.31MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 13:55:20	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	40.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	835Body
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	57.02
RELATIVE HUMIDITY:	39.00%	CONDUCTIVITY:	1.000
PHANTOM S/NO:	HeadBox1.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	N/A	MAX SAR X-AXIS LOCATION:	4.00mm
DUT POSITION:	15mm-Rear Facing	MAX SAR Y-AXIS LOCATION:	1.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	18.910
TEST FREQUENCY:	848.31MHz	SAR 1g:	0.461 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.330 W/kg
CONVERSION FACTORS:	0.206 / 0.195 / 0.199	SAR START:	0.155 W/kg
TYPE OF MODULATION:	BPSK	SAR END:	0.149 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-3.720 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/05/2012
INPUT POWER LEVEL:	23dBm	EXTRAPOLATION:	poly4

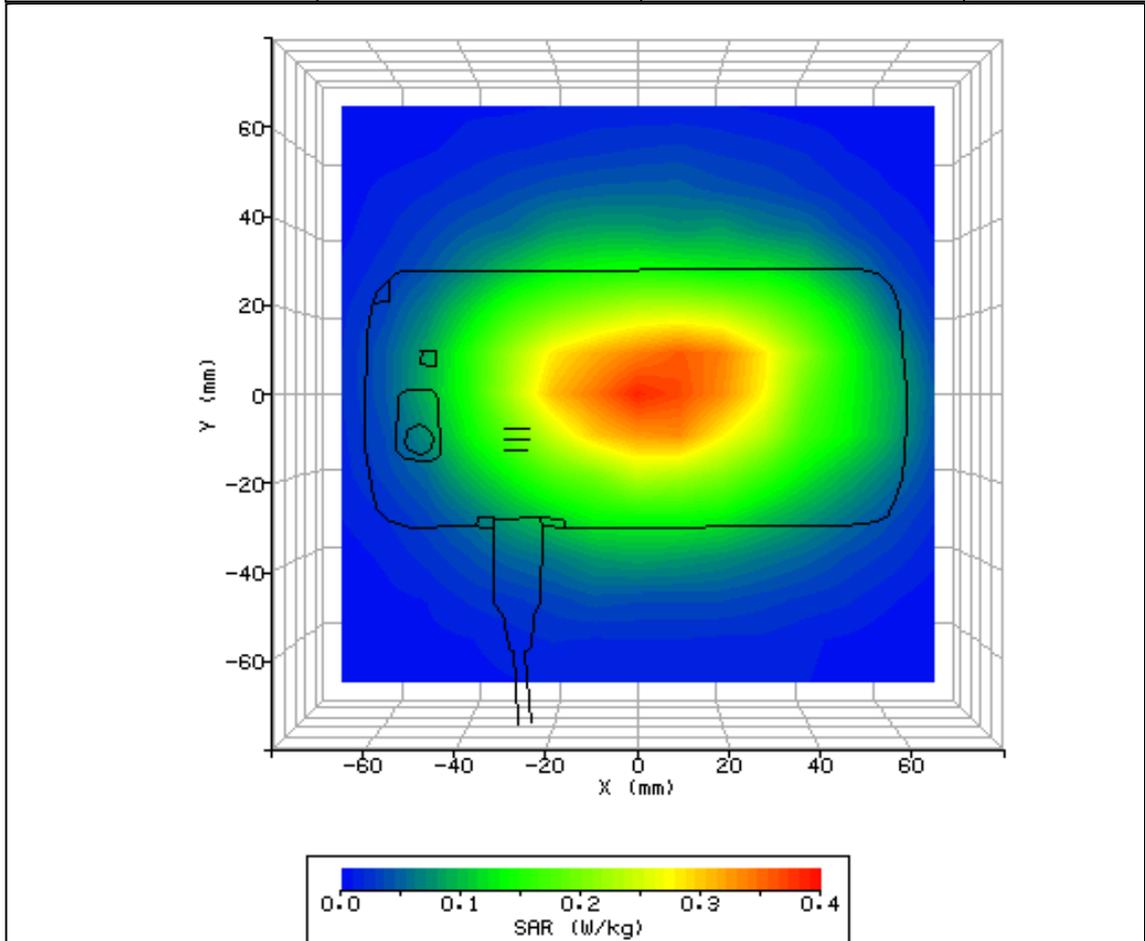


Figure 14: SAR Body Testing Results for the Sharp CDMA SHI15 at 848.31MHz.



2.5 PCS 1900MHz HEAD SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 12:24:57	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	41.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	1900Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	40.31
RELATIVE HUMIDITY:	43.30%	CONDUCTIVITY:	1.430
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.00°C
PHANTOM ROTATION:	330°	MAX SAR Y-AXIS LOCATION:	-8.50mm
DUT POSITION:	Left-Cheek	MAX SAR Z-AXIS LOCATION:	-167.80mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	10.650
TEST FREQUENCY:	1850.2MHz	SAR 1g:	0.269 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.135 W/kg
CONVERSION FACTORS:	0.274 / 0.255 / 0.259	SAR START:	0.090 W/kg
TYPE OF MODULATION:	GMSK (Voice Mode)	SAR END:	0.091 W/kg
MODN. DUTY CYCLE:	12.5%	SAR DRIFT DURING SCAN:	0.790 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	30dBm	EXTRAPOLATION:	poly4

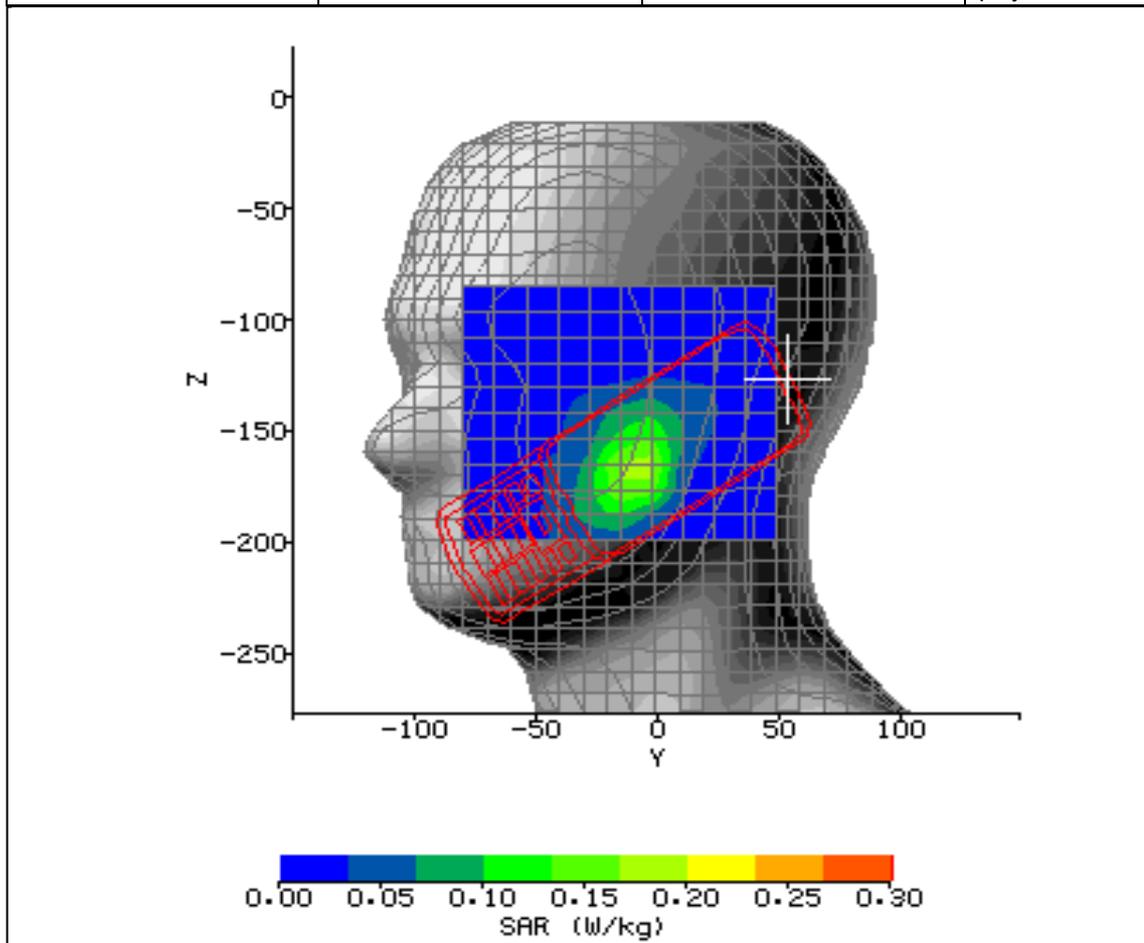


Figure 15: SAR Head Testing Results for the Sharp CDMA SHI15 at 1850.2MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 12:47:06	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	42.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	1900Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	40.31
RELATIVE HUMIDITY:	43.30%	CONDUCTIVITY:	1.430
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.00°C
PHANTOM ROTATION:	330°	MAX SAR Y-AXIS LOCATION:	18.80mm
DUT POSITION:	Left-15°	MAX SAR Z-AXIS LOCATION:	-139.05mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	8.070
TEST FREQUENCY:	1850.2MHz	SAR 1g:	0.160 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.098 W/kg
CONVERSION FACTORS:	0.274 / 0.255 / 0.259	SAR START:	0.083 W/kg
TYPE OF MODULATION:	GMSK (Voice Mode)	SAR END:	0.085 W/kg
MODN. DUTY CYCLE:	12.5%	SAR DRIFT DURING SCAN:	1.950 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	30dBm	EXTRAPOLATION:	poly4

