REPORT ON

Specific Absorption Rate Testing of the
Symbol Handheld Data Terminal 4121CDMA

Report No WS613597/01 Issue 1 **April 2005**

TÜV SÜD Product Service

BABT

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REPORT ON: Specific Absorption Rate Testing of the Symbol Handheld Data Terminal 4121CDMA

Report No: WS613597/01 Issue 1

PREPARED FOR: Symbol (UK) Ltd
One Symbol Plaza
Holtsville
NY 11742-1300
New York
United States of America

ATTESTATION: The wireless portable device described within this report has been shown to be capable of compliance for localised specific absorption rate (SAR) for FCC standard Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01) and RSS-102 Issue 1 (Provisional) September 25, 1999 of 1.6 W/kg.

The measurements shown in this report were made in accordance with the procedures specified in Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01), RSS-102 Issue 1 (Provisional) September 25, 1999.

All reported testing was carried out on a sample of equipment to demonstrate compliance with the above standards. The sample tested was found to comply with the requirements in the applied rules.

A. Miller
Senior SAR Test Engineer

APPROVED BY:

M J Hardy
UKAS Signatory

DATED: 19th April 2005

DISTRIBUTION:

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Note: The test results reported herein relate only to the item tested as identified above and on the Status Page.

CONTENTS

SECTION 1

REPORT SUMMARY

Specific Absorption Rate Testing of the Symbol
Handheld Data Terminal 4121CDMA

MAXIMUM 1g SAR TESTING RESULTS			
Position	**Frequency (MHz)**	**Max 1g SAR (W/kg)**	**SAR Drift (dB)**
Front Top of Device Placed Against Phantom	824.70	0.276	0.00
Front Top of Device Placed Against Phantom	1851.25	0.714	-0.08
Front Top of Device Placed Against Phantom	2412.00	0.292	-0.01
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).			

1.1 STATUS

MANUFACTURING DESCRIPTION	Handheld Data Terminal
STATUS OF TEST	Specific Absorption Rate Testing
APPLICANT	Symbol Technologies Inc
MANUFACTURER	Symbol Technologies Inc
TYPE	4121CDMA
PART NUMBER	4121CDMA0
SERIAL NUMBER	S/N: 4XEQ0155
HARDWARE VERSION	Rev 5 (to be released as Rev A)
RADIO CDMA	CDMA2000 (1XRTT) Radio Card
TYPE	Motorola C18
BANDS	US CELL 800MHz US PCS 1900MHz
RADIO LAN	Symbol Compact Flash RLAN Radio
TYPE	LA4137
POWER	100mW
RADIO BLUETOOTH	Symbol Bluetooth Module
TYPE	21-64381
POWER	100mW (restricted in this terminal integration to 1mW)
BATTERY MANUFACTURER	Symbol Technologies Inc
PART NUMBER	31-57157-01 (Li Ion 7.2v)

TEST SPECIFICATIONS:

US Federal Government, Code of Federal Regulations, Title 47 Telecommunication, Chapter I Federal Communications Commission, part 2, section 1093.

Federal Communications Commission (FCC) OET Bulletin 65c, Edition 01-01, 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

RSS-102 Issue 1 (Provisional) September 25, 1999: Evaluation Procedure for Mobile and Portable Radio Transmitters with respect to Health Canada's Safety Code 6 for Exposure of Humans to radio Frequency Fields.

REFERENCE DOCUMENTS:

IEEE 1528 – 2003: Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices: Experimental Techniques

BABT REGISTRATION NUMBER: WS613597

RECEIPT OF TEST SAMPLES: 31st March 2005

START OF TEST: 31st March 2005

FINISH OF TEST: 4th April 2005

1.2 DECLARATION OF BUILD STATUS

MAIN EUT	
MANUFACTURING DESCRIPTION	Handheld Data Terminal
MANUFACTURER	Symbol Technologies Inc.
TYPE	4121CDMA
PART NUMBER	4121CDMA0
SERIAL NUMBER	4XEQ0155,4XEQ0156, 4MES0022
HARDWARE VERSION	Rev 5 (to be released as Rev A)
FCC ID	H9P4121CDMA
INDUSTRY CANADA ID	1549D-4121CDMA
TECHNICAL DESCRIPTION	The 4121CDMA is a Handheld Data Terminal, which offers CDMA 800/1900, 802.11b Wireless LAN and Bluetooth connectivity. The terminal utilizes the approved Motorola C18 module to offer CDMA functionality. Also included in the terminal is the approved LA-4137 Symbol Compact Flash 802.11b RLAN radio card and the 21-64831 Symbol Bluetooth module.

BATTERY/POWER SUPPLY	
MANUFACTURING DESCRIPTION	Internal Lithium Ion Battery (Li ion)
PART NUMBER	31-57157-01
HARDWARE VERSION	Rev B
VOLTAGE	7.2V

MODULE			
MANUFACTURING DESCRIPTION	RLAN Module	Bluetooth Module	CDMA Module
MANUFACTURER	Symbol Technologies Inc	Symbol Technologies Inc	Motorola Inc.
TYPE	LA4137	21-64381	C18
ITU DESIGNATION OF EMISSION	11M0F1D	1M00F1D	1M25F9W
TRANSMITTER POWER	100mW	100mW (restricted in this terminal integration to 1 mW)	CDMA800: 0.32W CDMA1900: 0.32W
TRANSMITTER OPERATING BAND	2400-2483.5 MHz	2400-2483.5 MHz	824.7 to 848.31MHz 1851.25 to 1908.75MHz
RECEIVER OPERATING BAND	2400-2483.5 MHz	2400-2483.5 MHz	869.7 to 893.31MHz 1931.25 to 1988.75MHz
DHSS/FHSS/COMBINED OR OTHER	DSSS	FHSS	CDMA (1XRTT)
FCC ID	H9PLA4137	H9P2164381	IHDT56CW1
INDUSTRY CANADA ID	1549104431A	1549D-2164381	109O-CW1

ANCILLARIES	
MANUFACTURING DESCRIPTION	Belt Clip
PART NUMBER	UPS-BC5000
HARDWARE VERSION	Rev A

Signature Marco Bell

Date 24th March 2005

D of B S Serial No. OS613957

1.3 SUMMARY

The 4121CDMA is a Handheld Data Terminal, which offers CDMA 800/1900, 802.11b Wireless LAN and Bluetooth connectivity. The terminal utilizes the approved Motorola C18 module to offer CDMA functionality. Also included in the terminal is the approved LA-4137 Symbol Compact Flash 802.11b RLAN radio card and the 21-64831 Symbol Bluetooth module.

SAR testing was first performed with the device set the appropriate test mode, against a flat phantom dimension (W) 200mm x (H) 200mm x (D) 190mm and with a sidewall thickness of 2.0mm. The phantom was filled to a depth of 150mm with body simulant liquid. The dielectric properties were in accordance with the requirements for the dielectric properties specified in Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01). SAR testing was carried out at the top, middle and bottom frequency of each of the device operating bands. The device was in contact, to simulate the worst case position.

The CDMA Radio Card was tested was controlled using an Agilent 8960 and was in 6702 A Lab application. The Agilent 8960 was then configured to CDMA2000 Lab App A. Cell 1 power set to -50.00 dBm / 1.23MHz. Maximum transmit power was achieved by setting Cell parameters – SID/NID – Cell 1 Rvs CLPC to ALL up Bits.

The RLAN card was tested using onboard software supplied by the client, which enabled the device to be placed into a CW test mode. Maximum power level as defined by the client was achieved by setting 210 as the power level setting. The channels 1, 6 & 11 were selected in turn and the maximum SAR levels recorded.

The Bluetooth module is a Class 1 device, but is restricted for this product to Class 3 (1mW 0dBm) power output. No SAR scans for the Bluetooth module are included in this report.

Co-Location, this unit is designed to operate in co-located mode Bluetooth with CDMA 800 mode and Bluetooth with CDMA 1900 mode. No SAR scans were carried out with the unit in this mode due to the power classification of the Bluetooth module being below the limit for SAR testing. Note: for Body worn operation, the 4121CDMA is a portable data terminal and has been tested to meet the FCC RF exposure guidelines when used with accessories which contain no metal and which positions the device a minimum of 0.0cm from the body. Use of other accessories may not ensure compliance with FCC RF guidelines.

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 unit under test.

The maximum 10g volume averaged SAR level measured for all the tests performed did not exceed the 2 W/kg level defined for limiting the exposure of the general population to time-varying electric and magnetic fields by ICNIRP (1998), which is the relevant Standard for testing according to the CENELEC EN50361 test method.

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).

1.4 TEST RESULTS SUMMARY

SYSTEM PERFORMANCE / VALIDATION CHECK RESULTS

Prior to formal testing being performed a System Check was performed in accordance with IEEE 1528-2003. The following results were obtained: -

Dipole Used	Frequency (MHz)	Max 1g SAR (W/kg)*	Percentage Drift on 1g Reference	Max 10g SAR (W/kg)*	Percentage Drift on 10g Reference
900	907.5	10.86*	0.56%	6.96*	0.87%
1900	1833.6	40.79*	2.75%	21.52*	4.98%
2450	2450	49.69*	-5.18%	23.57*	-1.79%

*Normalised to 1W

OUTPUT POWER OF TEST DEVICE MEASUREMENT METHOD

The Spectrum Analyser was tuned to the test frequency. The device output power setting was controlled via the 'Test Mode' on each handset being set to the conditions specified in the Summary on page 5 of this document. The device was then rotated through 360 degrees until the highest power level was observed in both planes of polarisation. The device was then replaced with a substitution antenna, the signal to the antenna was adjusted to equal the related level detected from the device.

MAXIMUM POWER – Recorded from the Symbol 4121CDMA Hand Held Data Terminal

Module	Frequency (MHz)	Raw Result (dBm)	Substitution Antenna Gain (dB)	Result EIRP (dBm)	Result EIRP (mW)
RLAN	2412.00	-34.15	9.09	18.93	78.20
RLAN	2437.00	-35.47	9.12	17.67	58.48
RLAN	2462.00	-37.04	9.14	16.28	42.46
Bluetooth	2402.00	-56.00	9.10	-1.80	0.66
Bluetooth	2441.00	-57.40	9.10	-3.00	0.50
Bluetooth	2480.00	-58.30	9.10	-2.70	0.54
CDMA800	844.70	-13.70	6.40	20.60	114.82
CDMA800	836.52	-13.10	6.40	20.90	123.00
CDMA800	848.31	-12.50	6.40	21.60	114.50
CDMA1900	1851.25	-11.30	8.70	31.20	1320.00
CDMA1900	1880.00	-10.80	8.70	30.10	1020.00
CDMA1900	1908.75	-10.90	8.70	32.00	1580.00

1.4 TEST RESULTS SUMMARY – Continued

SUMMARY OF RESULTS FOUND DURING ASSESSMENT

The following is a summary of the maximum SAR values found during the assessment.

US CELLULAR 800MHz Specific Absorption Rate (Maximum SAR) 1g & 10g Results for Symbol 4121CDMA placed against the Flat Phantom (Body SAR)

Position	Channel Number	Frequency (MHz)	Max Spot (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	Area scan (Figure number)
Front Facing Phantom	384	836.52	0.080	0.096	0.069	Figure 3
Rear Facing Phantom	384	836.52	0.090	0.101	0.074	Figure 4
Rear Facing Phantom	1013	824.70	0.090	0.109	0.080	Figure 5
Rear Facing Phantom	777	848.31	0.080	0.100	0.074	Figure 6
Front Top of Device Placed Against Phantom	1013	824.70	0.250	0.276	0.190	Figure 7
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)						

US CELLULAR 1900MHz Specific Absorption Rate (Maximum SAR) 1g & 10g Results for Symbol 4121CDMA placed against the Flat Phantom (Body SAR)

Position	Channel Number	Frequency (MHz)	Max Spot (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	Area scan (Figure number)
Front Facing Phantom	600	1880.00	0.250	0.065	0.064	Figure 8
Rear Facing Phantom	600	1880.00	0.140	0.179	0.118	Figure 9
Front Facing Phantom	25	1851.25	0.320	0.393	0.246	Figure 10
Front Facing Phantom	1175	1908.75	0.290	0.373	0.225	Figure 11
Front Top of Device Placed Against Phantom	25	1851.25	0.660	0.714	0.517	Figure 12
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)						

1.4 TEST RESULTS SUMMARY – Continued

SUMMARY OF RESULTS FOUND DURING ASSESSMENT

The following is a summary of the maximum SAR values found during the assessment.

DSSS 2450MHz Specific Absorption Rate (Maximum SAR) 1g & 10g Results for Symbol 4121CDMA placed against the Flat Phantom (Body SAR)

Position	Channel Number	Frequency (MHz)	Max Spot (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	Area scan (Figure number)
Front Facing Phantom	6	2437	0.090	0.120	0.069	Figure 13
Rear Facing Phantom	6	2437	0.050	0.064	0.039	Figure 14
Front Facing Phantom	1	2412	0.090	0.125	0.073	Figure 15
Front Facing Phantom	11	2462	0.060	0.076	0.044	Figure 16
Front Top of Device Placed Against Phantom	1	2412	0.220	0.292	0.164	Figure 17
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)						

SECTION 2

TEST DETAILS

Specific Absorption Rate Testing of the
Symbol Handheld Data Terminal 4121CDMA

2.1 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.

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.

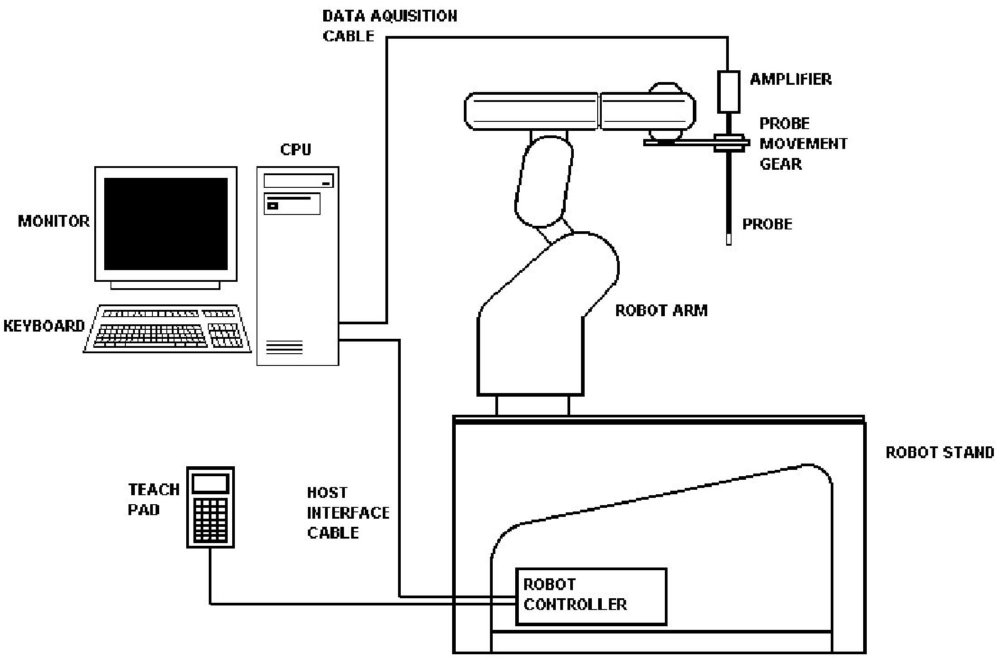

Figure 1: Schematic diagram of the SAR measurement system

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.