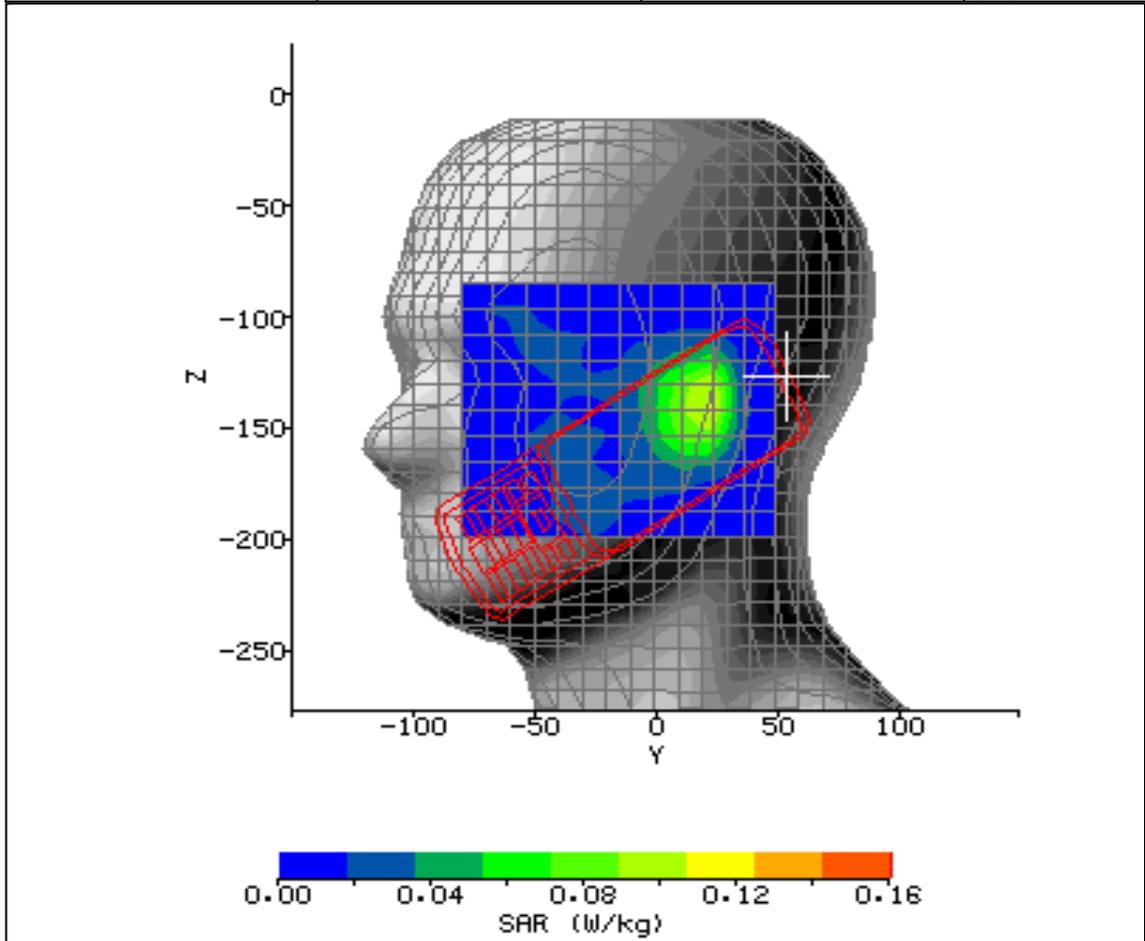


Figure 16: SAR Head Testing Results for the Sharp CDMA SHI15 at 1850.2MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 13:14:06	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	43.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	1900Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	40.31
RELATIVE HUMIDITY:	43.30%	CONDUCTIVITY:	1.430
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.00°C
PHANTOM ROTATION:	210°	MAX SAR Y-AXIS LOCATION:	13.70mm
DUT POSITION:	Right-Cheek	MAX SAR Z-AXIS LOCATION:	-149.40mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	9.360
TEST FREQUENCY:	1850.2MHz	SAR 1g:	0.171 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.111 W/kg
CONVERSION FACTORS:	0.274 / 0.255 / 0.259	SAR START:	0.076 W/kg
TYPE OF MODULATION:	GMSK (Voice Mode)	SAR END:	0.078 W/kg
MODN. DUTY CYCLE:	12.5%	SAR DRIFT DURING SCAN:	3.360 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	30dBm	EXTRAPOLATION:	poly4

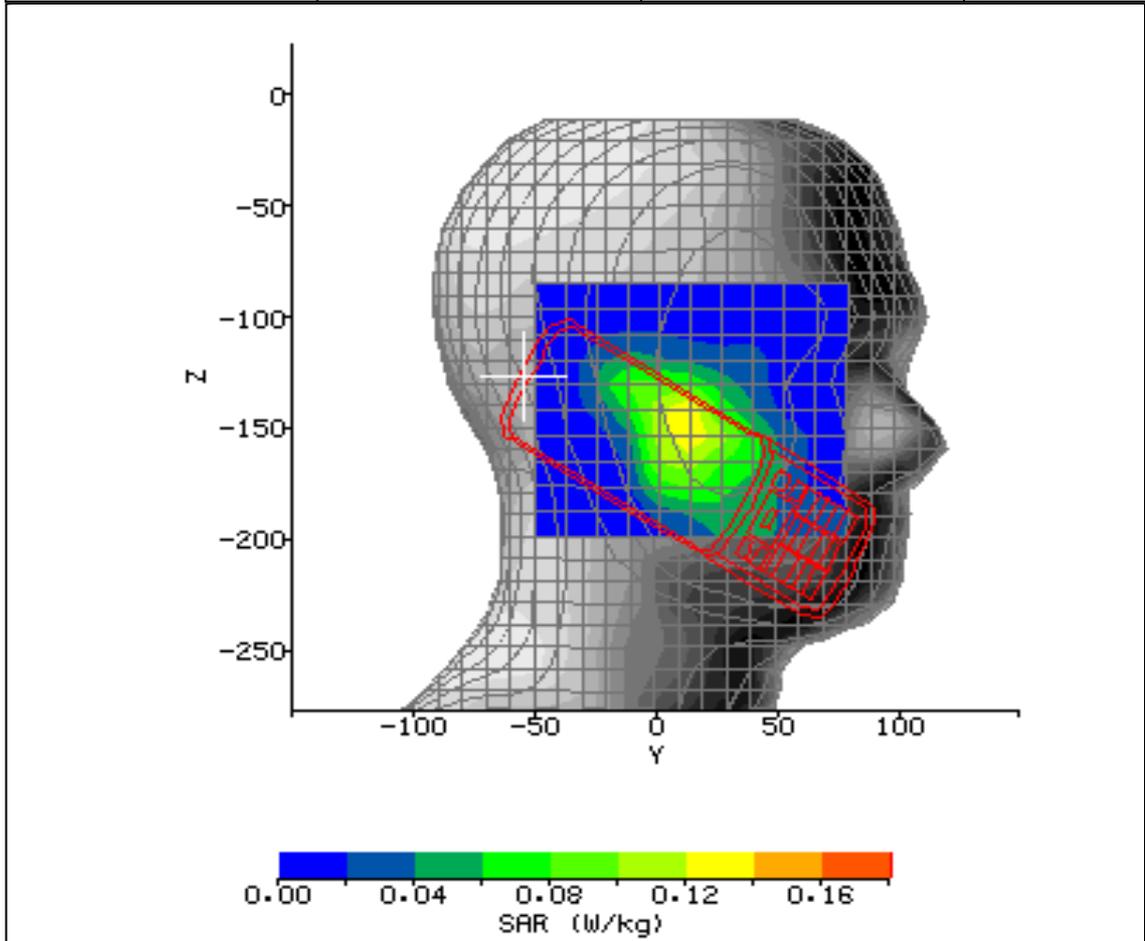


Figure 17: SAR Head Testing Results for the Sharp CDMA SHI15 at 1850.2MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 13:37:59	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	44.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	1900Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	40.31
RELATIVE HUMIDITY:	43.30%	CONDUCTIVITY:	1.430
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.00°C
PHANTOM ROTATION:	210°	MAX SAR Y-AXIS LOCATION:	-17.50mm
DUT POSITION:	Right-15°	MAX SAR Z-AXIS LOCATION:	-125.25mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	8.110
TEST FREQUENCY:	1850.2MHz	SAR 1g:	0.166 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.088 W/kg
CONVERSION FACTORS:	0.274 / 0.255 / 0.259	SAR START:	0.080 W/kg
TYPE OF MODULATION:	GMSK (Voice Mode)	SAR END:	0.085 W/kg
MODN. DUTY CYCLE:	12.5%	SAR DRIFT DURING SCAN:	6.070 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	30dBm	EXTRAPOLATION:	poly4

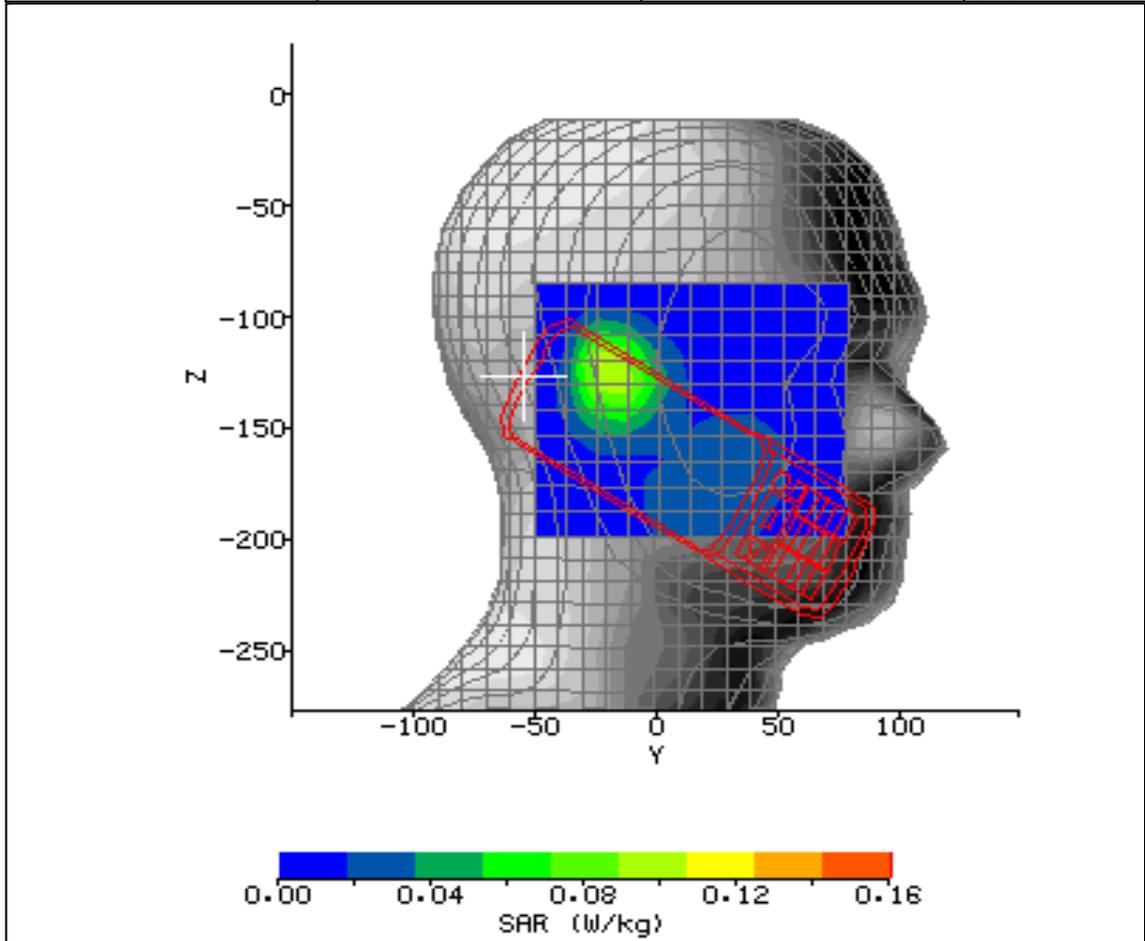


Figure 18: SAR Head Testing Results for the Sharp CDMA SHI15 at 1850.2MHz.



2.6 PCS 1900MHz HEAD SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 15:21:26	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	45.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	1900Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	40.31
RELATIVE HUMIDITY:	43.30%	CONDUCTIVITY:	1.430
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.00°C
PHANTOM ROTATION:	330°	MAX SAR Y-AXIS LOCATION:	-12.40mm
DUT POSITION:	Left-Cheek, Slider Closed	MAX SAR Z-AXIS LOCATION:	-163.20mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	12.410
TEST FREQUENCY:	1850.2MHz	SAR 1g:	0.259 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.181 W/kg
CONVERSION FACTORS:	0.274 / 0.255 / 0.259	SAR START:	0.127 W/kg
TYPE OF MODULATION:	GMSK (Voice Mode)	SAR END:	0.129 W/kg
MODN. DUTY CYCLE:	12.5%	SAR DRIFT DURING SCAN:	1.310 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	30dBm	EXTRAPOLATION:	poly4

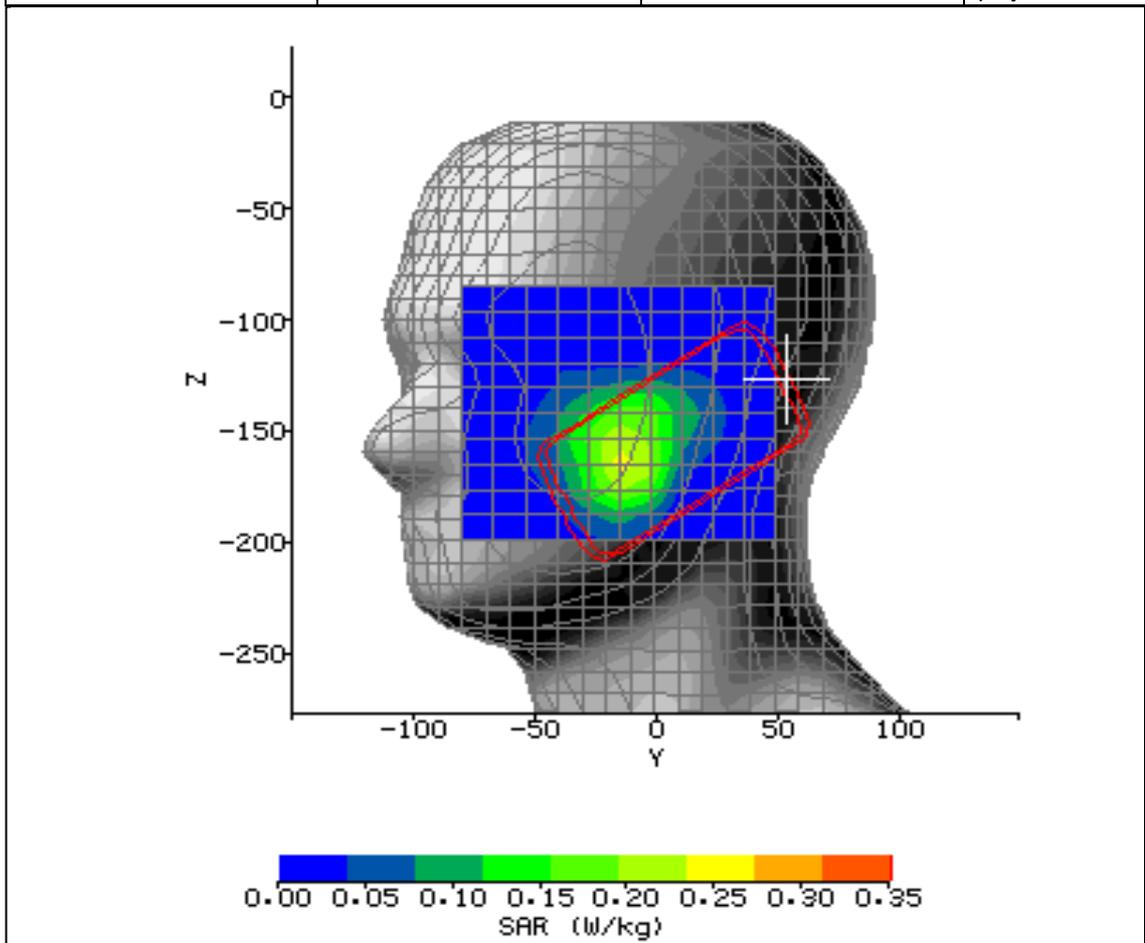


Figure 19: SAR Head Testing Results for the Sharp CDMA SHI15 at 1850.2MHz.



2.7 PCS 1900MHz BODY SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 07:35:38	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	46.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.90°C	LIQUID SIMULANT:	1900Body
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	53.94
RELATIVE HUMIDITY:	44.60%	CONDUCTIVITY:	1.580
PHANTOM S/NO:	HeadBox.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	N/A	MAX SAR X-AXIS LOCATION:	37.00mm
DUT POSITION:	15mm-Front Facing	MAX SAR Y-AXIS LOCATION:	10.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	13.140
TEST FREQUENCY:	1850.2MHz	SAR 1g:	0.366 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.236 W/kg
CONVERSION FACTORS:	0.295 / 0.270 / 0.278	SAR START:	0.070 W/kg
TYPE OF MODULATION:	GMSK (GPRS Mode)	SAR END:	0.068 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	-2.030 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	30dBm	EXTRAPOLATION:	poly4

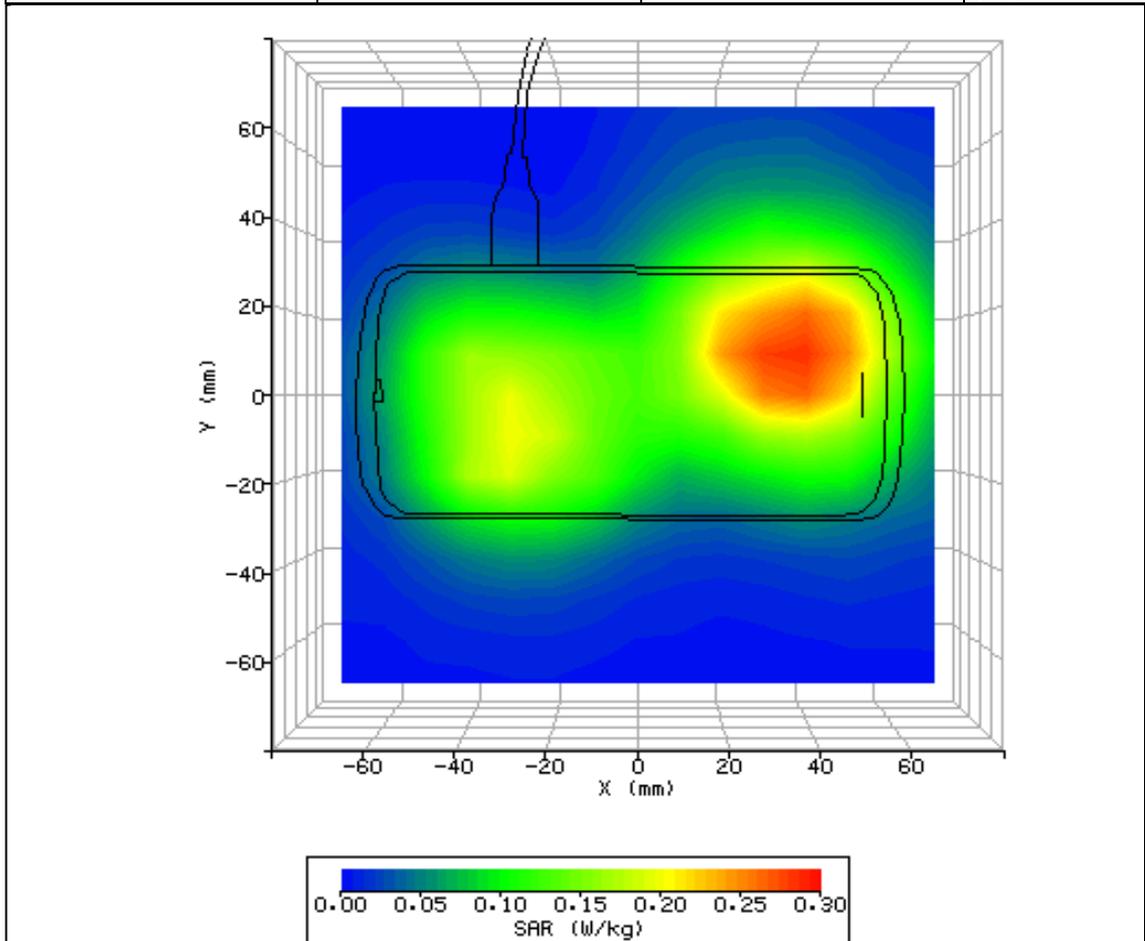


Figure 20: SAR Body Testing Results for the Sharp CDMA SHI15 at 1850.2MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 08:01:02	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	47.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.90°C	LIQUID SIMULANT:	1900Body
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	53.94
RELATIVE HUMIDITY:	44.60%	CONDUCTIVITY:	1.580
PHANTOM S/NO:	HeadBox.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	N/A	MAX SAR X-AXIS LOCATION:	38.00mm
DUT POSITION:	15mm-Rear Facing	MAX SAR Y-AXIS LOCATION:	-11.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	16.450
TEST FREQUENCY:	1850.2MHz	SAR 1g:	0.581 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.341 W/kg
CONVERSION FACTORS:	0.295 / 0.270 / 0.278	SAR START:	0.097 W/kg
TYPE OF MODULATION:	GMSK (GPRS Mode)	SAR END:	0.095 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	-2.110 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	30dBm	EXTRAPOLATION:	poly4