2.2 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.

IXP-039 Amplifier
The amplifier unit has a multi-pole connector to connect to the probe and a multiplexer selects between the 3-channel single-ended inputs. A 16-bit AtoD converter with programmable gain is used along with an on-board micro-controller with non-volatile firmware. Battery life is around 150 hours and data are transferred to the PC via 3m of duplex optical fibre and a self-powered RS232 to optical converter.

Phantoms
The Flat Phantom is manufactured from Perspex. Flat Phantom dimensions 220mmx200mmx150mm and with a sidewall thickness of 2.0mm. The phantom and robot alignment is assured by both mechanical and laser registration systems.

2.3 SAR MEASUREMENT PROCEDURE

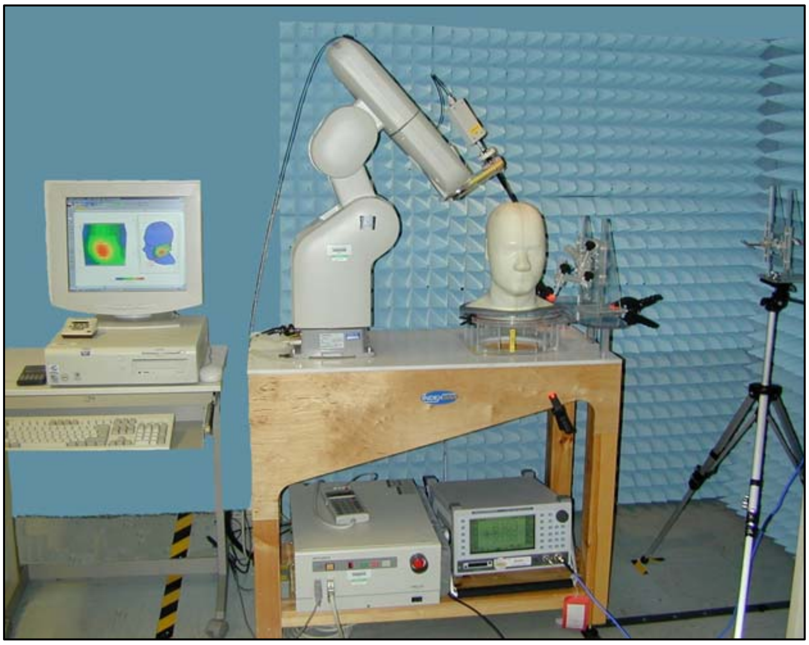

Figure 2: Principal components of the SAR measurement test bench

The major components of the test bench are shown in the picture 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 4^{th} 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. 10mm 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.

2.3 SAR MEASUREMENT PROCEDURE - Continued

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 50361). 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 50361.

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 50361) 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.

The robot positioning system specification for the repeatability of the positioning (**dss** in EN50361) is +/- 0.04mm.

2.3 SAR MEASUREMENT PROCEDURE - Continued

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).

2.4 800MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	01/04/2005 15:21:56	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_006.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	23.3°C	LIQUID SIMULANT:	835Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	57.54
RELATIVE HUMIDITY:	31.7%	CONDUCTIVITY:	1.058
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.9°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-13.00 mm
DUT POSITION:	Front 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	-17.00 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	8.98 V/m
TEST FREQUENCY:	836.52MHz	SAR 1g:	0.096 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.069 W/kg
CONVERSION FACTORS:	.273 / .273 / .273	SAR START:	0.027 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.027 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.06 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

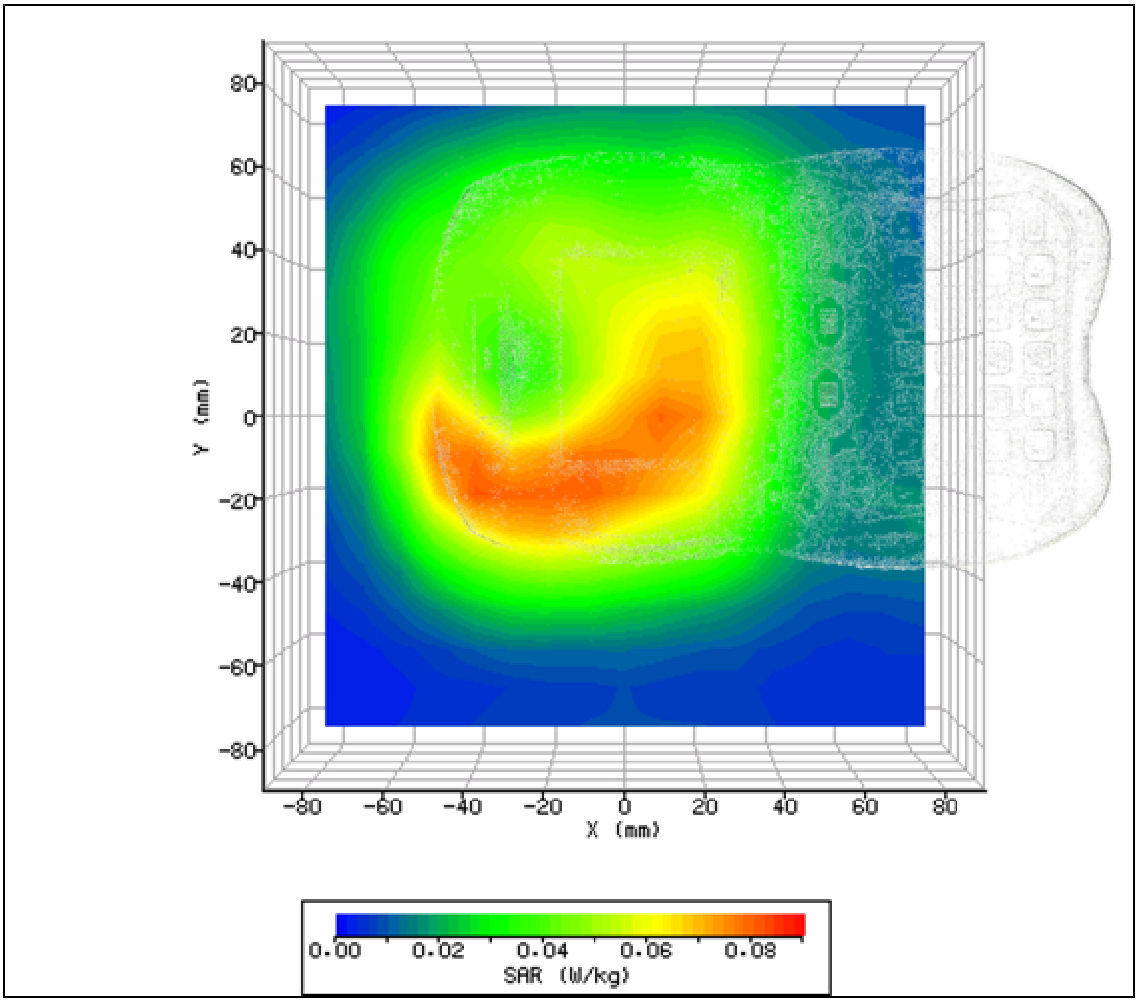

Figure 3

2.4 800MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	01/04/2005 15:51:58	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_007.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	21.9°C	LIQUID SIMULANT:	835Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	57.54
RELATIVE HUMIDITY:	33.3%	CONDUCTIVITY:	1.058
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.8°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-28.00 mm
DUT POSITION:	Rear 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	48.33 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	9.28 V/m
TEST FREQUENCY:	836.52MHz	SAR 1g:	0.101 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.074 W/kg
CONVERSION FACTORS:	.273 / .273 / .273	SAR START:	0.033 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.033 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.010 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

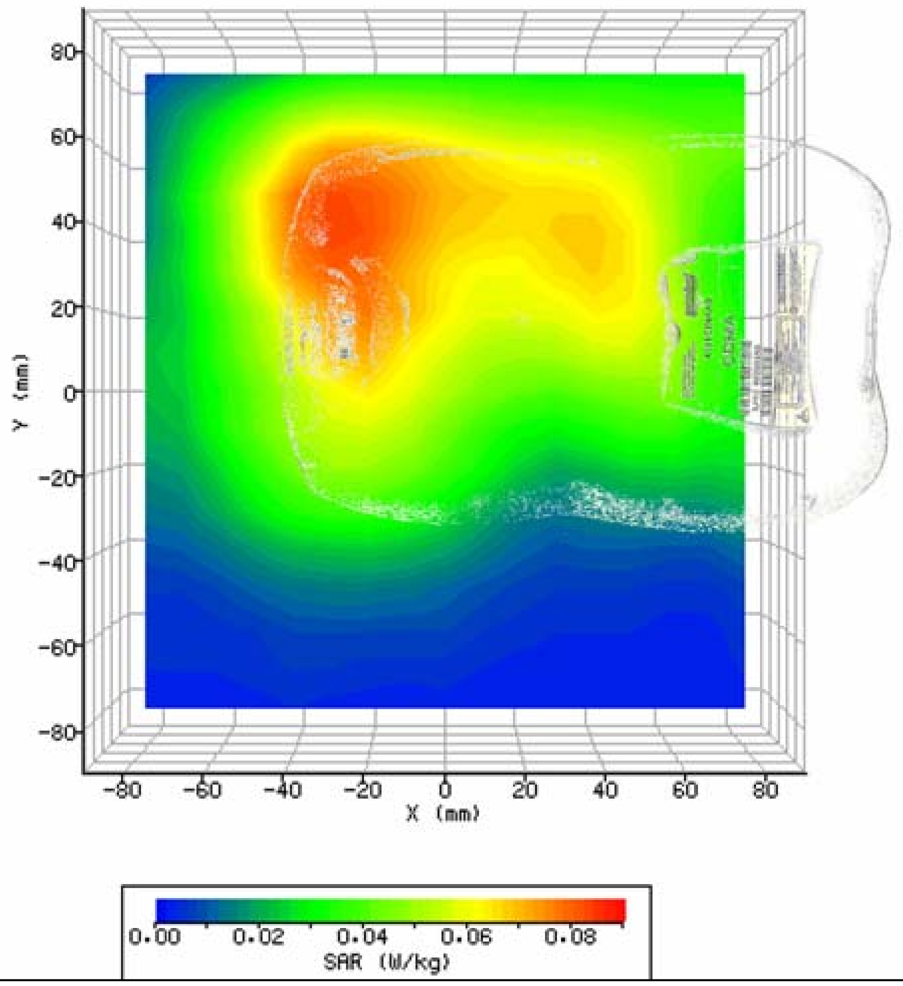

Figure 4

2.4 800MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	01/04/2005 16:52:16	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_008.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	23.0°C	LIQUID SIMULANT:	835Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	57.54
RELATIVE HUMIDITY:	37.8%	CONDUCTIVITY:	1.058
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.6°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-45.00 mm
DUT POSITION:	Rear 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	48.00 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	9.59 V/m
TEST FREQUENCY:	824.70MHz	SAR 1g:	0.109 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.08 W/kg
CONVERSION FACTORS:	.273 / .273 / .273	SAR START:	0.036 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.037 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.16 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

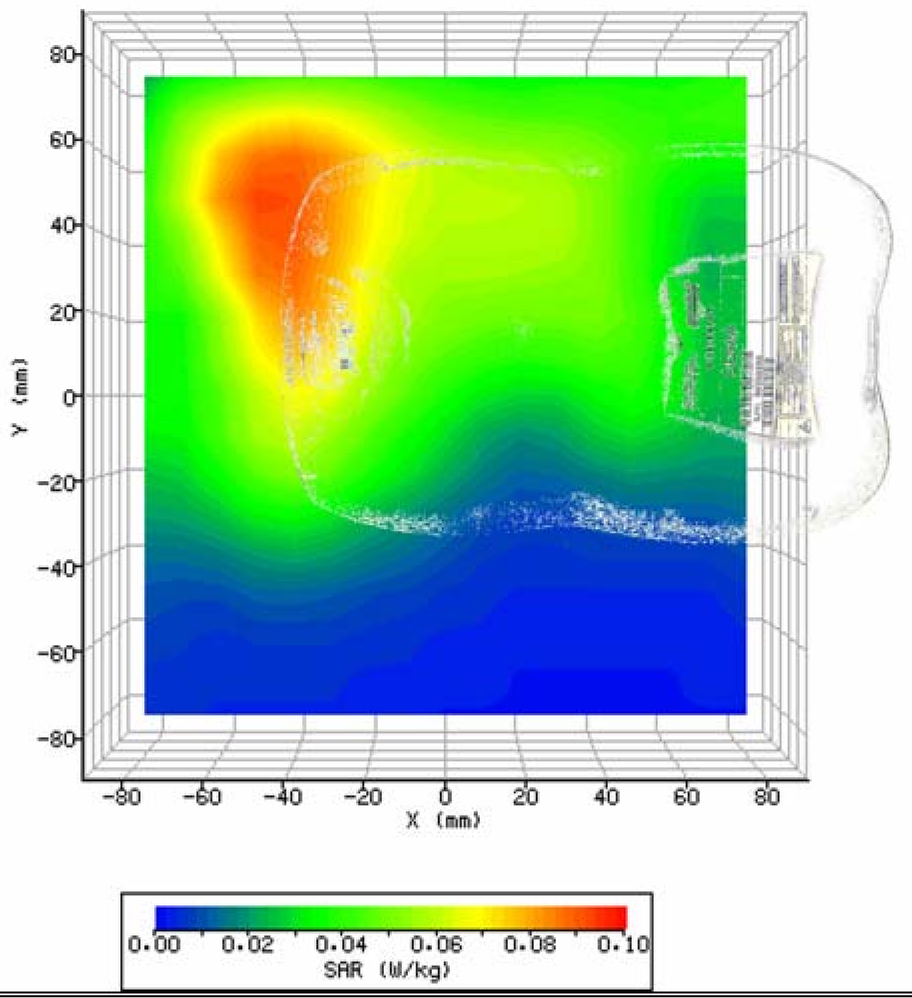

Figure 5

2.4 800MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	01/04/2005 17:23:43	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_009.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	23.4°C	LIQUID SIMULANT:	835Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	57.54
RELATIVE HUMIDITY:	35.0%	CONDUCTIVITY:	1.058
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.4°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-44.00 mm
DUT POSITION:	Rear 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	43.00 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	9.24 V/m
TEST FREQUENCY:	848.31MHz	SAR 1g:	0.10 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.074 W/kg
CONVERSION FACTORS:	.273 / .273 / .273	SAR START:	0.033 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.033 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.08 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