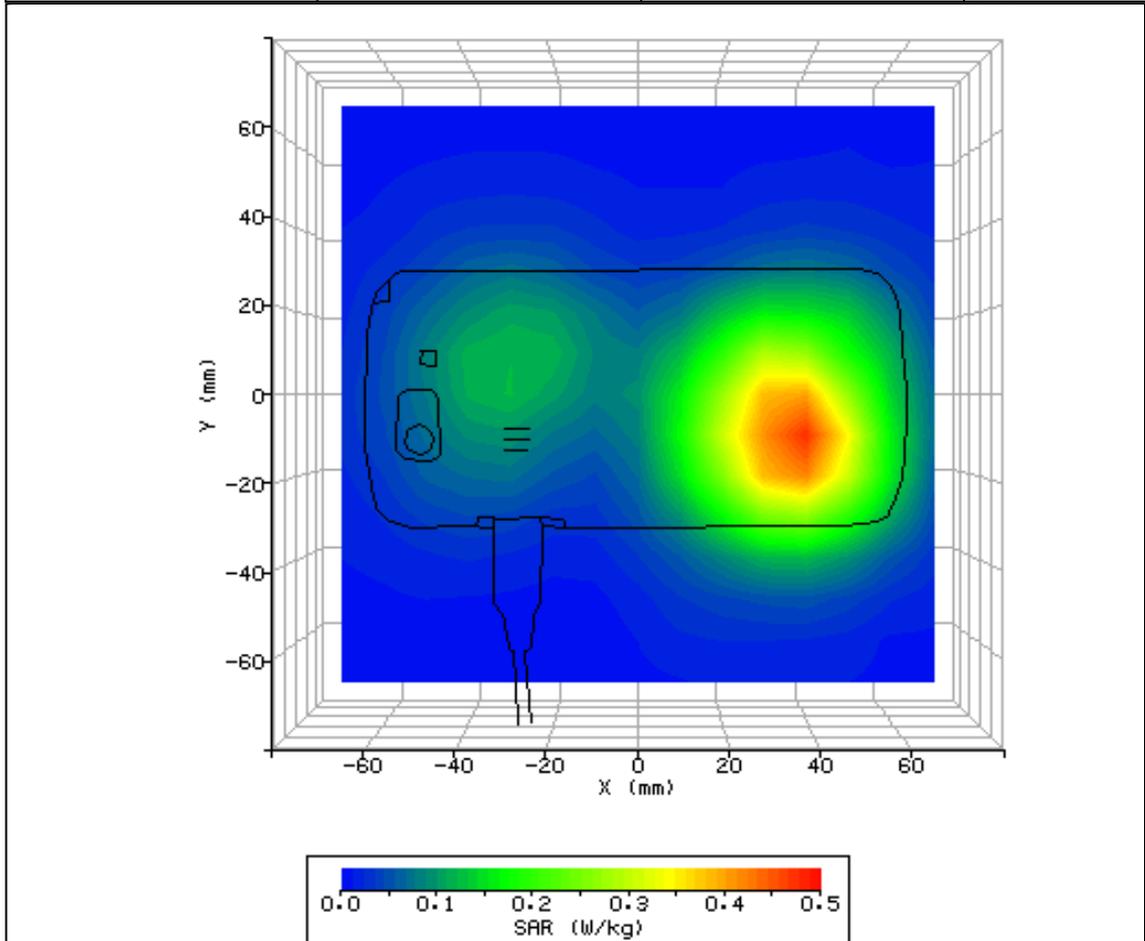


Figure 21: SAR Body Testing Results for the Sharp CDMA SHI15 at 1850.2MHz.



2.8 WLAN 2450MHz HEAD SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 17:46:51	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	49.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	2450Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	37.30
RELATIVE HUMIDITY:	38.80%	CONDUCTIVITY:	1.739
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.50°C
PHANTOM ROTATION:	330°	MAX SAR Y-AXIS LOCATION:	-12.40mm
DUT POSITION:	Left-Cheek	MAX SAR Z-AXIS LOCATION:	-155.15mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	3.820
TEST FREQUENCY:	2412MHz	SAR 1g:	0.038 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.024 W/kg
CONVERSION FACTORS:	0.293 / 0.268 / 0.274	SAR START:	0.016 W/kg
TYPE OF MODULATION:	WLAN (DSSS)	SAR END:	0.017 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	2.800 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	20dBm	EXTRAPOLATION:	poly4

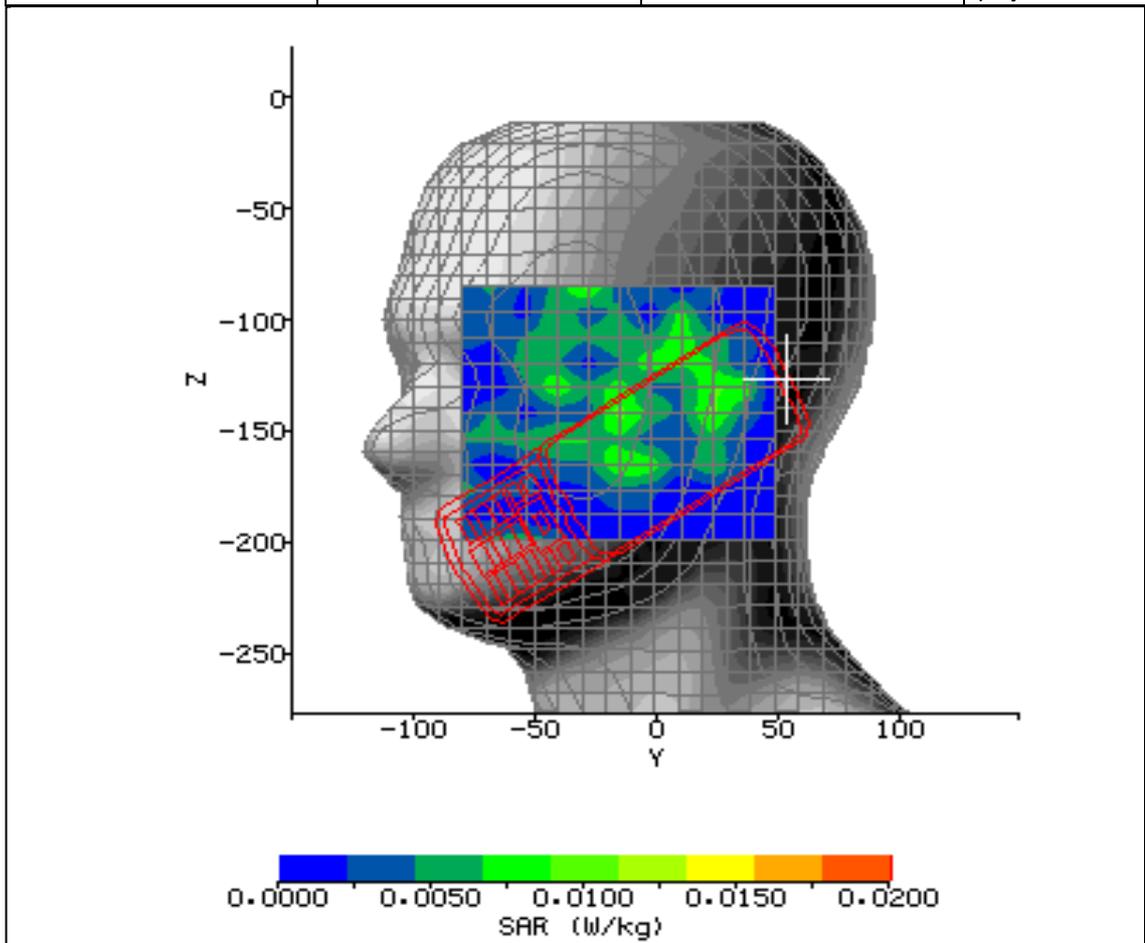


Figure 22: SAR Head Testing Results for the Sharp CDMA SHI15 at 2412MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 17:46:51	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	49.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	2450Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	37.30
RELATIVE HUMIDITY:	38.80%	CONDUCTIVITY:	1.739
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.50°C
PHANTOM ROTATION:	330°	MAX SAR Y-AXIS LOCATION:	25.30mm
DUT POSITION:	Left-15°	MAX SAR Z-AXIS LOCATION:	-134.45mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	2.110
TEST FREQUENCY:	2412MHz	SAR 1g:	0.021 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.012 W/kg
CONVERSION FACTORS:	0.293 / 0.268 / 0.274	SAR START:	0.005 W/kg
TYPE OF MODULATION:	WLAN (DSSS)	SAR END:	0.005 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.000 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	20dBm	EXTRAPOLATION:	poly4

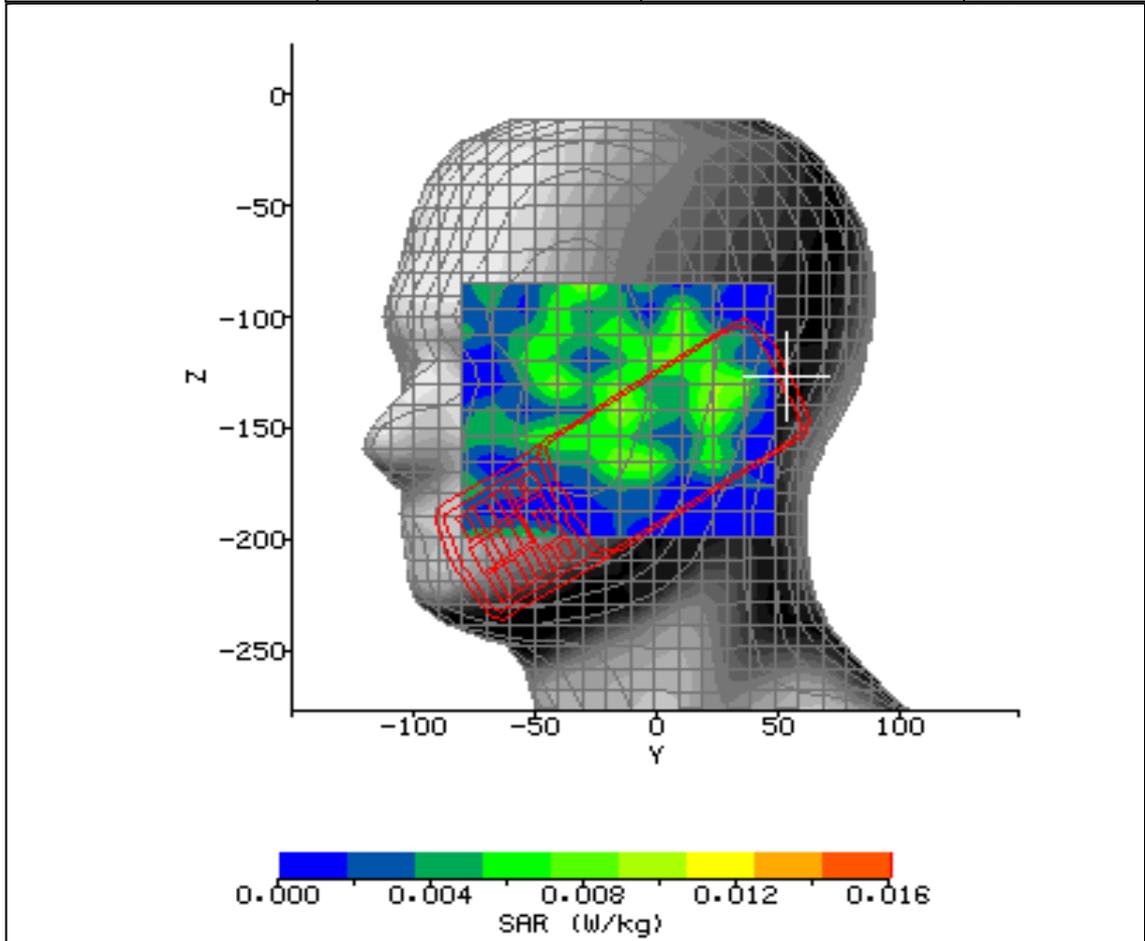


Figure 23: SAR Head Testing Results for the Sharp CDMA SHI15 at 2412MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 18:12:38	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	50.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	2450Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	37.30
RELATIVE HUMIDITY:	38.80%	CONDUCTIVITY:	1.739
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.50°C
PHANTOM ROTATION:	210°	MAX SAR Y-AXIS LOCATION:	8.50mm
DUT POSITION:	Right-Cheek	MAX SAR Z-AXIS LOCATION:	-155.15mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	3.430
TEST FREQUENCY:	2412MHz	SAR 1g:	0.031 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.020 W/kg
CONVERSION FACTORS:	0.293 / 0.268 / 0.274	SAR START:	0.011 W/kg
TYPE OF MODULATION:	WLAN (DSSS)	SAR END:	0.011 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.000 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	20dBm	EXTRAPOLATION:	poly4