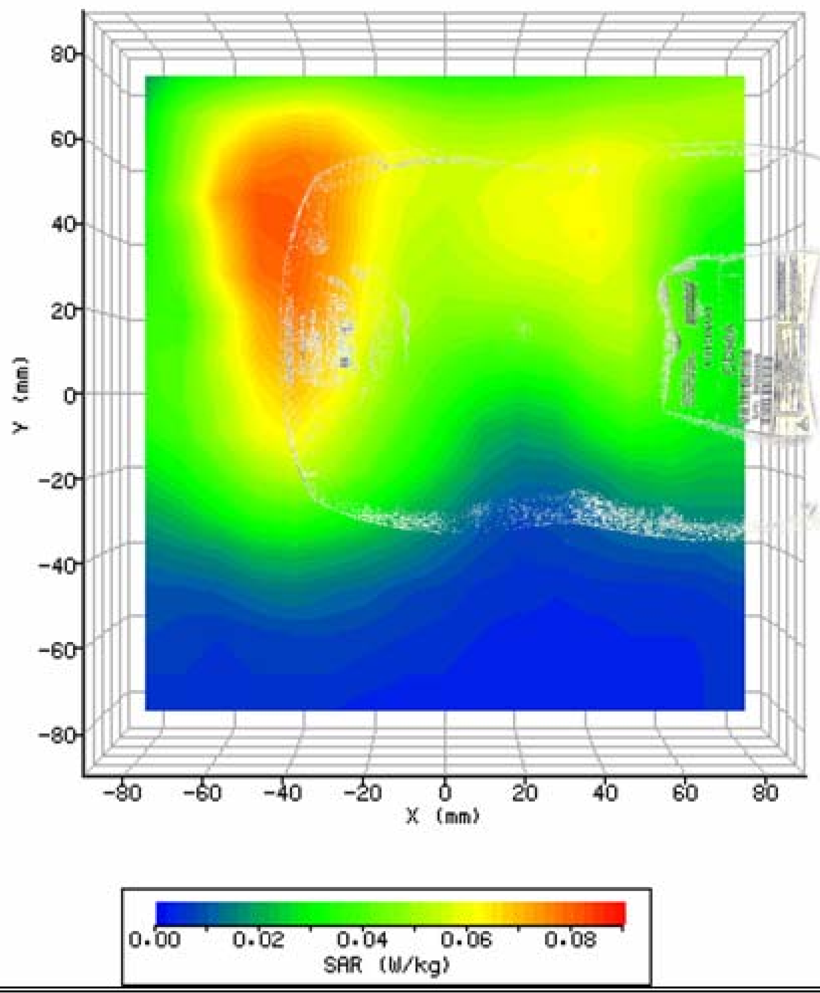

Figure 6

2.4 800MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	01/04/2005 18:11:58	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_010.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	21.8°C	LIQUID SIMULANT:	835Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	57.54
RELATIVE HUMIDITY:	37.90%	CONDUCTIVITY:	1.058
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.4°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-5.00 mm
DUT POSITION:	Front Tilt 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	-26.33 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	15.73 V/m
TEST FREQUENCY:	824.70MHz	SAR 1g:	0.276 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.190 W/kg
CONVERSION FACTORS:	.273 / .273 / .273	SAR START:	0.083 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.083 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.0 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

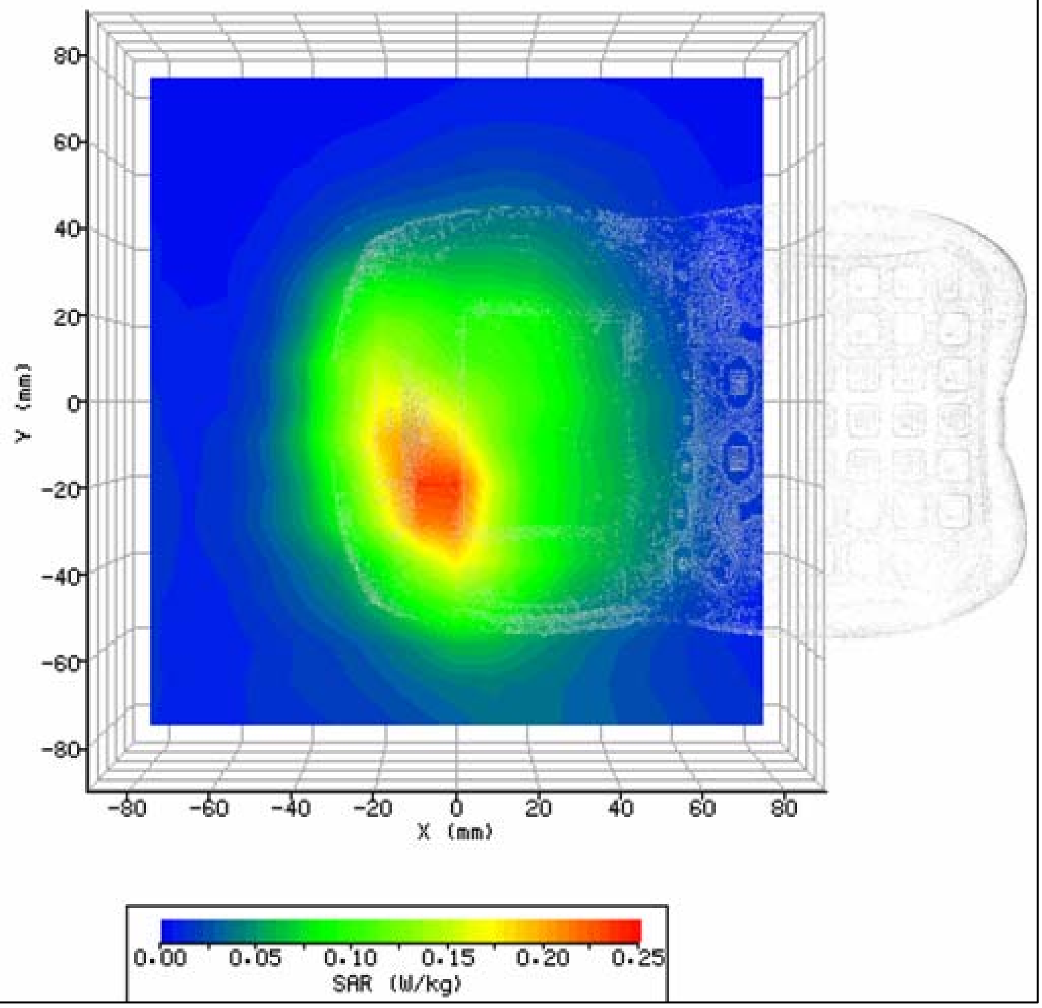

Figure 7

2.4 1900MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	04/04/2005 12:00:07	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_0011.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	24.5°C	LIQUID SIMULANT:	1900Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.41
RELATIVE HUMIDITY:	33.1%	CONDUCTIVITY:	1.558
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.6°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-56.00 mm
DUT POSITION:	Front 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	0.00 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	12.68 V/m
TEST FREQUENCY:	1880.00MHz	SAR 1g:	0.065 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.064 W/kg
CONVERSION FACTORS:	.346 / .346 / .346	SAR START:	0.321 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.194 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.1 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

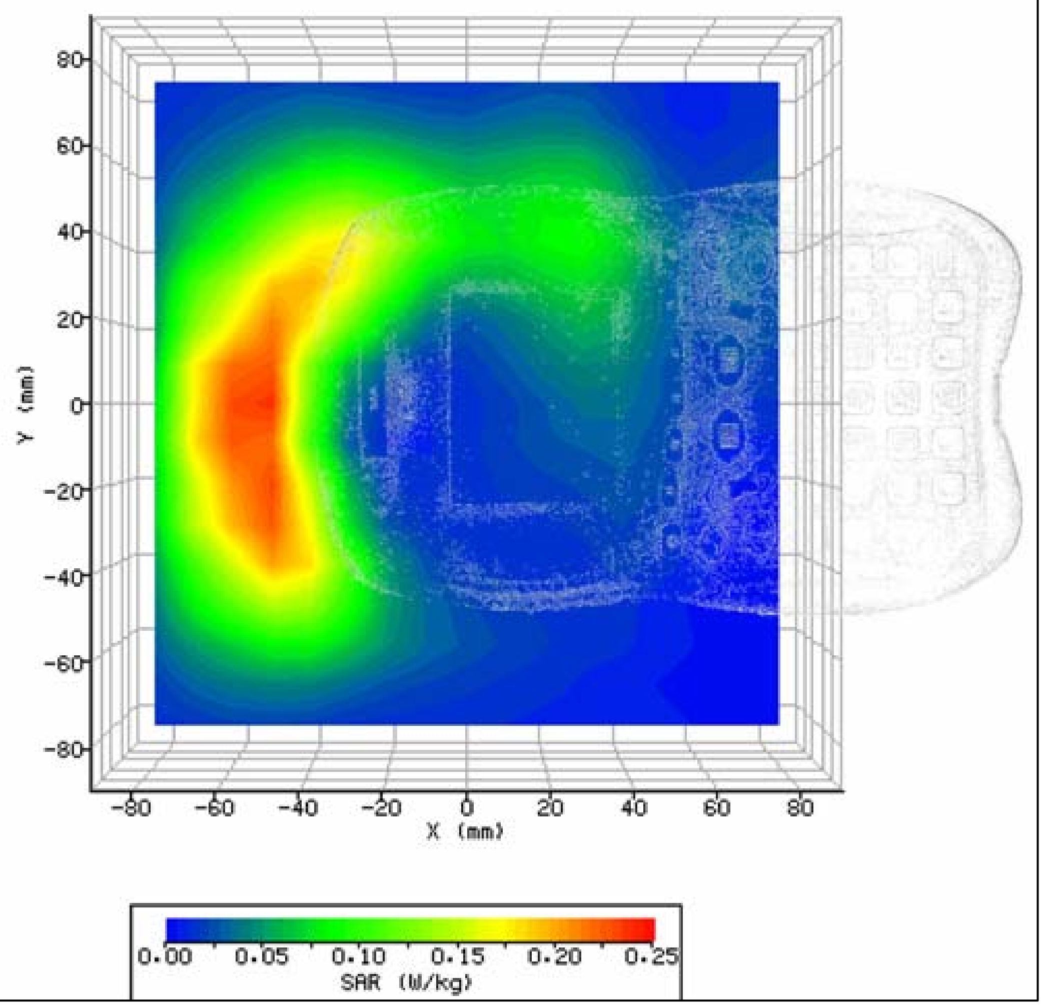

Figure 8

2.4 1900MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	04/04/2005 12:50:04	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_0012.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	24.4°C	LIQUID SIMULANT:	1900Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.41
RELATIVE HUMIDITY:	33.0%	CONDUCTIVITY:	1.558
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.6°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-45.00 mm
DUT POSITION:	Rear 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	5.67 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	9.63 V/m
TEST FREQUENCY:	1880.00MHz	SAR 1g:	0.179 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.118 W/kg
CONVERSION FACTORS:	.346 / .346 / .346	SAR START:	0.030 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.030 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.02 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

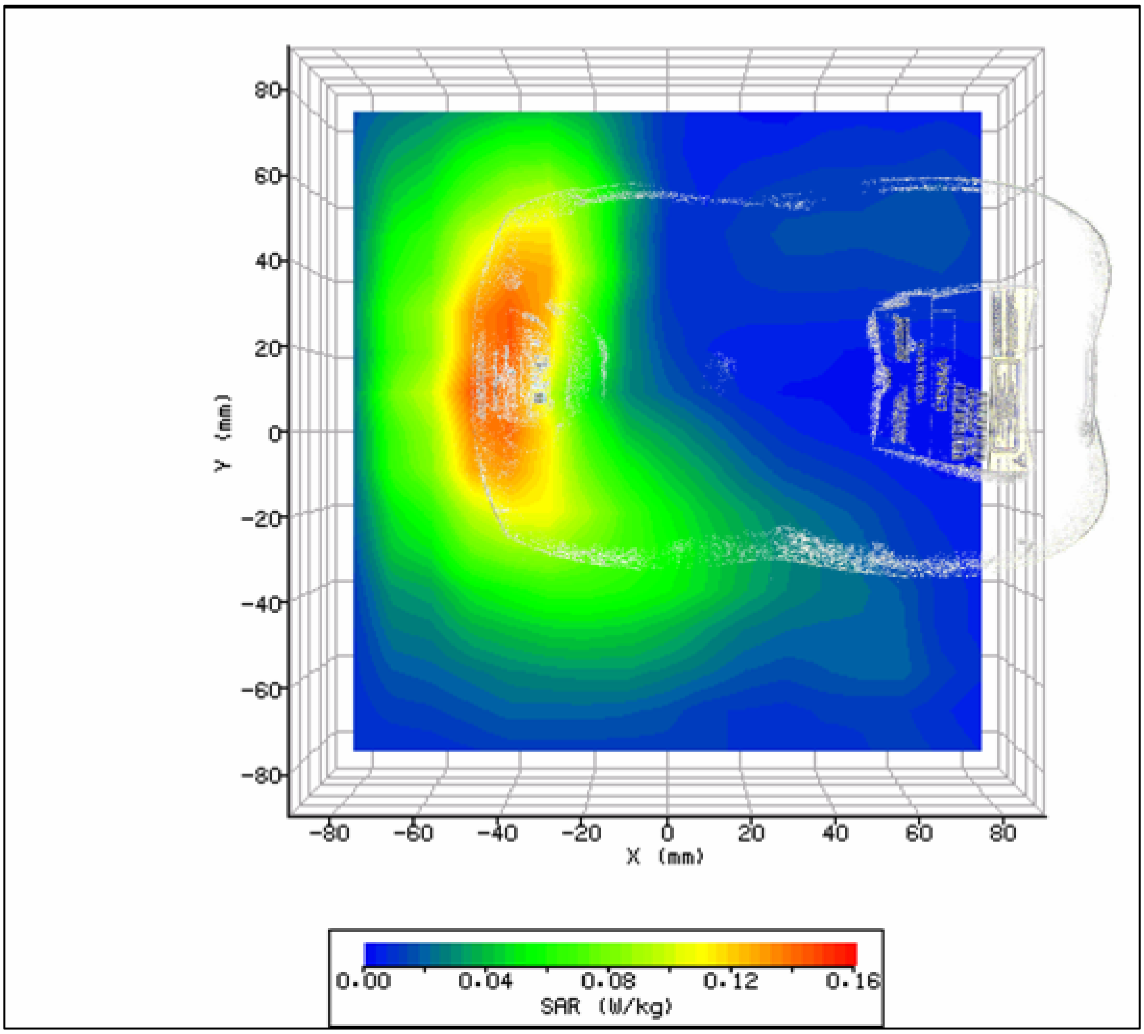

Figure 9

2.4 1900MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	04/04/2005 13:24:27	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_0013.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	24.4°C	LIQUID SIMULANT:	1900Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.41
RELATIVE HUMIDITY:	32.7%	CONDUCTIVITY:	1.558
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.8°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-43.00 mm
DUT POSITION:	Front 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	44.00 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	14.27 V/m
TEST FREQUENCY:	1851.25MHz	SAR 1g:	0.393 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.246 W/kg
CONVERSION FACTORS:	.346 / .346 / .346	SAR START:	0.067 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.067 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.02 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