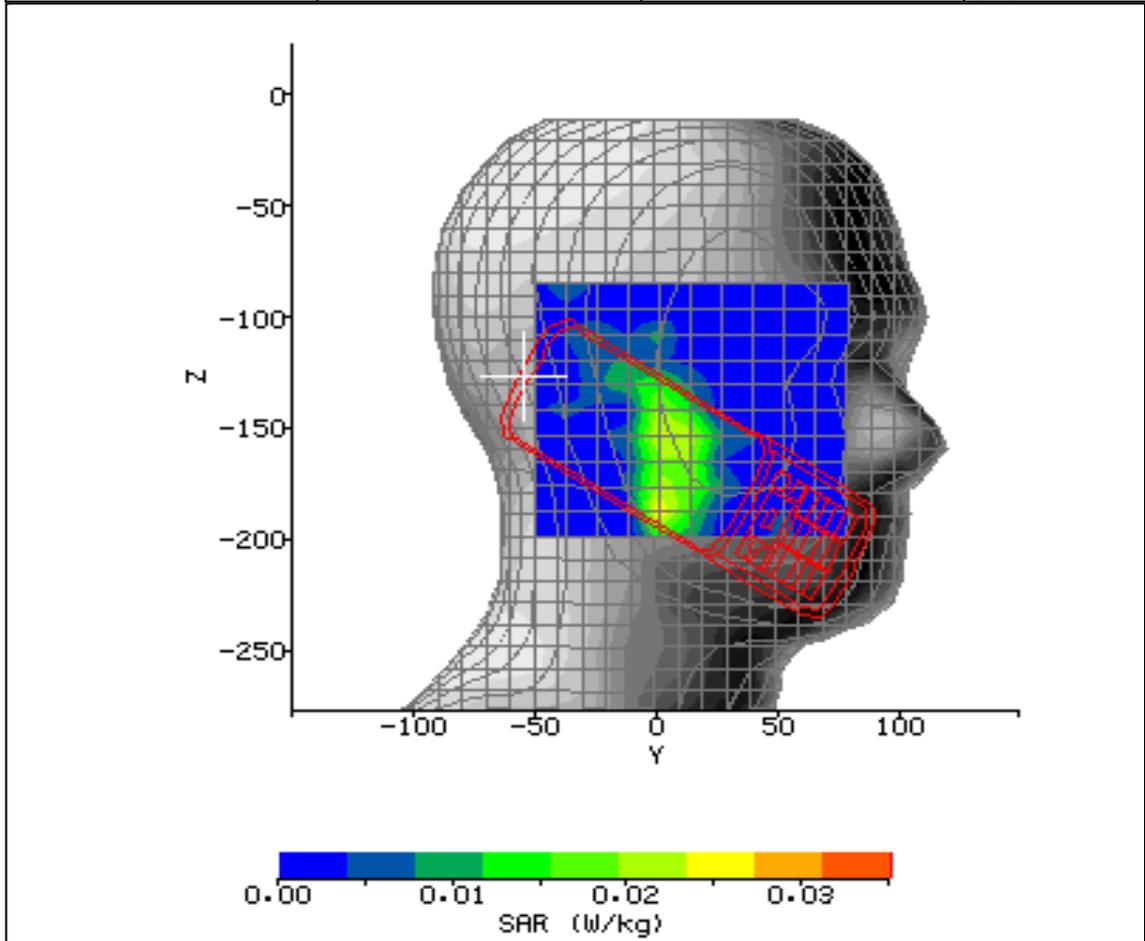


Figure 24: SAR Head Testing Results for the Sharp CDMA SHI15 at 2412MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 18:42:13	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	51.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	2450Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	37.30
RELATIVE HUMIDITY:	38.80%	CONDUCTIVITY:	1.739
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.50°C
PHANTOM ROTATION:	210°	MAX SAR Y-AXIS LOCATION:	-22.70mm
DUT POSITION:	Right-15°	MAX SAR Z-AXIS LOCATION:	-111.45mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	2.100
TEST FREQUENCY:	2412MHz	SAR 1g:	0.015 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.010 W/kg
CONVERSION FACTORS:	0.293 / 0.268 / 0.274	SAR START:	0.005 W/kg
TYPE OF MODULATION:	WLAN (DSSS)	SAR END:	0.004 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-6.120 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	20dBm	EXTRAPOLATION:	poly4

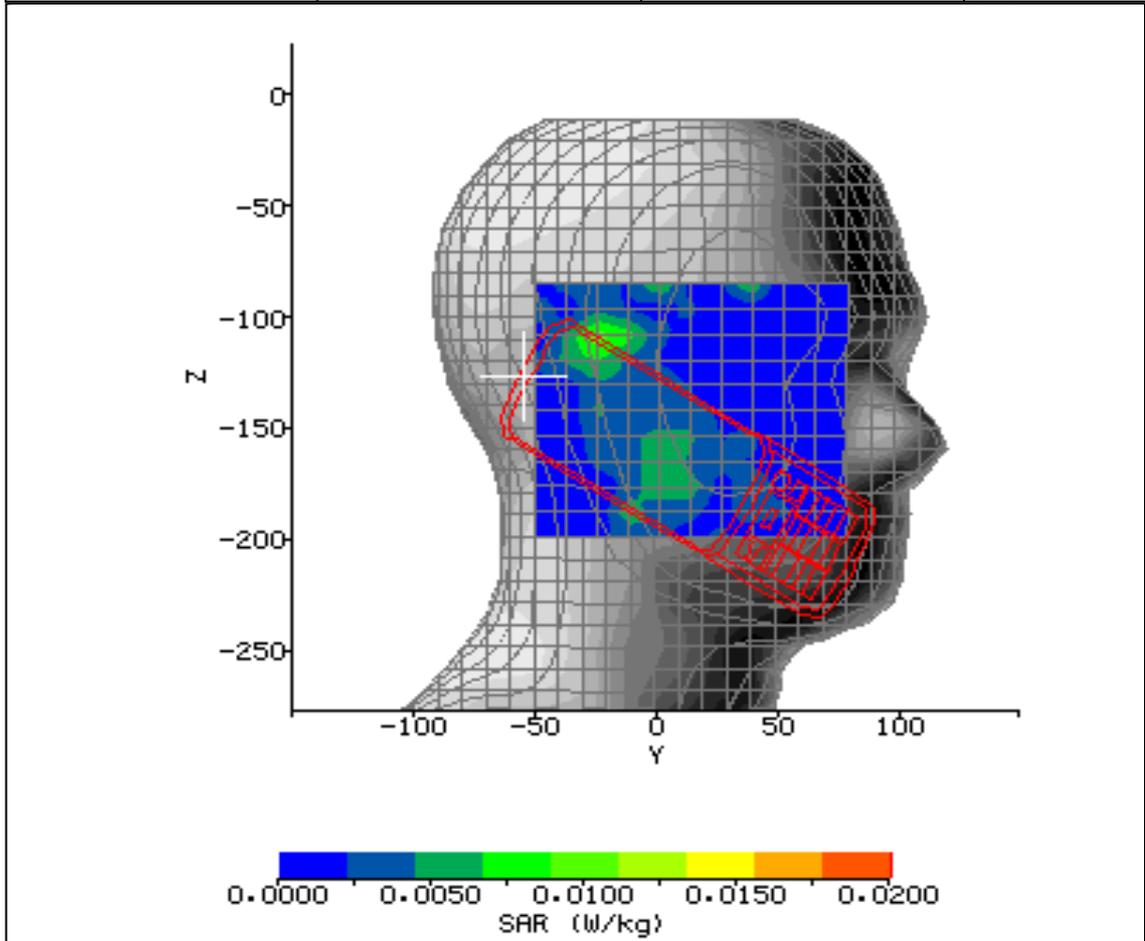


Figure 25: SAR Head Testing Results for the Sharp CDMA SHI15 at 2412MHz.



2.9 WLAN 2450MHz HEAD SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	30/05/2012 19:06:16	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	52.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	2450Head
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	37.30
RELATIVE HUMIDITY:	38.80%	CONDUCTIVITY:	1.739
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	21.50°C
PHANTOM ROTATION:	330°	MAX SAR Y-AXIS LOCATION:	20.10mm
DUT POSITION:	Left-Cheek, Slider Closed	MAX SAR Z-AXIS LOCATION:	-117.20mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	6.850
TEST FREQUENCY:	2412MHz	SAR 1g:	0.164 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.089 W/kg
CONVERSION FACTORS:	0.293 / 0.268 / 0.274	SAR START:	0.056 W/kg
TYPE OF MODULATION:	WLAN (DSSS)	SAR END:	0.056 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-1.870 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	30/05/2012
INPUT POWER LEVEL:	20dBm	EXTRAPOLATION:	poly4

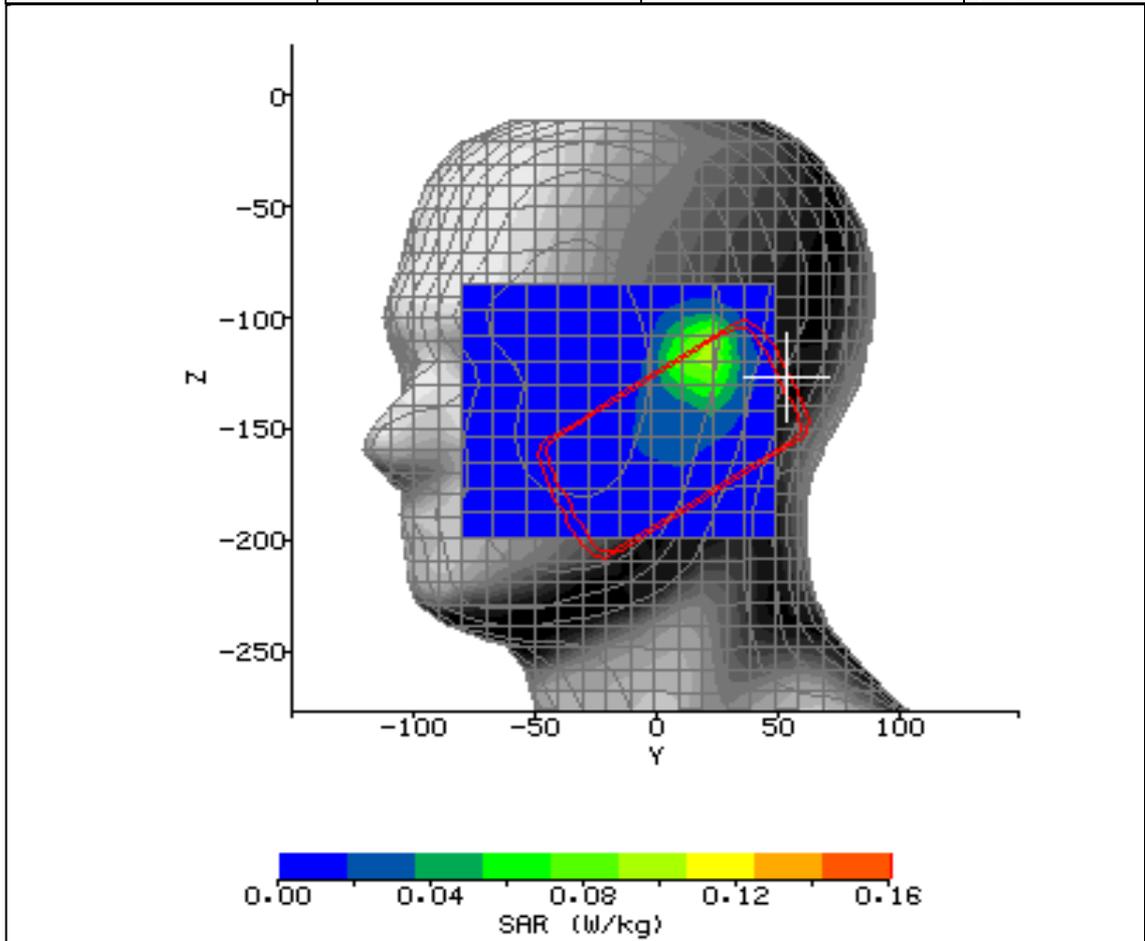


Figure 26: SAR Head Testing Results for the Sharp CDMA SHI15 at 2412MHz.