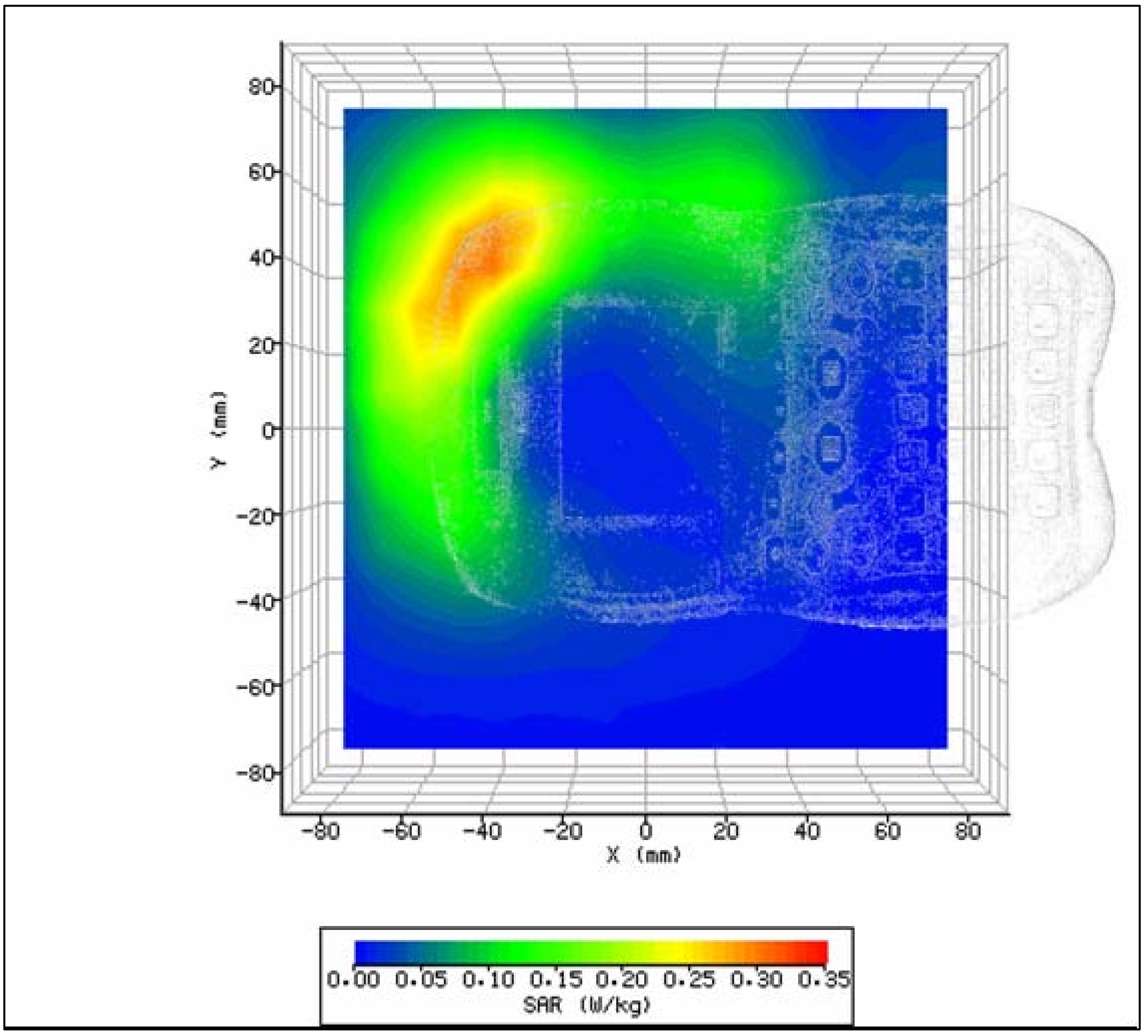

Figure 10

2.4 1900MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	04/04/2005 13:53:09	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_0014.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	24.4°C	LIQUID SIMULANT:	1900Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.41
RELATIVE HUMIDITY:	32.4%	CONDUCTIVITY:	1.558
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.8°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-52.00 mm
DUT POSITION:	Front 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	-18.00 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	13.70 V/m
TEST FREQUENCY:	1908.75MHz	SAR 1g:	0.373 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.225 W/kg
CONVERSION FACTORS:	.346 / .346 / .346	SAR START:	0.064 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.062 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.11 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

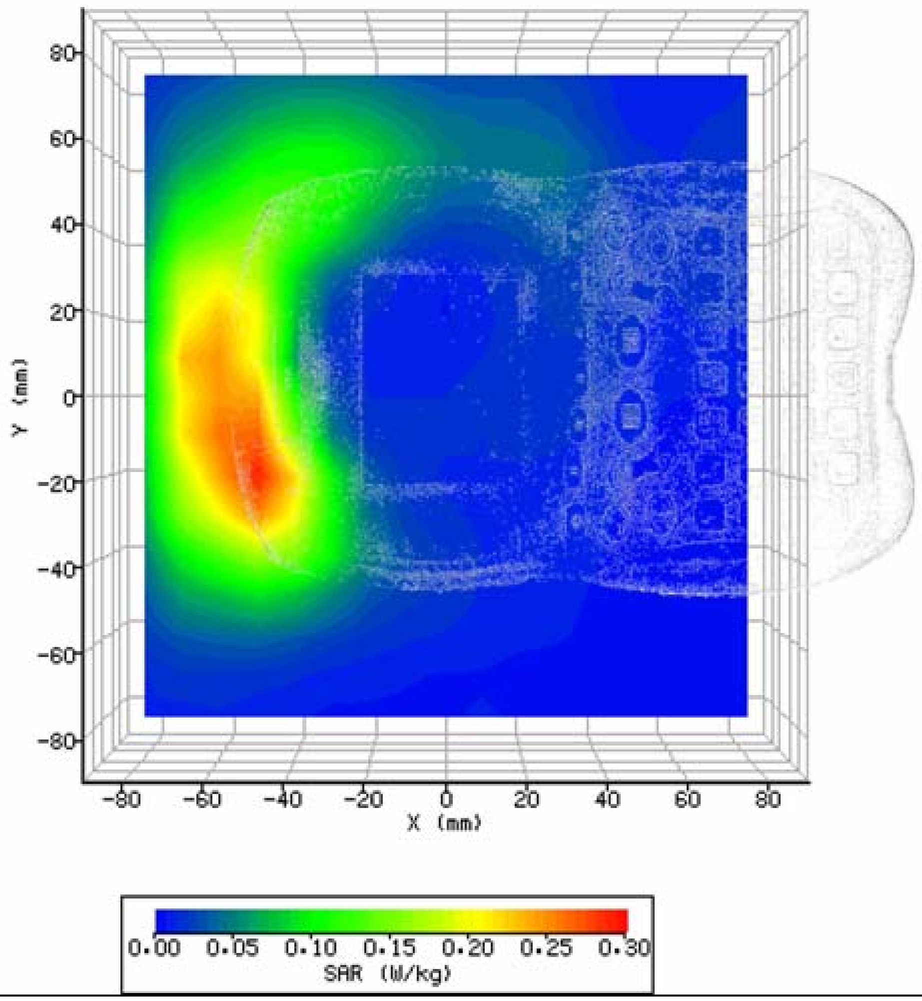

Figure 11

2.4 1900MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	04/04/2005 14:29:38	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_0015.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	22.2°C	LIQUID SIMULANT:	1900Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.41
RELATIVE HUMIDITY:	35.4%	CONDUCTIVITY:	1.558
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.8°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-1.00 mm
DUT POSITION:	Front Tilt 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	-17.33 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	20.53 V/m
TEST FREQUENCY:	1851.25MHz	SAR 1g:	0.714 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.517 W/kg
CONVERSION FACTORS:	.346 / .346 / .346	SAR START:	0.300 W/kg
TYPE OF MODULATION:	CDMA2000	SAR END:	0.295 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.08 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	All Up Bits (8960)	EXTRAPOLATION:	poly4

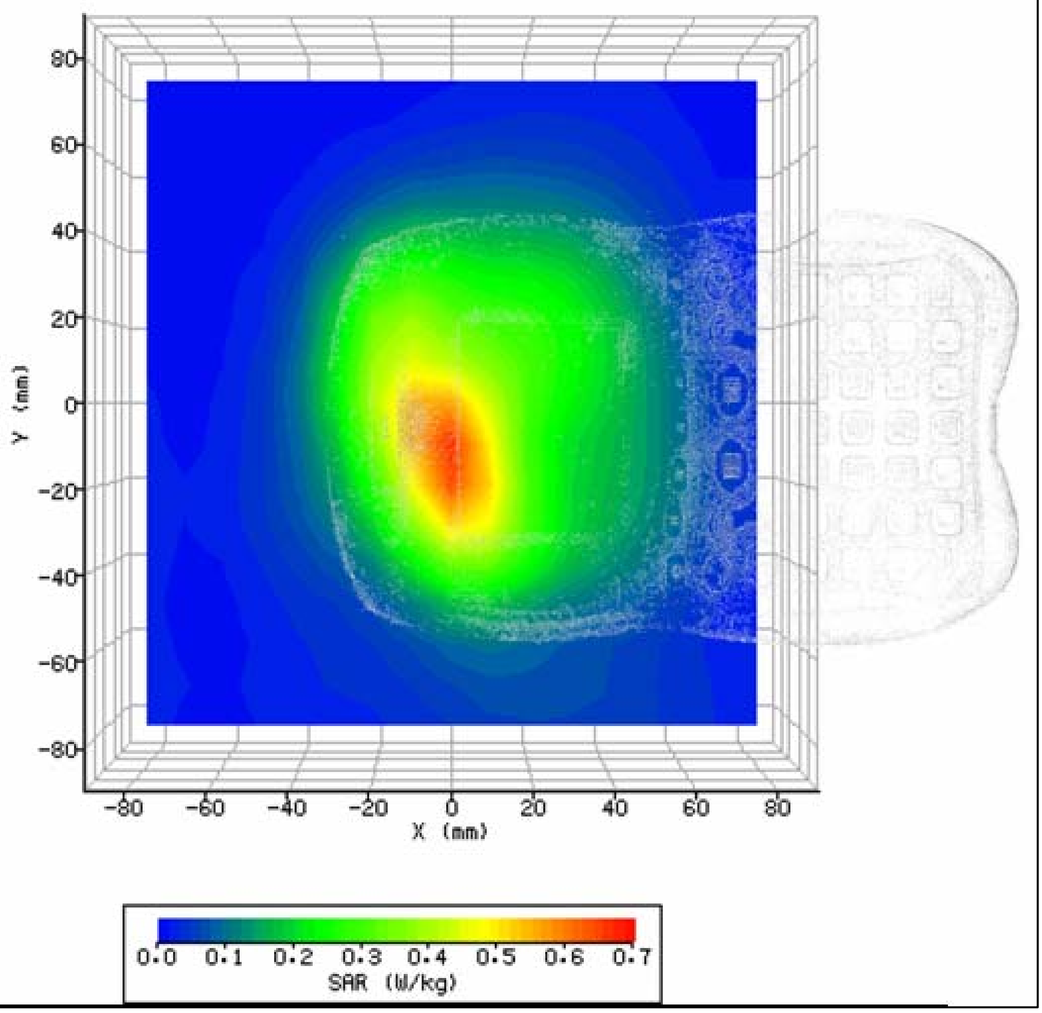

Figure 12

2.4 2450MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	31/03/2005 12:03:39	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_001.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	23.1°C	LIQUID SIMULANT:	2450Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.24
RELATIVE HUMIDITY:	38.9%	CONDUCTIVITY:	2.054
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.9°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-22.8 mm
DUT POSITION:	Front 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	-47.80 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	6.58 V/m
TEST FREQUENCY:	2437MHz	SAR 1g:	0.120 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.069 W/kg
CONVERSION FACTORS:	.415 / .415 / .415	SAR START:	0.014 W/kg
TYPE OF MODULATION:	DSSS	SAR END:	0.014 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.050 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	210	EXTRAPOLATION:	poly4

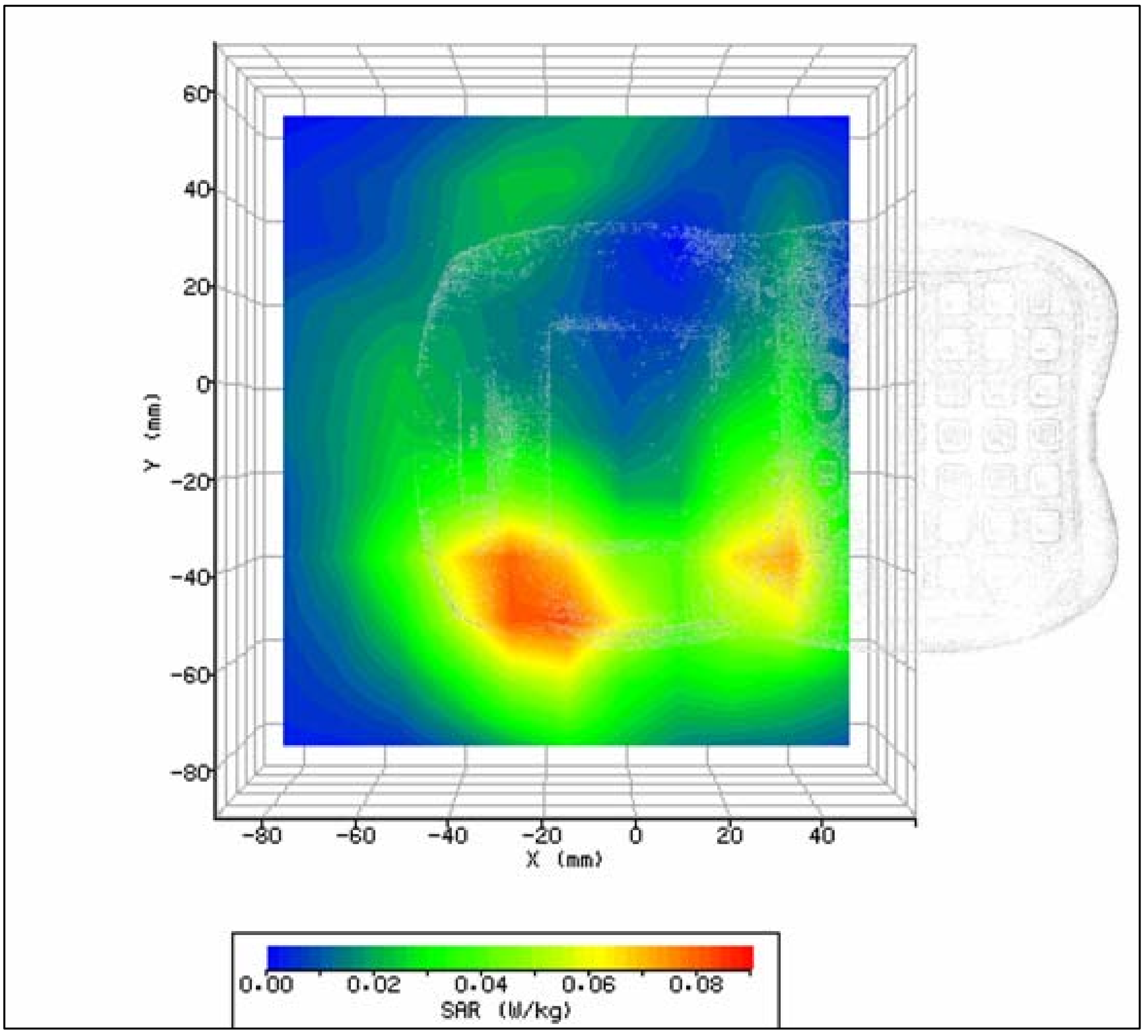

Figure 13

2.4 2450MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	31/03/2005 12:51:52	DUT BATTERY MODEL/NO:	31-57157-01
LENAME:	613597_002.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	23.1°C	LIQUID SIMULANT:	2450Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.24
RELATIVE HUMIDITY:	39.2%	CONDUCTIVITY:	2.054
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.8°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-35.8 mm
DUT POSITION:	Rear 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	12.67 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	4.89 V/m
TEST FREQUENCY:	2437MHz	SAR 1g:	0.064 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.039 W/kg
CONVERSION FACTORS:	.415 / .415 / .415	SAR START:	0.007 W/kg
TYPE OF MODULATION:	DSSS	SAR END:	0.007 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.250 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	210	EXTRAPOLATION:	poly4