2.10 WLAN 2450MHz BODY SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 08:49:14	DUT BATTERY MODEL/NO:	SHI15UAA
FILENAME:	53.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.90°C	LIQUID SIMULANT:	2450Body
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	52.17
RELATIVE HUMIDITY:	44.60%	CONDUCTIVITY:	1.948
PHANTOM S/NO:	HeadBox.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	N/A	MAX SAR X-AXIS LOCATION:	-39.00mm
DUT POSITION:	15mm-Front Facing	MAX SAR Y-AXIS LOCATION:	-14.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	3.53
TEST FREQUENCY:	2412MHz	SAR 1g:	0.037 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.022 W/kg
CONVERSION FACTORS:	0.328 / 0.298 / 0.304	SAR START:	0.004 W/kg
TYPE OF MODULATION:	WLAN (DSSS)	SAR END:	0.004 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.000 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/05/2012
INPUT POWER LEVEL:	20dBm	EXTRAPOLATION:	poly4

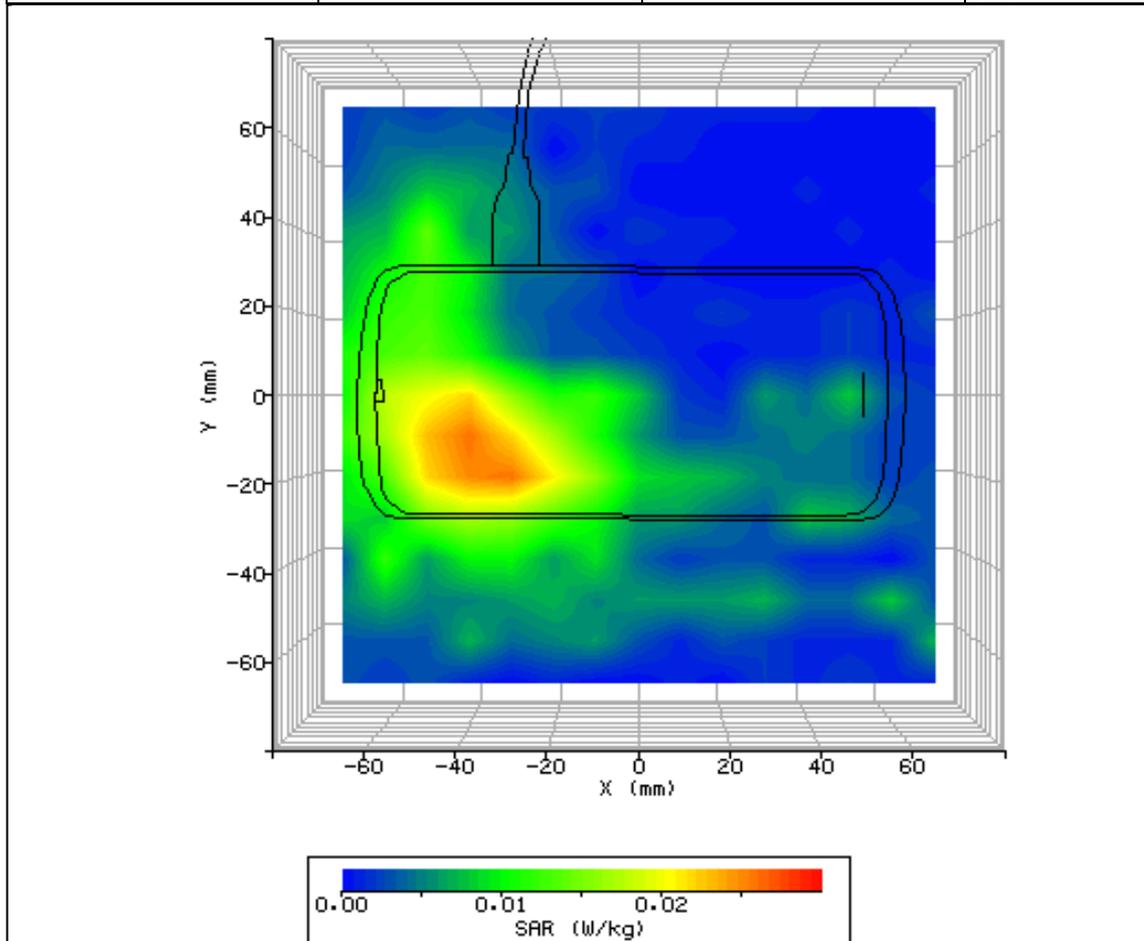


Figure 27: SAR Body Testing Results for the Sharp CDMA SHI15 at 2412MHz.



SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	31/05/2012 09:15:12	DUT BATTERY MODEL/NO:	
FILENAME:	54.txt	PROBE SERIAL NUMBER:	187
AMBIENT TEMPERATURE:	22.90°C	LIQUID SIMULANT:	2450Body
DEVICE UNDER TEST:	Sharp CDMA SHI15	RELATIVE PERMITTIVITY:	52.17
RELATIVE HUMIDITY:	44.60%	CONDUCTIVITY:	1.948
PHANTOM S/NO:	HeadBox.csv	LIQUID TEMPERATURE:	22.00°C
PHANTOM ROTATION:	N/A	MAX SAR X-AXIS LOCATION:	-39.00mm
DUT POSITION:	15mm-Rear Facing	MAX SAR Y-AXIS LOCATION:	3.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	4.26
TEST FREQUENCY:	2412MHz	SAR 1g:	0.054 W/kg
AIR FACTORS:	540.09 / 736.31 / 658.07	SAR 10g:	0.035 W/kg
CONVERSION FACTORS:	0.328 / 0.298 / 0.304	SAR START:	0.009 W/kg
TYPE OF MODULATION:	WLAN (DSSS)	SAR END:	0.009 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.000 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/05/2012
INPUT POWER LEVEL:	20dBm	EXTRAPOLATION:	poly4

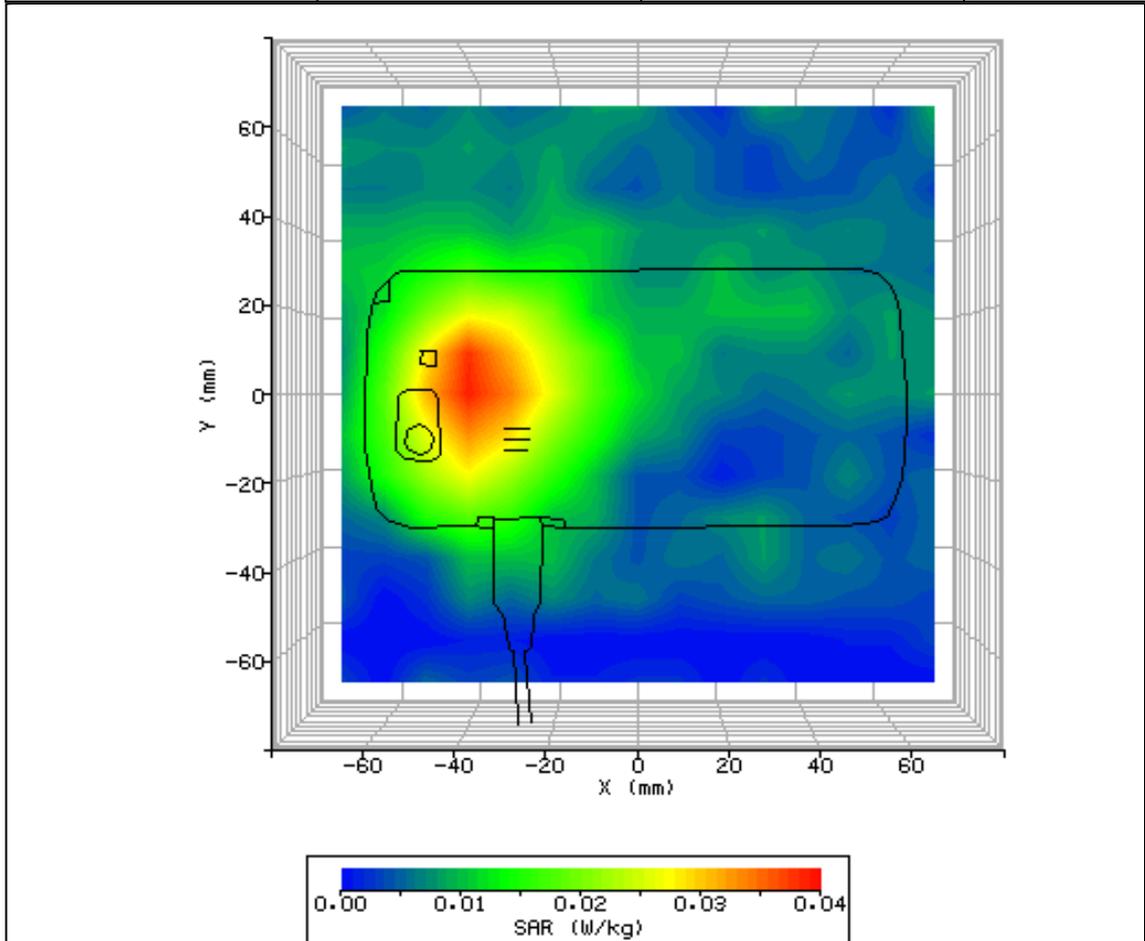


Figure 28: SAR Body Testing Results for the Sharp CDMA SHI15 at 2412MHz.



Product Service

SECTION 3

TEST EQUIPMENT USED



3.1 TEST EQUIPMENT USED

The following test equipment was used at TÜV SÜD Product Service Ltd:

Instrument Description	Manufacturer	Model Type	TE Number	Cal Period (months)	Calibration Due Date
Radiocommunications Tester	Rohde & Schwarz	CMU 200	39	12	09-Dec-12
10MHz - 2.5GHz, 3W, Amplifier	Vectawave Technology	VTL5400	51	-	TU
Directional Coupler	Krytar	1850	58	-	TU
Signal Generator	Hewlett Packard	ESG4000A	61	12	23-May-13
SAR Robot	Mitsubishi	RV-E2	156	-	TU
Attenuator (20dB, 20W)	Narda	766F-20	483	12	09-Jun-12
SAM Head Phantom	Antennessa	Head_04_35.csv	1561	-	TU
Dipole Positioner/Support (plastic)	IndexSar Ltd	IXH-020	1585	-	TU
Hygromer	Rotronic	Hygropalm	2404	12	07-Feb-13
Power Meter	Rohde & Schwarz	NRVD	2979	12	24-May-13
Power Sensor	Rohde & Schwarz	NRV-Z1	3563	12	24-May-13
Meter & T/C	R.S Components	Meter 615-8206 & Type K T/C	3612	12	13-Mar-13
Immersible SAR Probe	IndexSar Ltd	IXP-050	3892	24	28-Feb-14
835 MHz Head Fluid	TUV Product Service	Batch 19	N/A	1	01-Jun-12
835 MHz Body Fluid	TUV Product Service	Batch 12	N/A	1	01-Jun-12
1900 MHz Head Fluid	TUV Product Service	Batch 7	N/A	1	01-Jun-12
1900 MHz Body Fluid	TUV Product Service	Batch 4	N/A	1	01-Jun-12
2450 MHz Head Fluid	TUV Product Service	Batch 9	N/A	1	01-Jun-12
2450 MHz Body Fluid	TUV Product Service	Batch 7	N/A	1	01-Jun-12

TU – Traceability Unscheduled



Product Service

3.2 TEST SOFTWARE

The following software was used to control the TÜV SÜD Product Service Ltd SARA2 System.

Instrument	Version Number	Date
SARA2 system	v.2.5.3 VPM	28 November 2006
Mitsubishi robot controller firmware revision	RV-E2 Version C9a	-
IFA-10 Probe amplifier	Version 2	-



3.3 DIELECTRIC PROPERTIES OF SIMULANT LIQUIDS

The fluid properties of the simulant fluids used during routine SAR evaluation meet the dielectric properties required by OET 65(C) – 2001.

The fluids were calibrated in our Laboratory and re-checked prior to any measurements being made against reference fluids stated in IEEE 1528-2003 of 0.9% NaCl (Salt Solution) at 23°C and also for Dimethylsulphoxide (DMS) at 21°C.

IEEE 1528 Recipes

Frequency (MHz)	300	450		835	900			1450	1800				1900	1950	2000	2100		2450			3000
Recipe#	1	1	3	1	1	2	3	1	1	2	2	3	1	2	4	1	1	2	2	3	2
Ingredients (% by weight)																					
1, 2-Propanediol						64.81															
Bactericide	0.19	0.19	0.50	0.10	0.10		0.50														0.50
Diacetin			48.90				49.20														49.45
DGBE								45.41	47.00	13.84	44.92		44.94	13.84	45.00	50.00	50.00	7.99	7.99		7.99
HEC	0.98	0.96		1.00	1.00																
NaCl	5.95	3.95	1.70	1.45	1.48	0.79	1.10	0.67	0.36	0.35	0.18	0.64	0.18	0.35					0.16	0.16	0.16
Sucrose	55.32	56.32		57.00	56.50																
Triton X-100										30.45				30.45					19.97	19.97	19.97
Water	37.56	38.56	48.90	40.45	40.92	34.40	49.20	53.80	52.64	55.36	54.90	49.43	54.90	55.36	55.00	50.00	50.00	71.88	71.88	49.75	71.88
Measured dielectric parameters																					
ϵ_r	46.00	43.40	44.30	41.60	41.20	41.80	42.70	40.9	39.3	41.00	40.40	39.20	39.90	41.00	40.10	37.00	36.80	41.10	40.30	39.20	37.90
σ (S/m)	0.86	0.85	0.90	0.90	0.98	0.97	0.99	1.21	1.39	1.38	1.40	1.40	1.42	1.38	1.41	1.40	1.51	1.55	1.88	1.82	2.46
Temp (°C)	22	22	20	22	22	22	20	22	22	21	22	20	21	21	20	22	22	20	20	20	20
Target dielectric parameters (Table 2)																					
ϵ_r	45.30	43.50		41.5		41.50		40.50					40.00				39.80		39.20		38.50
σ (S/m)	0.87	0.87		0.9		0.97		1.20					1.40				1.49		1.80		2.40

NOTE – Multiple columns for any single frequency are optional recipe #, reference: 1 (Kanda et al. [B185]), 2 (Vigneras [B143]), 3 (Peyman and Gabriel [B119]), 4 (Fukunaga et al [B50])

The dielectric properties of the tissue simulant liquids used for the SAR testing at TÜV SÜD Product Service Ltd are as follows:-

Fluid Type and Frequency	Relative Permittivity ϵ_R (ϵ') Target	Relative Permittivity ϵ_R (ϵ') Measured	Conductivity σ Target	Conductivity σ Measured
S055 RC3				
1900 MHz Head	40.0	40.31	1.40	1.430
1900 MHz Body	53.3	53.94	1.52	1.580
2450 MHz Head	39.2	37.30	1.8	1.739
2450 MHz Body	52.7	52.17	1.95	1.948



Product Service

3.4 TEST CONDITIONS

3.4.1 Test Laboratory Conditions

Ambient temperature: Within +15°C to +35°C.

The actual temperature during the testing ranged from 22°C to 22.9°C.

The actual humidity during the testing ranged from 38.8% to 44.6% RH.

3.4.2 Test Fluid Temperature Range

Frequency	Body / Head Fluid	Min Temperature °C	Max Temperature °C
800 MHz	Head	22	22
800 MHz	Body	22	22
1900 MHz	Head	21	21
1900 MHz	Body	22	22
2450 MHz	Head	21.5	21.5
2450 MHz	Body	22	22

3.4.3 SAR Drift

The SAR Drift was within acceptable limits during scans. The maximum SAR Drift, drift due to the handset electronics, was recorded as -9.28% (-0.42 dB) for all of the testing. The measurement uncertainty budget for this assessment includes the maximum SAR Drift figures for Head and/or Body as applicable.



3.5 MEASUREMENT UNCERTAINTY

Head SAR Measurements.

Source of Uncertainty	Description	Tolerance / Uncertainty ± %	Probability distribution	Div	c _i (1g)	Standard Uncertainty ± % (1g)	V _i or V _{eff}
<i>Measurement System</i>							
Probe calibration	7.2.1	8.73	N	1	1	8.73	∞
Isotropy	7.2.1.2	3.18	R	1.73	1	1.84	∞
Probe angle >30deg	additional	12.00	R	1.73	1	6.93	∞
Boundary effect	7.2.1.5	0.49	R	1.73	1	0.28	∞
Linearity	7.2.1.3	1.00	R	1.73	1	0.58	∞
Detection limits	7.2.1.4	0.00	R	1.73	1	0.00	∞
Readout electronics	7.2.1.6	0.30	N	1	1	0.30	∞
Response time	7.2.1.7	0.00	R	1.73	1	0.00	∞
Integration time (equiv.)	7.2.1.8	1.38	R	1.73	1	0.80	∞
RF ambient conditions	7.2.3.6	3.00	R	1.73	1	1.73	∞
Probe positioner mech. restrictions	7.2.2.1	5.35	R	1.73	1	3.09	∞
Probe positioning with respect to phantom shell	7.2.2.3	5.00	R	1.73	1	2.89	∞
Post-processing	7.2.4	7.00	R	1.73	1	4.04	∞
<i>Test sample related</i>							
Test sample positioning	7.2.2.4	1.50	R	1.73	1	0.87	∞
447699999----- Device holder uncertainty	7.2.2.4.2	1.73	R	1.73	1	1.00	∞
Drift of output power	7.2.3.4	-9.28	R	1.73	1	-5.36	∞
<i>Phantom and set-up</i>							
Phantom uncertainty (shape and thickness tolerances)	7.2.2.2	2.01	R	1.73	1	1.16	∞
Liquid conductivity (target)	7.2.3.3	5.00	R	1.73	0.64	1.85	∞
Liquid conductivity (meas.)	7.2.3.3	5.00	N	1	0.64	3.20	∞
Liquid permittivity (target)	7.2.3.4	5.00	R	1.73	0.6	1.73	∞
Liquid permittivity (meas.)	7.2.3.4	3.00	N	1	0.6	1.80	∞
Combined standard uncertainty			RSS			14.75	
Expanded uncertainty (95% confidence interval)			K=2			29.50	



Body SAR Measurements.

Source of Uncertainty	Description	Tolerance / Uncertainty ± %	Probability distribution	Div	c_i (1g)	Standard Uncertainty ± % (1g)	V_i or V_{eff}
<i>Measurement System</i>							
Probe calibration	7.2.1	8.73	N	1	1	8.73	∞
Isotropy	7.2.1.2	3.18	R	1.73	1	1.84	∞
Boundary effect	7.2.1.5	0.49	R	1.73	1	0.28	∞
Linearity	7.2.1.3	1.00	R	1.73	1	0.58	∞
Detection limits	7.2.1.4	0.00	R	1.73	1	0.00	∞
Readout electronics	7.2.1.6	0.30	N	1	1	0.30	∞
Response time	7.2.1.7	0.00	R	1.73	1	0.00	∞
Integration time (equiv.)	7.2.1.8	1.38	R	1.73	1	0.80	∞
RF ambient conditions	7.2.3.6	3.00	R	1.73	1	1.73	∞
Probe positioner mech. restrictions	7.2.2.1	0.60	R	1.73	1	0.35	∞
Probe positioning with respect to phantom shell	7.2.2.3	2.00	R	1.73	1	1.15	∞
Post-processing	7.2.4	7.00	R	1.73	1	4.04	∞
<i>Test sample related</i>							
Test sample positioning	7.2.2.4	1.50	R	1.73	1	0.87	∞
Device holder uncertainty	7.2.2.4.2	1.73	R	1.73	1	1.00	∞
Drift of output power	7.2.3.4	0	R	1.73	1	2.89	∞
<i>Phantom and set-up</i>							
Phantom uncertainty (shape and thickness tolerances)	7.2.2.2	2.01	R	1.73	1	1.16	∞
Liquid conductivity (target)	7.2.3.3	5.00	R	1.73	0.64	1.85	∞
Liquid conductivity (meas.)	7.2.3.3	5.00	N	1	0.64	3.20	∞
Liquid permittivity (target)	7.2.3.4	5.00	R	1.73	0.6	1.73	∞
Liquid permittivity (meas.)	7.2.3.4	3.00	N	1	0.6	1.80	∞
Combined standard uncertainty			RSS			11.52	
Expanded uncertainty (95% confidence interval)			K=2			23.05	



Product Service



Product Service

SECTION 4

ACCREDITATION, DISCLAIMERS AND COPYRIGHT



Product Service

4.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT



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ANNEX A

PROBE CALIBRATION REPORT



NATIONAL PHYSICAL LABORATORY

Teddington Middlesex UK TW11 0LW Telephone +44 20 8977 3222

Certificate of Calibration

SAR PROBE

IndexSAR

Model: IXP-050

Serial number: 0187

This certificate provides traceability of measurement to recognised national standards, and to the units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full, unless permission for the publication of an approved extract has been obtained in writing from the Managing Director. It does not of itself impute to the subject of calibration any attributes beyond those shown by the data contained herein.