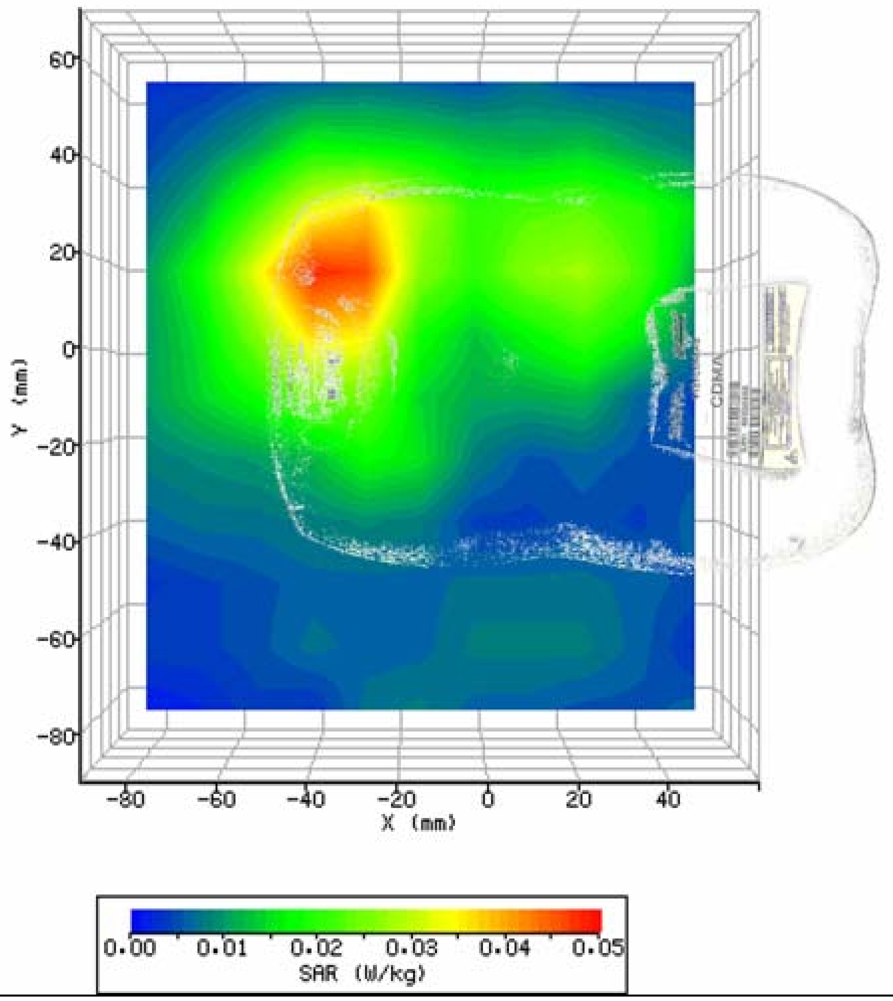

Figure 14

2.4 2450MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	31/03/2005 13:25:46	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_003.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	23.7°C	LIQUID SIMULANT:	2450Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.24
RELATIVE HUMIDITY:	38.6%	CONDUCTIVITY:	2.054
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.5°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-33.2 mm
DUT POSITION:	Front 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	-1.90 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	6.72 V/m
TEST FREQUENCY:	2412MHz	SAR 1g:	0.125 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.073 W/kg
CONVERSION FACTORS:	.415 / .415 / .415	SAR START:	0.013 W/kg
TYPE OF MODULATION:	DSSS	SAR END:	0.013 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.010 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	210	EXTRAPOLATION:	poly4

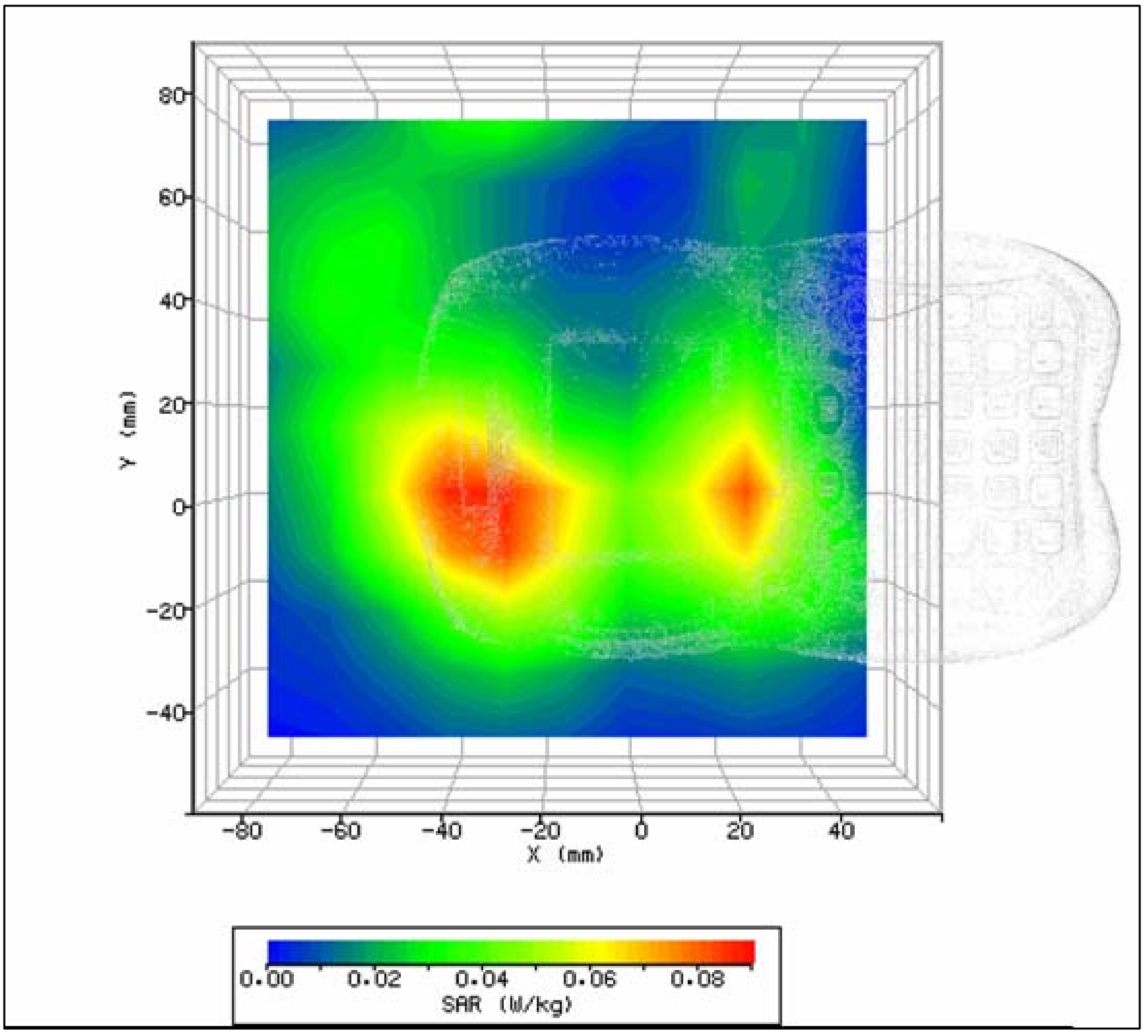

Figure 15

2.4 2450MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	31/03/2005 15:36:04	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_004.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	24.9°C	LIQUID SIMULANT:	2450Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.24
RELATIVE HUMIDITY:	35.6%	CONDUCTIVITY:	2.054
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.3°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-41.0 mm
DUT POSITION:	Front 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	2.00 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	5.22 V/m
TEST FREQUENCY:	2462MHz	SAR 1g:	0.076 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.044 W/kg
CONVERSION FACTORS:	.415 / .415 / .415	SAR START:	0.005 W/kg
TYPE OF MODULATION:	DSSS	SAR END:	0.005 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	0.080 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	210	EXTRAPOLATION:	poly4

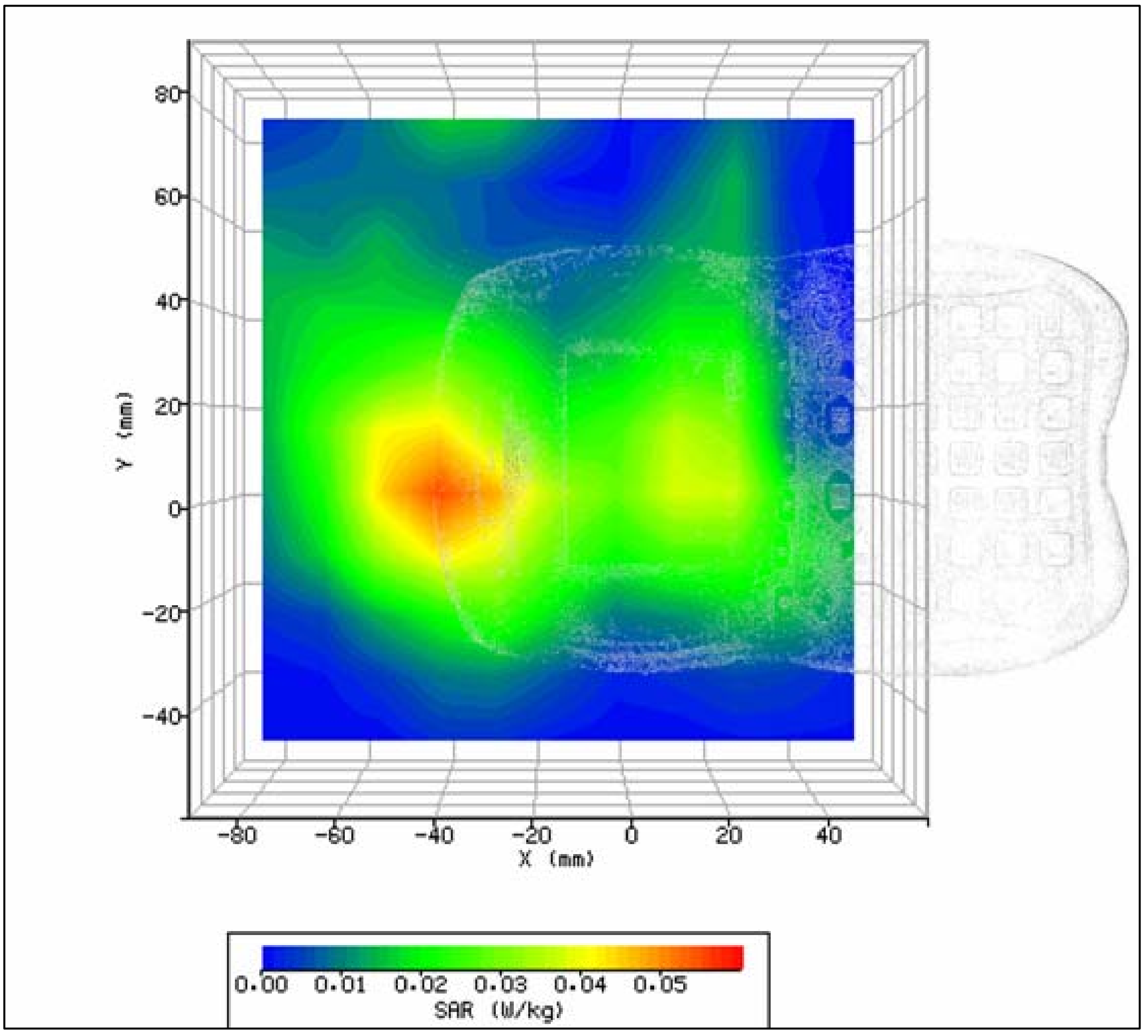

Figure 16

2.4 2450MHz TEST RESULTS INCLUDING SAR DISTRIBUTIONS (AREA SCANS – 2D)

SYSTEM / SOFTWARE:	SARA2 / 2.33 VPM	INPUT POWER DRIFT:	0.0 dB
DATE / TIME:	01/04/2005 09:37:33	DUT BATTERY MODEL/NO:	31-57157-01
FILENAME:	613597_005.txt	PROBE SERIAL NUMBER:	0170
AMBIENT TEMPERATURE:	22.6°C	LIQUID SIMULANT:	2450Body
DEVICE UNDER TEST:	Symbol 4121CDMA	RELATIVE PERMITTIVITY:	51.24
RELATIVE HUMIDITY:	35.2%	CONDUCTIVITY:	2.054
PHANTOM S/NO:	Side Bench 001	LIQUID TEMPERATURE:	21.8°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	-11.00 mm
DUT POSITION:	Front Tilt 0.0mm Spacing	MAX SAR Y-AXIS LOCATION:	-42.00 mm
ANTENNA CONFIGURATION:	Fixed Internal	MAX E FIELD:	10.31 V/m
TEST FREQUENCY:	2412MHz	SAR 1g:	0.292 W/kg
AIR FACTORS:	406 / 385 / 409	SAR 10g:	0.164 W/kg
CONVERSION FACTORS:	.415 / .415 / .415	SAR START:	0.030 W/kg
TYPE OF MODULATION:	DSSS	SAR END:	0.030 W/kg
MODN. DUTY CYCLE:	100%	SAR DRIFT DURING SCAN:	-0.010 dB
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	31/03/05
INPUT POWER LEVEL:	210	EXTRAPOLATION:	poly4

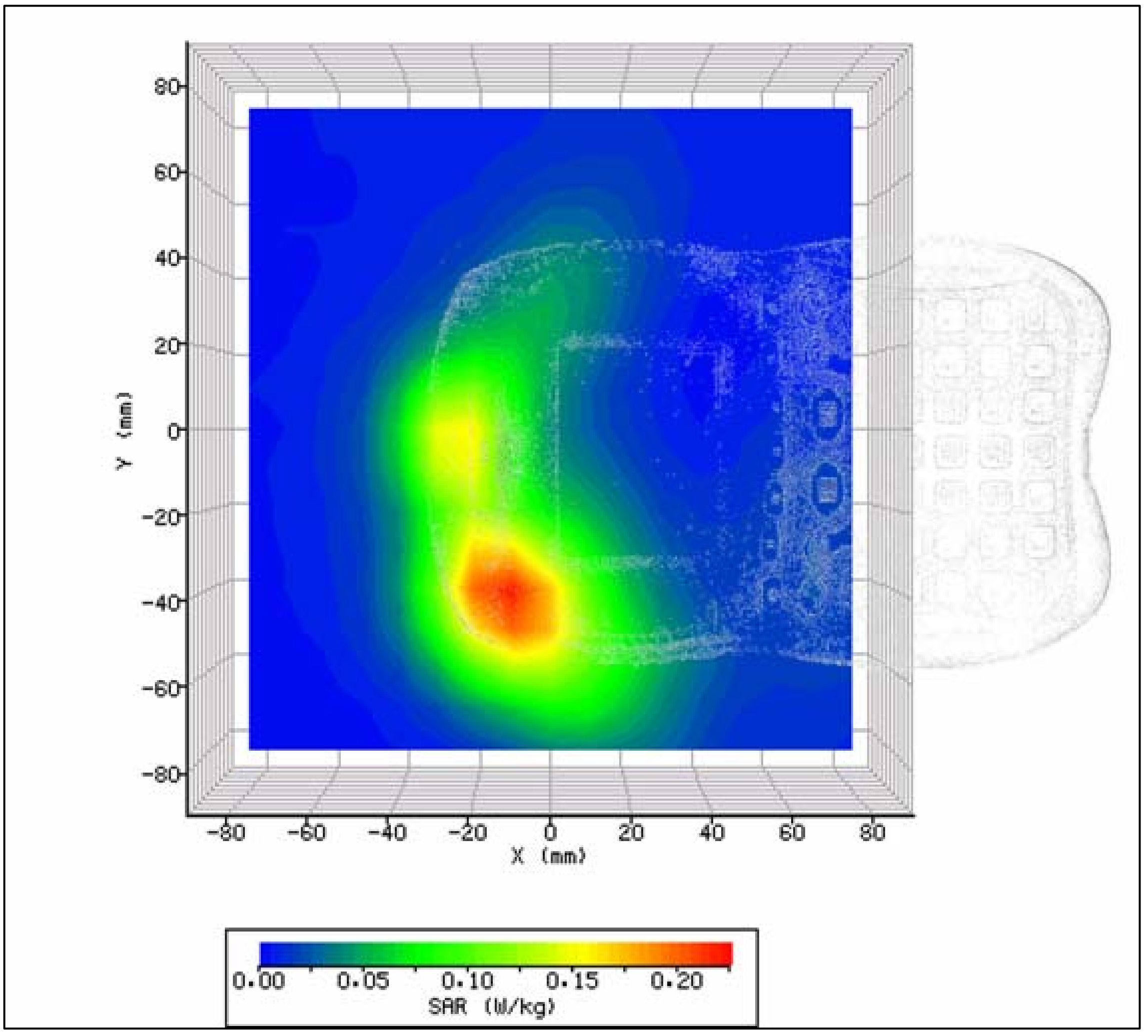

Figure 17

SECTION 3

TEST EQUIPMENT USED

3.1 TEST EQUIPMENT

The following test equipment was used at BABT:

INSTRUMENT DESCRIPTION	MANUFACTURER	MODEL TYPE	INVENTORY NO.	SERIAL NUMBER	CALIBRATION DATES	
					FROM	TO
Bench-top Robot	Mitsubishi	RV-E2	4691	EA009006	N/A	N/A
900 MHz Head Tissue Simulant	BABT	Batch 8	N/A	N/A	22/03/05**	19/04/05
1900 MHz Head Tissue Simulant	BABT	Batch 2	N/A	N/A	22/03/05*	19/04/05
2450 MHz Head Tissue Simulant	BABT	Batch 6	N/A	N/A	22/03/05*	19/04/05
900 MHz Body Tissue Simulant	BABT	Batch 2	N/A	N/A	22/03/05*	19/04/05
1900 MHz Body Tissue Simulant	BABT	Batch 1	N/A	N/A	22/03/05*	19/04/05
2450 MHz Body Tissue Simulant	BABT	Batch 4	N/A	N/A	22/03/05*	19/04/05
900 MHz Dipole	IndexSAR	IEEE1528	N/A	N/A	01/04/05	02/04/05
1900 MHz Dipole	IndexSAR	IEEE1528	N/A	N/A	04/04/05	05/04/05
2450 MHz Dipole	IndexSAR	IEEE1528	N/A	N/A	31/03/05	01/04/05
RF Pre-Amplifier	Vectawave	10M-2.5G	4697	N/A	N/A	N/A
Bi-Directional Coupler	Krytar	1850	4651	N/A	N/A	N/A
20dB Attenuator	Weinschel	46-20-34	4653	AT9195	28/05/04	28/05/05
Power Meter	Rohde and Schwarz	NRV	2472	860327/025	27/05/04	27/05/05
Hygrometer	Rotronic	-	3230	N/A	04/10/04	04/10/05
Thermometer	Digitron	T208	3178	N/A	16/07/04	16/07/05
SAR Probe	IndexSAR	IXP- 050	N/A	0170	05/03/05	05/03/06
Flat Phantom box (200mm cube)	SARTest Ltd.	N/A	N/A	N/A	N/A	N/A

* Verified at time of test.

3.2 TEST SOFTWARE

The following software was used to control the BABT SARA2 System:

INSTRUMENT	VERSION NO.	DATE
SARA2 system	v.2.34	09/03/2005
Mitsubishi robot controller firmware revision	RV-E2 Version C9a	-
IXA-10 Probe amplifier	Version 2.5	-

3.3 DIELECTRIC PROPERTIES OF SIMULANT LIQUIDS

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 23ºC and also for Dimethylsulphoxide (DMS) at 21ºC.

The fluids were made at BABT under controlled conditions from the following OET(65)c formulae and reference made to IEEE1528-2003. The composition of ingredients may have been modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation:

OET 65(c)Recipes

Ingredients	**Frequency (MHz)**									
(% by weight)	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

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**	**1**
Ingredients (% by weight)																					
1,2-Propanediol						64.81															
Bactericide	0.19	0.19	0.5	0.1	0.1		0.5					0.5								0.5	
Diacetin			48.9				49.2					49.43								49.75	
DGBE								45.41	47	13.84	44.92		44.92	13.84	45	50	50	7.99	7.99		7.99
HEC	0.98	0.98		1	1																
NaCl	5.95	3.95	1.7	1.45	1.48	0.79	1.1	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	56.5																
Triton X-100										30.45				30.45				19.97	19.97		19.97
Water	37.56	38.56	48.9	40.45	40.92	34.4	49.2	53.82	52.64	55.36	54.9	49.43	54.9	55.36	55	50	50	71.88	71.88	49.75	71.88
Measured dielectric parameters																					
ε_r'	46	43.4	44.3	41.6	41.2	41.8	42.7	40.9	39.3	41	40.4	39.2	39.9	41	40.1	37	36.8	41.1	40.3	39.2	37.9
σ (S/m)	0.86	0.85	0.9	0.9	0.98	0.97	0.99	1.21	1.39	1.38	1.4	1.4	1.42	1.38	1.41	1.4	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 5-1)																					
ε_r'	45.3	43.5		41.5	41.5			40.5	40								39.8		39.2		38.5
σ (S/m)	0.87	0.87		0.9	0.97			1.2	1.4								1.49		1.8		2.4

3.3 DIELECTRIC PROPERTIES OF SIMULANT LIQUIDS - CONTINUED

The dielectric properties of the tissue simulant liquids used for the SAR testing at BABT are as follows:-

FLUID TYPE AND FREQUENY	RELATIVE PERMITTIVITY εr (ε') TARGET	RELATIVE PERMITTIVITY εr (ε') MEASURED	CONDUCTIVITY σ TARGET	CONDUCTIVITY σ MEASURED
900 MHz Head	42.0	**41.81**	0.99	**0.987**
1900 MHz Head	40.0	**41.22**	1.40	**1.397**
2450 MHz Head	39.2	**39.71**	1.80	**1.842**
900 MHz Body	55.0	**57.54**	1.05	**1.058**
1900 MHz Body	53.3	**51.41**	1.52	**1.558**
2450 MHz Body	52.7	**51.24**	1.95	**2.054**

3.4 TEST CONDITIONS

TEST LABORATORY CONDITIONS

Ambient Temperature: Within +15°C to +35°C at 20% RH to 75% RH.
The actual Temperature during the testing ranged from 21.3°C to 21.9°C.
The actual Humidity during the testing ranged from 31.7% to 39.2% RH.

TEST FLUID TEMPERATURE RANGE

FREQUENCY	**900 MHz**		**1900MHz**		**2450 MHz**	
HEAD / BODY FLUID	**HEAD**	**BODY**	**HEAD**	**BODY**	**HEAD**	**BODY**
MIN TEMPERATURE	21.9°C	21.4°C	22.4°C	21.6°C	21.4°C	21.3°C
MAX TEMPERATURE	21.9°C	21.9°C	22.4°C	21.8°C	21.4°C	21.9°C

SAR DRIFT

The SAR Drift was within limits during scans. The maximum SAR Drift, drift due to input signal generator, was recorded as -5.55% (-0.25dB) for all of the testing. The value of 5.55% has been included in the measurement uncertainty.

3.5 MEASUREMENT UNCERTAINTY

ERROR SOURCES	EN 50361 Description (Subclause)	Uncertainty (%)	Probability Distribution	Divisor	ci	ci^2	Standard Uncertainty (%)	Stand Uncert^2	(Stand Uncert^2) X (ci^2)
Measurement Equipment									
Calibration	7.2.1.1	10	Normal	2.00	1	1	5.00	25.00	25.00
Isotropy	7.2.1.2	10.6	Rectangular	1.73	1	1	6.12	37.45	37.45
Linearity	7.2.1.3	2.92	Rectangular	1.73	1	1	1.69	2.84	2.84
Probe Stability	-	2.46	Rectangular	1.73	1	1	1.42	2.02	2.02
Detection limits	7.2.1.4	0	Rectangular	1.73	1	1	0.00	0.00	0.00
Boundary effect	7.2.1.5	1.7	Rectangular	1.73	1	1	0.98	0.96	0.96
Measurement device	7.2.1.6	0	Normal	1.00	1	1	0.00	0.00	0.00
Response time	7.2.1.7	0	Normal	1.00	1	1	0.00	0.00	0.00
Noise	7.2.1.8	0	Normal	1.00	1	1	0.00	0.00	0.00
Integration time	7.2.1.9	2.3	Normal	1.00	1	1	2.30	5.29	5.29
Mechanical constraints									
Scanning system	7.2.2.1	0.57	Rectangular	1.73	1	1	0.33	0.11	0.11
Phantom shell	7.2.2.2	1.43	Rectangular	1.73	1	1	0.83	0.68	0.68
Matching between probe and phantom	7.2.2.3	2.86	Rectangular	1.73	1	1	1.65	2.73	2.73
Positioning of the phone 'Y' Co-ordinate	7.2.2.4	1.5	Normal	1.00	1	1	1.50	2.25	2.25
Positioning of the phone 'Z' Co-ordinate	7.2.2.4	1.73	Normal	1.00	1	1	1.73	2.99	2.99
Physical Parameters									
Liquid conductivity (deviation from target)	7.2.3.2	5	Rectangular	1.73	0.5	0.25	2.89	8.33	2.08
Liquid conductivity (measurement error)	7.2.3.2	5	Rectangular	1.73	0.5	0.25	2.89	8.33	2.08
Liquid permittivity (deviation from target)	7.2.3.3	5	Rectangular	1.73	0.5	0.25	2.89	8.33	2.08
Liquid permittivity (measurement error)	7.2.3.3	5	Rectangular	1.73	0.5	0.25	2.89	8.33	2.08
Drifts in output power of the phone, probe, temperature and humidity	7.2.3.4	5.55	Rectangular	1.73	1	1	3.20	10.27	10.27
Perturbation by the environment	7.2.3.5	3	Rectangular	1.73	1	1	1.73	3.00	3.00
Post-Processing									
SAR interpolation and extrapolation	7.2.4.1	2.4	Rectangular	1.73	1	1	1.39	1.92	1.92
Maximum SAR evaluation	7.2.4.2	2.4	Rectangular	1.73	1	1	1.39	1.92	1.92
Combined standard uncertainty	11.19						**Total**		125.19
Expanded uncertainty = **(confidence interval of 95 %)**	**22.38**	**%** (Using a Coverage Factor of K=2)							

SECTION 4

PHOTOGRAPHS

4.1 TEST POSITIONAL PHOTOGRAPHS

Figure 18. Positional photograph of the Symbol 4121CDMA Handheld Data Terminal in Front Touch Position

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Figure 19. Positional photograph of the Symbol 4121CDMA Handheld Data Terminal in Rear Touch Position

Figure 20. Positional photograph of the Symbol 4121CDMA Handheld Data Terminal in Front Tilt Test Position

4.2 PHOTOGRAPHS OF TEST SAMPLE

Figure 21. Front View.

4.2 **PHOTOGRAPHS OF TEST SAMPLE** - CONTINUED

Figure 22. Rear View

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

ANNEX A

PROBE CALIBRATION PROCEDURE

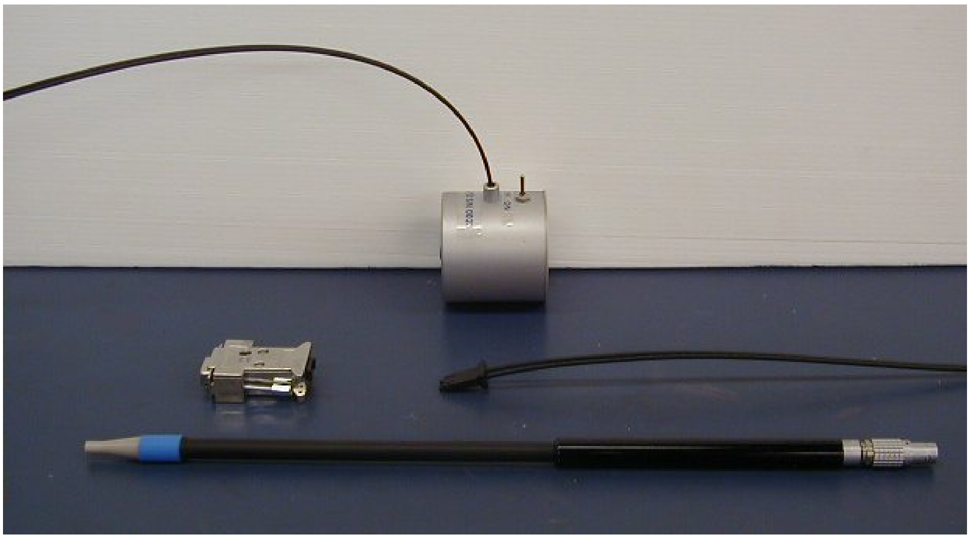
IMMERSIBLE SAR PROBE

CALIBRATION REPORT

Part Number: IXP – 050

S/N 0170

January 2005



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INTRODUCTION

This Report presents measured calibration data for a particular Indexsar SAR probe (S/N 0170) and describes the procedures used for characterisation and calibration.

Indexsar probes are characterised using procedures that, where applicable, follow the recommendations of CENELEC [1] and IEEE [2] standards. The procedures incorporate techniques for probe linearisation, isotropy assessment and determination of liquid factors (conversion factors). Calibrations are determined by comparing probe readings with analytical computations in canonical test geometries (waveguides) using normalised power inputs.

Each step of the calibration procedure and the equipment used is described in the sections below.

CALIBRATION PROCEDURE

1. Objectives

The calibration process comprises three stages

1) Determination of the channel sensitivity factors which optimise the probe's overall rotational isotropy in 1800MHz brain fluid
2) At each frequency of interest, application of these channel sensitivity factors to model the exponential decay of SAR in a waveguide fluid cell, and hence derive the liquid conversion factors at that frequency
3) Determination of the effective tip radius and angular offset of the X channel which together optimise the probe's spherical isotropy in 900MHz brain fluid

2. Probe output

The probe channel output signals are linearised in the manner set out in Refs [1] and [2]. The following equation is utilized for each channel:

$$U_{lin} = U_{o/p} + U_{o/p}{}^{2} / DCP \qquad (1)$$

where U_{lin} is the linearised signal, $U_{o/p}$ is the raw output signal in voltage units and DCP is the diode compression potential in similar voltage units.

DCP is determined from fitting equation (1) to measurements of U_{lin} versus source feed power over the full dynamic range of the probe. The DCP is a characteristic of the Schottky diodes used as the sensors. For the IXP-050 probes with CW signals the DCP values are typically 0.10V (or 20 in the voltage units used by Indexsar software, which are V*200).