FOR: Indexsar Ltd.
Oakfield House
Cudworth Lane
Newdigate
Surrey
RH5 5BG

DESCRIPTION: An IndexSAR isotropic electric field probe for determining specific absorption rates (SAR) in dielectric liquids. The probe has three orthogonal sensors, and the output voltage of the sensors is converted to an optical signal by a meter unit containing an analogue to digital (AD) converter. Probe readings are obtained using software via the RS232 port. The probe was calibrated with IndexSAR amplifier model IXA-010 S/N 036 belonging to NPL.

IDENTIFICATION: The probe is marked with the manufacturer's serial number 0187

MEASUREMENTS COMPLETED ON: 1 March 2012

The reported uncertainty is based on a coverage factor $k=2$, providing a level of confidence of approximately 95%

Reference : 2012020074-2

Page 1 of 7

Date of Issue : 1 March 2012

Signed : *B. Loader* (Authorised Signatory)

Checked by : *B. Cel*

Name : Mr B G Loader on behalf of NPLML

NPL/LO 1-06/07

NATIONAL PHYSICAL LABORATORY

Continuation Sheet

MEASUREMENT PROCEDURE

For frequencies at or above 835 MHz, the calibration method is based on establishing a calculable specific absorption rate (SAR) using a matched waveguide cell [1]. The cell has a feed-section and a liquid-filled section separated by a matching window that is designed to minimise reflections at the interface. A TE₀₁ mode is launched into the waveguide by means of a N-type-to-waveguide adapter. The power delivered to the liquid is calculated from the forward power and reflection coefficient measured at the input to the cell. At the centre of the cross-section of the waveguide cell, the volume specific absorption rate (SAR^V) in the liquid as a function of distance from the window is given by

$$SAR^V = \frac{4(P_w)}{ab\delta} e^{-2Z/\delta} \quad (1)$$

where

- a = the larger cross-sectional dimension of the waveguide.
- b = the smaller cross-sectional dimension of the waveguide.
- δ = the skin depth for the liquid in the waveguide.
- Z = the distance of the probe's sensors from the liquid to matching window boundary.
- P_w = the power delivered to the liquid.

For frequencies below 835 MHz, the SAR in the liquid is established by measuring the rate of temperature rise in the liquid at the calibration point. In this case the SAR in the liquid is related to the temperature rise by

$$SAR = c \frac{dT}{dt} \quad (2)$$

where c is the specific heat of the liquid.

Liquids having the properties specified by SAR measurement standards [2, 3, 4] were used for the calibration. The value of δ for the liquid was obtained by measuring the electric field (E) at a number of distances from the matching window. The calibration was for continuous wave (CW) signals, and the axis of the probe was parallel to the direction of propagation of the incident field i.e. end-on to the incident radiation. The probe was rotated about its axis in 15-degree steps, and the ratio of the calibration factors for the three probe sensors X, Y, & Z were optimized to give the best axial isotropy.

Reference : 2012020074-2

Page 2 of 7

Date of Issue : 1 March 2012

Checked by : *BCA*

NPL/5004/0007

NATIONAL PHYSICAL LABORATORY

Continuation Sheet

The probe was calibrated with the linearisation and air-correction factors enabled. Comparing the measured values of E^2 in the liquid to those calculated for the waveguide cell allows the ratio, $ConvF$, of sensitivity for $(E^2_{LIQUID}) / (E^2_{AIR})$ to be determined, as required by the probe software.

The linear response of the probe to continuous wave signals was tested at 1800 MHz over the range 0.12 W/kg to 100 W/kg in accordance with [3].

The spherical isotropy of the probe was tested in head liquid at 900 MHz, in accordance with [3, 5, 6], for probe axial rotation (θ) through 360° and source polarisation (ϕ) rotation through 90° in 15° increments.

ENVIRONMENT

Measurements were made in a temperature-controlled laboratory at $22 \pm 1^\circ\text{C}$. The temperature of the liquid used was measured at the beginning and end of each measurement.

UNCERTAINTIES

The estimated uncertainty in calibration for SAR (W kg^{-1}) is $\pm 10\%$. The reported uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a level of confidence of approximately 95%.

This uncertainty is valid when the probe is used in a liquid with the same dielectric properties as those used for the calibration. No estimate is made for the long-term stability of the device calibrated or of the fluids used in the calibration.

When using the probe for SAR testing, additional uncertainties should be added to account for the spherical isotropy of the probe, proximity effects, linearity, and response to pulsed fields. There will be additional uncertainty if the probe is used in liquids having significantly different electrical properties to those used for the calibration. The electrical properties of the liquids will be related to temperature.

RESULTS

Tables 1 and 2 give the results for calibration in liquid.

These calibration factors are only correct when the values for sensitivity in free-space, diode compression and sensor offset from the tip of the probe, as set in the probe software, are the same as those given in Table 1 and 2.

Reference : 2012020074-2

Page 3 of 7

Date of Issue : 1 March 2012

Checked by : *BCL*

NPLCS00048/07

NATIONAL PHYSICAL LABORATORY

Continuation Sheet

Table 3 contains the values of the boundary correction factors $f(\theta)$ and d .

Table 4 gives the probe linearity and spherical isotropy.

REFERENCES:

- [1] Pokovic, KT, T.Schmid and N.Kuster, "Robust set-up for Precise Calibration of E-field probes in Tissue Simulating Liquids at Mobile Phone Frequencies", Proceedings ICECOM 1997, pp 120 – 124, Dubrovnik, Croatia Oct 12-17, 1997.
- [2] British Standard BS EN 503361:2001. "Basic standard for the measurement of specific absorption rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz)".
- [3] IEEE Standard 1528-2003 "Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques".
- [4] Federal Communications Commission, FCC OET Bulletin 65, Supplement C, June 2001, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields Additional Information for Evaluating Compliance of Mobile and Portable Devices with FCC Limits for Human Exposure to Radiofrequency Emissions", David L. Means, Kwok W. Chan.
- [5] IEC Standard 62209-1 Ed 1. (2005), "Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices - Human models, Instrumentation, and Procedures – - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)".
- [6] IEC Standard 62209-2 Ed 1. (2010), "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)".

Reference : 2012020074-2

Page 4 of 7

Date of Issue : 1 March 2012

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NPLCS0048807

NATIONAL PHYSICAL LABORATORY

Continuation Sheet

Table 1
Sensitivity in Head Simulating Liquids.
SAR probe: IXP-050
S/N 0187

Probe settings for calibration						
Sensitivity in free-space ⁽¹⁾		Diode Compression ⁽²⁾		Sensor offset from tip of probe ⁽²⁾		
Lin X = 540.09 (V/m) ² /(V*200)		DCP _X = 20 (V*200)		2.7 mm		
Lin Y = 736.31 (V/m) ² /(V*200)		DCP _Y = 20 (V*200)				
Lin Z = 658.07 (V/m) ² /(V*200)		DCP _Z = 20 (V*200)				
Sensitivity in Head Simulating Liquid.						
Calibration frequency (MHz)	Liquid Phantom ⁽³⁾		Calibration Factors for $E^2_{\text{Liquid}} / E^2_{\text{Air}}$			Axial Isotropy
	ϵ' ⁽³⁾	σ ⁽³⁾ (Sm ⁻¹)	<i>ConvF_X</i>	<i>ConvF_Y</i>	<i>ConvF_Z</i>	(dB)
450	41.8	0.88	0.172	0.166	0.164	±0.01
835	40.2	0.93	0.204	0.193	0.195	±0.01
900	39.8	0.97	0.205	0.193	0.196	±0.01
1800	40.0	1.41	0.259	0.242	0.247	±0.03
1900	39.2	1.39	0.274	0.255	0.259	±0.05
2100	40.5	1.46	0.300	0.277	0.284	±0.02
2450	39.1	1.80	0.293	0.268	0.274	±0.04
2600	38.6	1.95	0.302	0.277	0.283	±0.04

Reference : 2012020074-2

Page 5 of 7

Date of Issue : 1 March 2012

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NPLCS00-06807

NATIONAL PHYSICAL LABORATORY

Continuation Sheet

Table 2
Sensitivity in Body Simulating Liquids.
SAR probe: IXP-050
S/N 0187

Probe settings for calibration						
Sensitivity in free-space ⁽¹⁾		Diode Compression ⁽²⁾		Sensor offset from tip of probe ⁽²⁾		
Lin X = 540.09 (V/m) ² /(V*200)		DCP _x = 20 (V*200)		2.7 mm		
Lin Y = 736.31 (V/m) ² /(V*200)		DCP _y = 20 (V*200)				
Lin Z = 658.07 (V/m) ² /(V*200)		DCP _z = 20 (V*200)				
Sensitivity in Body Simulating Liquid.						
Calibration frequency (MHz)	Liquid Phantom ⁽³⁾		Calibration Factors for $E^2_{\text{Liquid}} / E^2_{\text{Air}}$			Axial Isotropy
	ϵ' ⁽³⁾	σ ⁽³⁾ (Sm ⁻¹)	<i>ConvF_x</i>	<i>ConvF_y</i>	<i>ConvF_z</i>	(dB)
450	55.6	0.98	0.181	0.175	0.173	±0.03
835	56.1	1.02	0.206	0.195	0.199	±0.01
900	55.8	1.05	0.214	0.202	0.206	±0.01
1800	52.3	1.51	0.281	0.257	0.265	±0.01
1900	52.0	1.59	0.295	0.270	0.278	±0.02
2100	51.5	1.63	0.321	0.294	0.301	±0.02
2450	50.5	1.96	0.328	0.298	0.304	±0.04
2600	50.2	2.12	0.340	0.309	0.316	±0.04

Notes.

- (1) Measured at 900 MHz
- (2) The manufacturer supplied these figures.
- (3) Measured at a temperature of 22 ± 1 °C.

Reference : 2012020074-2

Page 6 of 7

Date of Issue : 1 March 2012

Checked by : *Blal*

NPLCS004807

NATIONAL PHYSICAL LABORATORY

Continuation Sheet

Table 3
Boundary Correction Factors
SAR probe: IXP-050
S/N 0187

Frequency (MHz)	Head Simulating Liquid		Body Simulating Liquid	
	$f(0)$	d	$f(0)$	d
450	1.66	1.19	1.26	1.27
835	0.60	2.30	3.08	0.92
900	1.49	1.18	1.12	1.41
1800	0.67	1.73	0.65	1.82
1900	0.37	2.69	0.66	1.82
2100	0.65	1.82	0.73	1.71
2450	1.04	1.37	0.95	1.41
2600	0.97	1.35	0.87	1.40

Table 4
Linearity and Spherical Isotropy
SAR probe: IXP-050
S/N 0187

Parameter	Frequency	Range	Maximum deviation
Linearity	1800 MHz	0.12 – 100 W/kg	± 0.11 dB
Spherical isotropy in head liquid	900 MHz	$\theta = 0$ to 360° , $\phi = 0$ to 90°	± 1.3 dB

Reference : 2012020074-2

Page 7 of 7

Date of Issue : 1 March 2012

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