In turn, measurements of E-field are determined using the following equation (where output voltages are also in units of V*200):

$$E_{liq}^{2}\,(V/m) = U_{linx} * \text{Air Factor}_x * \text{Liq Factor}_x + U_{liny} * \text{Air Factor}_y * \text{Liq Factor}_y + U_{linz} * \text{Air Factor}_z * \text{Liq Factor}_z \qquad (3)$$

Here, "Air Factor" represents each channel's sensitivity, while "Liq Factor" represents the enhancement in signal level when the probe is immersed in tissue-simulant liquids at each frequency of interest.

3. Selecting channel sensitivity factors to optimise isotropic response

After manufacture, the first stage of the calibration process is to balance the three channels' Air Factor values, thereby optimising the probe's overall axial response ("rotational isotropy").

To do this, an 1800MHz waveguide containing head-fluid simulant is selected. Like all waveguides used during probe calibration, this particular waveguide contains two distinct sections: an air-filled launcher section, and a liquid cell section, separated by a dielectric matching window designed to minimise reflections at the air-liquid interface.

The waveguide stands in an upright position and the liquid cell section is filled with 1800MHz brain fluid to within 10 mm of the open end. The depth of liquid ensures there is negligible radiation from the waveguide open top and that the probe calibration is not influenced by reflections from nearby objects.

During the measurement, a TE_{01} mode is launched into the waveguide by means of an N-type-to-waveguide adapter. The probe is then lowered vertically into the liquid until the tip is exactly 10mm above the centre of the dielectric window. This particular separation ensures that the probe is operating in a part of the waveguide where boundary corrections are not necessary.

Care must also be taken that the probe tip is centred while rotating.

The exact power applied to the input of the waveguide during this stage of the probe calibration is immaterial since only relative values are of interest while the probe rotates. However, the power must be sufficiently above the noise floor and free from drift.

The dedicated Indexsar calibration software rotates the probe in 10 degree steps about its axis, and at each position, an Indexsar 'Fast' amplifier samples the probe channels 500 times per second for 0.4 s. The raw $U_{o/p}$ data from each sample are packed into 10 bytes and transmitted back to the PC controller via an optical cable. U_{linx}, U_{liny} and U_{linz} are derived from the raw $U_{o/p}$ values and written to an Excel template.

Once data have been collected from a full probe rotation, the Air Factors are adjusted using a special Excel Solver routine to equalise the output from each channel and hence minimise the rotational isotropy. This automated approach to optimisation removes the effect of human bias.

Figure 5 represents the output from each diode sensor as a function of probe rotation angle. The directionality of the orthogonally-arranged sensors can be checked by analysing the data using dedicated Indexsar software, which displays the data in 3D format, a representative image of which is shown in Figure 3. The left-hand side of this diagram shows the individual channel outputs after linearisation (see above). The program uses these data to balance the channel outputs and then applies an optimisation process, which makes fine adjustments to the channel factors for optimum isotropic response.

4. Determination of Conversion (“Liquid”) Factors at each frequency of interest

A lookup table of conversion factors for a probe allows a SAR value to be derived at the measured frequencies, and for either brain or body fluid-simulant.

The method by which the conversion factors are assessed is based on the comparison between measured and analytical rates of decay of SAR with height above a dielectric window. This way, not only can the conversion factors for that frequency/fluid combination be determined, but an allowance can also be made for the scale and range of boundary layer effects.

The theoretical relationship between the SAR at the cross-sectional centre of the lossy waveguide as a function of the longitudinal distance (*z*) from the dielectric separator is given by Equation 4:

$$SAR(z) = \frac{4\left(P_f - P_b\right)}{\rho ab\delta} e^{-2z/\delta} \tag{4}$$

Here, the density ρ is conventionally assumed to be 1000 kg/m^3, *ab* is the cross-sectional area of the waveguide, and P_f and P_b are the forward and reflected power inside the lossless section of the waveguide, respectively. The penetration depth δ (which is the reciprocal of the waveguide-mode attenuation coefficient) is a property of the lossy liquid and is given by Equation (5).

$$\delta = \left[\mathrm{Re}\left\{ \sqrt{\left(\pi / a\right)^2 + j\omega\mu_o\left(\sigma + j\omega\varepsilon_o\varepsilon_r\right)} \right\} \right]^{-1} \tag{5}$$

where σ is the conductivity of the tissue-simulant liquid in S/m, ε_r is its relative permittivity, and ω is the radial frequency (rad/s). Values for σ and ε_r are obtained prior to each waveguide test using an Indexsar DiLine measurement kit, which uses the TEM method as recommended in [2]. σ and ε_r are both temperature- and fluid-dependent, so are best measured using a sample of the tissue-simulant fluid immediately prior to the actual calibration.

Wherever possible, all DiLine and calibration measurements should be made in the open laboratory at 22 $\pm$ 2.0^{o}C; if this is not possible, the values of σ and ε_r should reflect the actual temperature. Values employed for calibration are listed in the tables below.

By ensuring the liquid height in the waveguide is at least three penetration depths, reflections at the upper surface of the liquid are negligible. The power absorbed in the liquid is therefore determined solely from the waveguide forward and reflected power.

Different waveguides are used for 835/900MHz, 1800/1900MHz, 2450MHz and 5200/5800MHz measurements. Table A.1 of [1] can be used for designing calibration waveguides with a return loss greater than 20 dB at the most important frequencies used for personal wireless communications, and better than 15dB for frequencies greater than 5GHz. Values for the penetration depth for these specific fixtures and tissue-simulating mixtures are also listed in Table A.1.

According to [1], this calibration technique provides excellent accuracy, with standard uncertainty of less than 3.6% depending on the frequency and medium. The calibration itself is reduced to power measurements traceable to a standard calibration procedure. The practical limitation to the frequency band of 800 to 5800 MHz because of the waveguide size is not severe in the context of compliance testing.

During calibration, the probe is lowered carefully until it is just touching the cross-sectional centre of the dielectric window. 200 samples are then taken and written to an Excel template file before moving the probe vertically upwards. This cycle is repeated 50 times. The vertical separation between readings is determined from practical considerations of the expected SAR decay rate, and range from 1mm steps at low frequency, through 0.5mm at 2450MHz, down to 0.2mm at 5GHz.

Once the data collection is complete, a Solver routine is run which optimises the measured-theoretical fit by varying the conversion factor, and the boundary correction size and range.

5. Measurement of Spherical Isotropy
The setup for measuring the probe's spherical isotropy is shown in Figure 2.

A box phantom containing 900MHz head fluid is irradiated by a vertically-polarised, tuned dipole, mounted to the side of the phantom on the robot's seventh axis. During calibration, the spherical response is generated by rotating the probe about its axis in 20 degree steps and changing the dipole polarisation in 10 degree steps.

By using the VPM technique discussed below, an allowance can also be made for the effect of E-field gradient across the probe's spatial extent. This permits values for the probe's effective tip radius and X-channel angular offset to be modelled until the overall spherical isotropy figure is optimised.

The dipole is connected to a signal generator and amplifier via a directional coupler and power meter. As with the determination of rotational isotropy, the absolute power level is not important as long as it is stable.

The probe is positioned within the fluid so that its sensors are at the same vertical height as the centre of the source dipole. The line joining probe to dipole should be perpendicular to the phantom wall, while the horizontal separation between the two should be small enough for VPM corrections to be applicable, without encroaching near the boundary layer of the phantom wall. VPM corrections require a knowledge of the fluid skin depth. This is measured during the calibration by recording the E-field strength while systematically moving the probe away from the dipole in 2mm steps over a 20mm range.

VPM (Virtual Probe Miniaturisation)

SAR probes with 3 diode-sensors in an orthogonal arrangement are designed to display an isotropic response when exposed to a uniform field. However, the probes are ordinarily used for measurements in non-uniform fields and isotropy is not assured when the field gradients are significant compared to the dimensions of the tip containing the three orthogonally-arranged dipole sensors.

It becomes increasingly important to assess the effects of field gradients on SAR probe readings when higher frequencies are being used. For Indexsar IXP-050 probes, which are of 5mm tip diameter, field gradient effects are minor at GSM frequencies, but are major above 5GHz. Smaller probes are less affected by field gradients and so probes, which are significantly less than 5mm diameter, would be better for applications above 5GHz.

The IndexSAR report IXS0223 describes theoretical and experimental studies to evaluate the issues associated with the use of probes at arbitrary angles to surfaces and field directions. Based upon these studies, the procedures and uncertainty analyses referred to in P1528 are addressed for the full range of probe presentation angles.

In addition, generalized procedures for correcting for the finite size of immersible SAR probes are developed. Use of these procedures enables application of schemes for virtual probe miniaturization (VPM) – allowing probes of a specific size to be used where physically-smaller probes would otherwise be required.

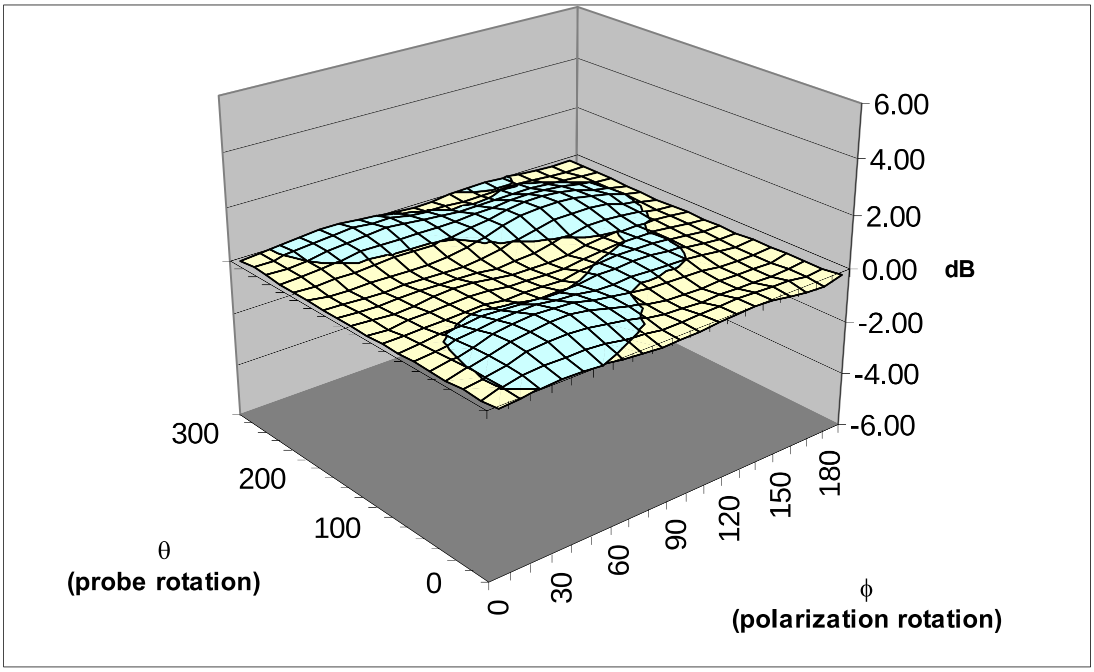
Given the typical dimensions of 3-channel SAR probes presently available, use of the VPM technique extends the satisfactory measurement range to higher frequencies.

CALIBRATION FACTORS MEASURED FOR PROBE S/N 0170

The probe was calibrated at 835, 900, 1800, 1900, 2450, 5200 and 5800 MHz in liquid samples representing both brain liquid and body fluid at these frequencies. The calibration was for CW signals only, 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 axial isotropy of the probe was measured by rotating the probe about its axis in 10 degree steps through 360 degrees in this orientation.

The reference point for the calibration is in the centre of the probe's cross-section at a distance of 2.7 mm from the probe tip in the direction of the probe amplifier. A value of 2.7 mm should be used for the tip to sensor offset distance in the software. The distance of 2.7mm for assembled probes has been confirmed by taking X-ray images of the probe tips (see Figure 8).

It is important that the diode compression point and air factors used in the software are the same as those quoted in the results tables, as these are used to convert the diode output voltages to a SAR value.



Surface Isotropy diagram of IXP-050 Probe S/N 0170 at 900MHz after VPM (rotational isotropy at side +/-0.09dB, spherical isotropy +/-0.44dB)

Probe tip radius	1.33
X Ch. Angle to red dot	1

	Head		Body	
Frequency	**Bdy. Corrn. – f(0)**	**Bdy. Corrn. – d(mm)**	**Bdy. Corrn. – f(0)**	**Bdy. Corrn. – d(mm)**
835	0.50	3.0	0.51	3.0
900	0.50	3.0	0.51	3.0
1800	0.69	1.6	0.60	1.9
1900	0.65	1.7	0.56	2.0
2450	0.39	3.0	0.43	3.0
5200	1.00	1.0	1.00	1.7
5800	1.00	1.0	1.00	1.8

SUMMARY OF CALIBRATION FACTORS FOR PROBE IXP-050 S/N 0170

Spherical isotropy measured at 900MHz	0.44	(+/-) dB

	X	Y	Z	
Air Factors	406	385	409	(V*200)
CW DCPs	20	20	20	(V*200)

Freq (MHz)	Axial Isotropy (+/- dB)		SAR ConvF (liq/air)		Notes
	Head	Body	Head	Body	
835	-	-	0.256	0.273	1,2
900	-	-	0.258	0.280	1,2
1800	0.09	-	0.305	0.331	1,2
1900	-	-	0.314	0.346	1,2
2450	-	-	0.360	0.412	1,2
5200	-	-	0.372	0.635	1,2
5800	-	-	0.343	0.589	1,2

Notes	
1)	Calibrations done at 22°C +/-2°C
2)	Waveguide calibration

PROBE SPECIFICATIONS

Indexsar probe 0170, along with its calibration, is compared with CENELEC and IEEE standards recommendations (Refs [1] and [2]) in the Tables below. A listing of relevant specifications is contained in the tables below:

Dimensions	S/N 0170	CENELEC [1]	IEEE [2]
Overall length (mm)	350		
Tip length (mm)	10		
Body diameter (mm)	12		
Tip diameter (mm)	5.2	8	8
Distance from probe tip to dipole centers (mm)	2.7		

Dynamic range	S/N 0170	CENELEC [1]	IEEE [2]
Minimum (W/kg)	0.01	<0.02	0.01
Maximum (W/kg) N.B. only measured to > 100 W/kg on representative probes	>100	>100	100

Isotropy (measured at 900MHz)	S/N 0170	CENELEC [1]	IEEE [2]
Axial rotation with probe normal to source (+/- dB)	0.09 Max (See table above)	0.5	0.25
Spherical isotropy covering all orientations to source (+/- dB)	0.44	1.0	0.50

Construction	Each probe contains three orthogonal dipole sensors arranged on a triangular prism core, protected against static charges by built-in shielding, and covered at the tip by PEEK cylindrical enclosure material. No adhesives are used in the immersed section. Outer case materials are PEEK and heat-shrink sleeving.
Chemical resistance	Tested to be resistant to glycol and alcohol containing simulant liquids but probes should be removed, cleaned and dried when not in use.

REFERENCES

[1] CENELEC, EN 50361, July 2001. Basic Standard for the measurement of specific absorption rate related to human exposure to electromagnetic fields from mobile phones.

[2] IEEE 1528, Recommended practice for determining the spatial-peak specific absorption rate (SAR) in the human body due to wireless communications devices: Experimental techniques.

FIGURES

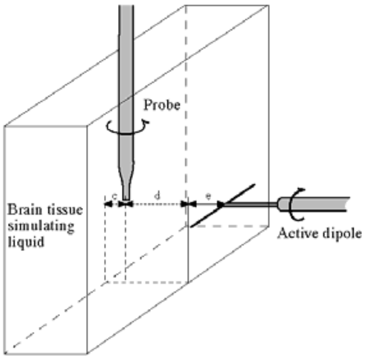


Figure 1. Spherical isotropy jig showing probe, dipole and box filled with simulated brain liquid (see Ref [2], Section A.5.2.1)

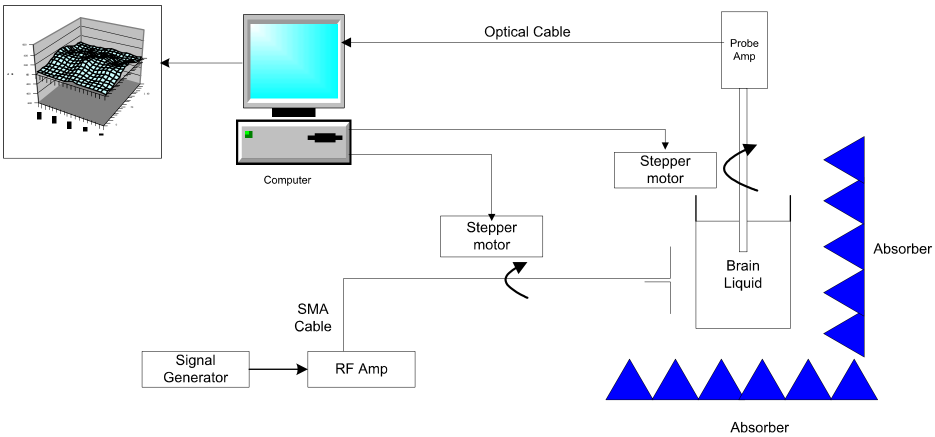


Figure 2. Schematic diagram of the test geometry used for isotropy determination

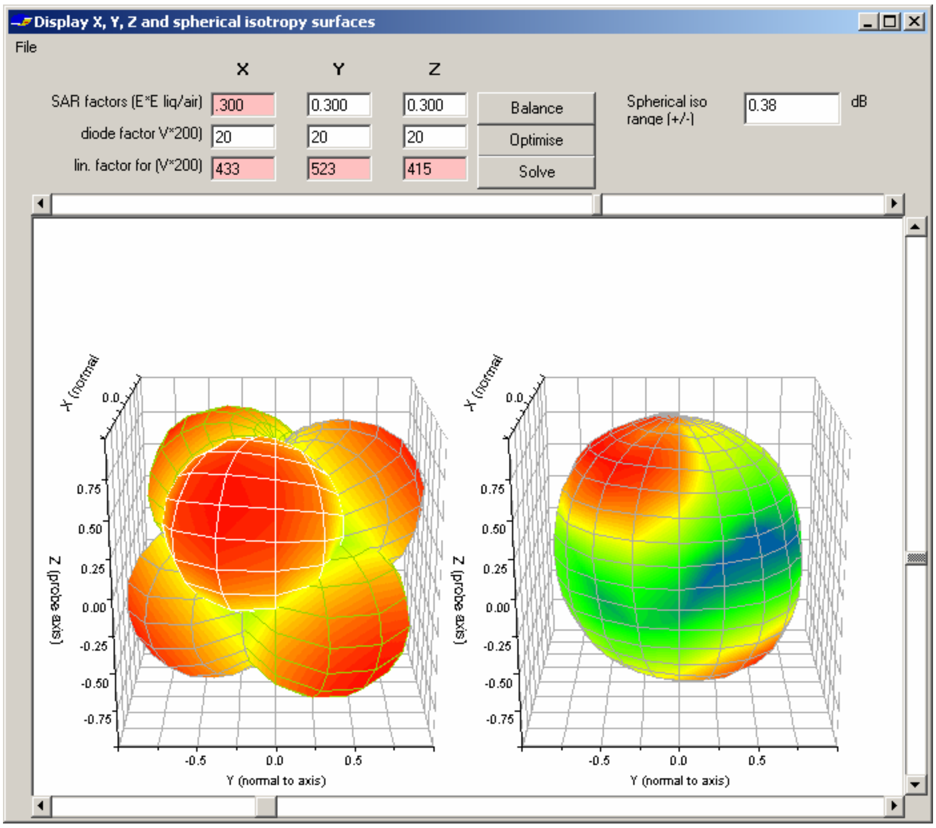


Figure 3. Graphical representation of a probe's response to fields applied from each direction. The diagram on the left shows the individual response characteristics of each of the three channels and the diagram on the right shows the resulting probe sensitivity in each direction. The colour range in the figure images the lowest values as blue and the maximum values as red. For the probe S/N 0170, this range is (+/-) 0.44 dB.

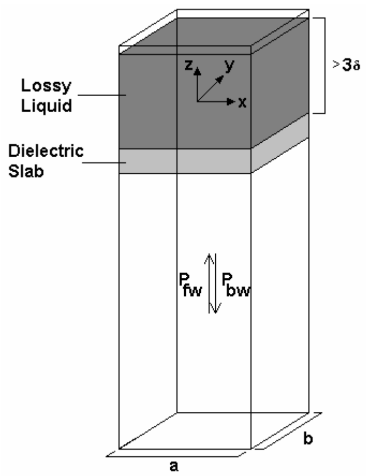
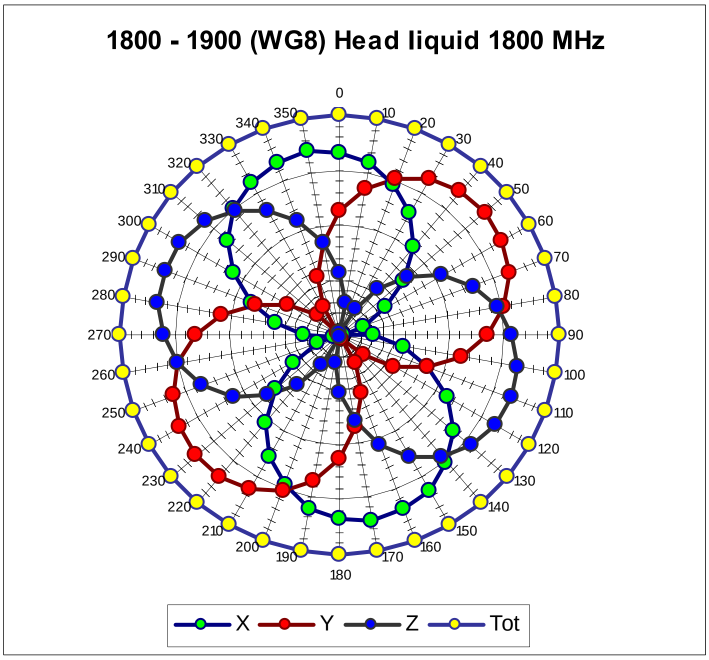


Figure 4. Geometry used for waveguide calibration (after Ref [2]. Section A.3.2.2)



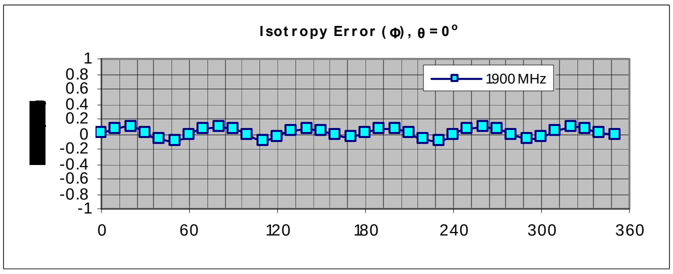


Figure 5. The rotational isotropy of probe S/N 0170 obtained by rotating the probe in a liquid-filled waveguide at 1800 MHz.

SAR DECAY FUNCTION – Analytical And Measurements

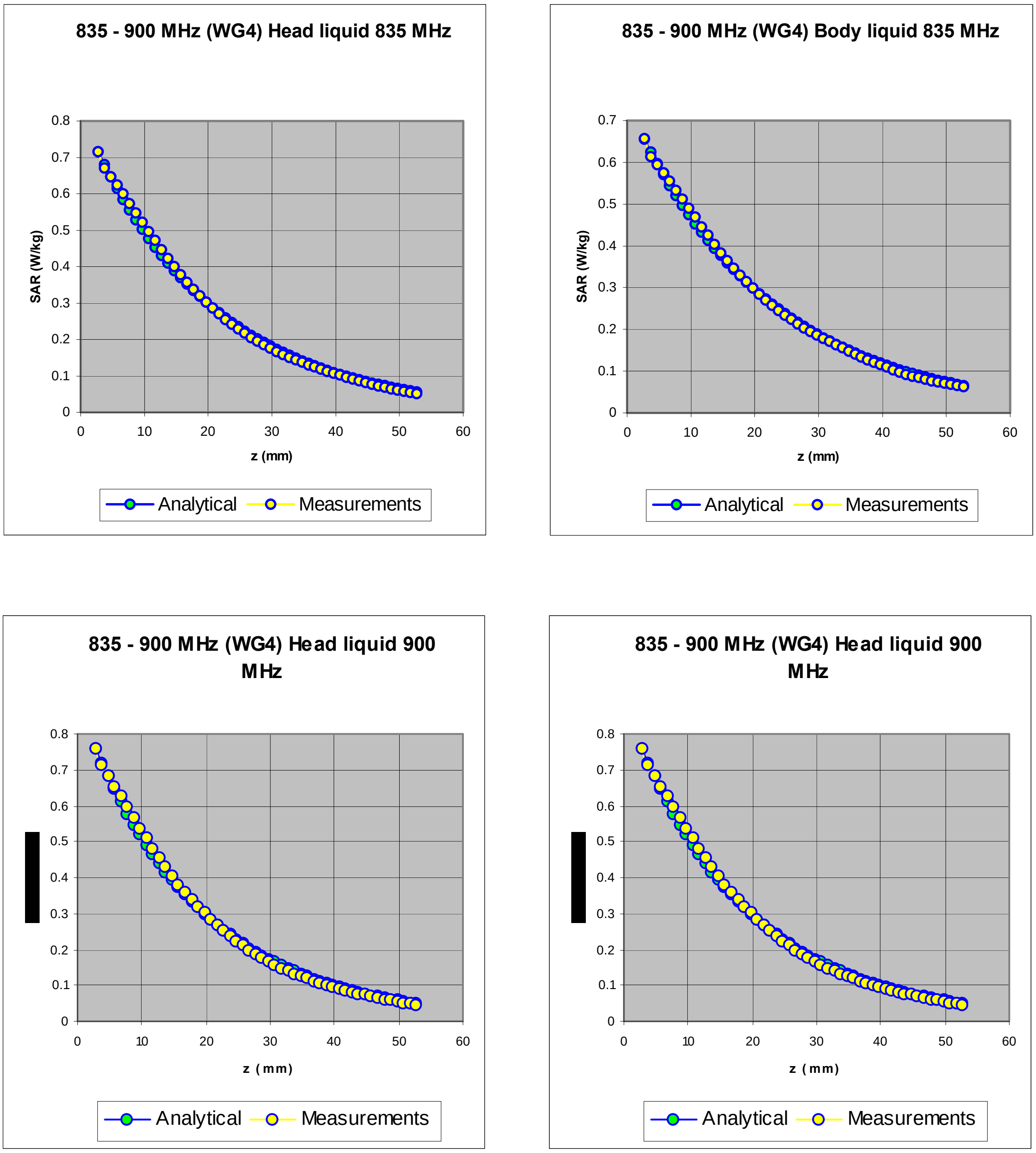


Figure 6a. The measured SAR decay function along the centreline of the WG4 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

SAR DECAY FUNCTION – Analytical And Measurements

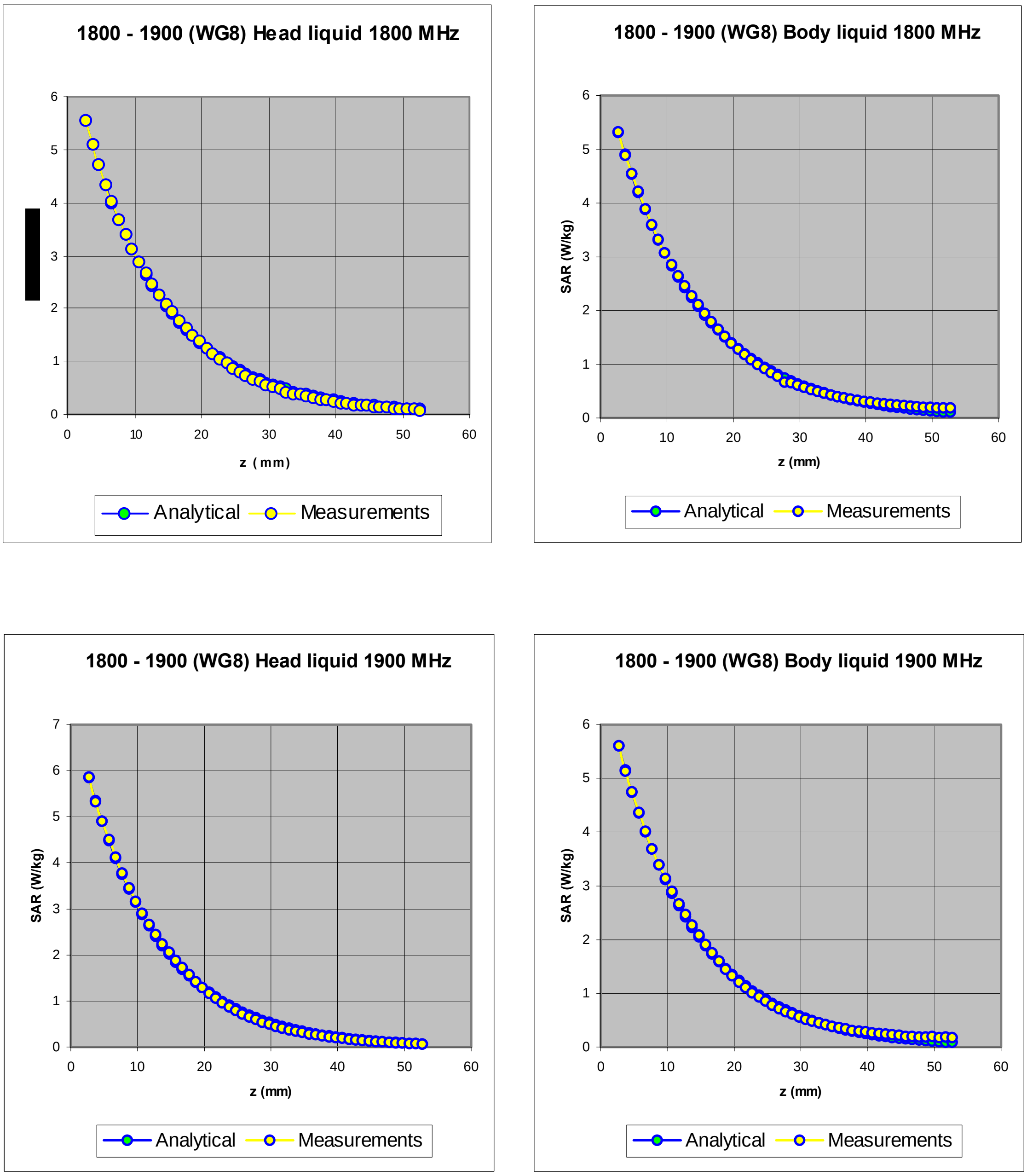


Figure 6b The measured SAR decay function along the centreline of the WG4 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

SAR DECAY FUNCTION – Analytical And Measurements

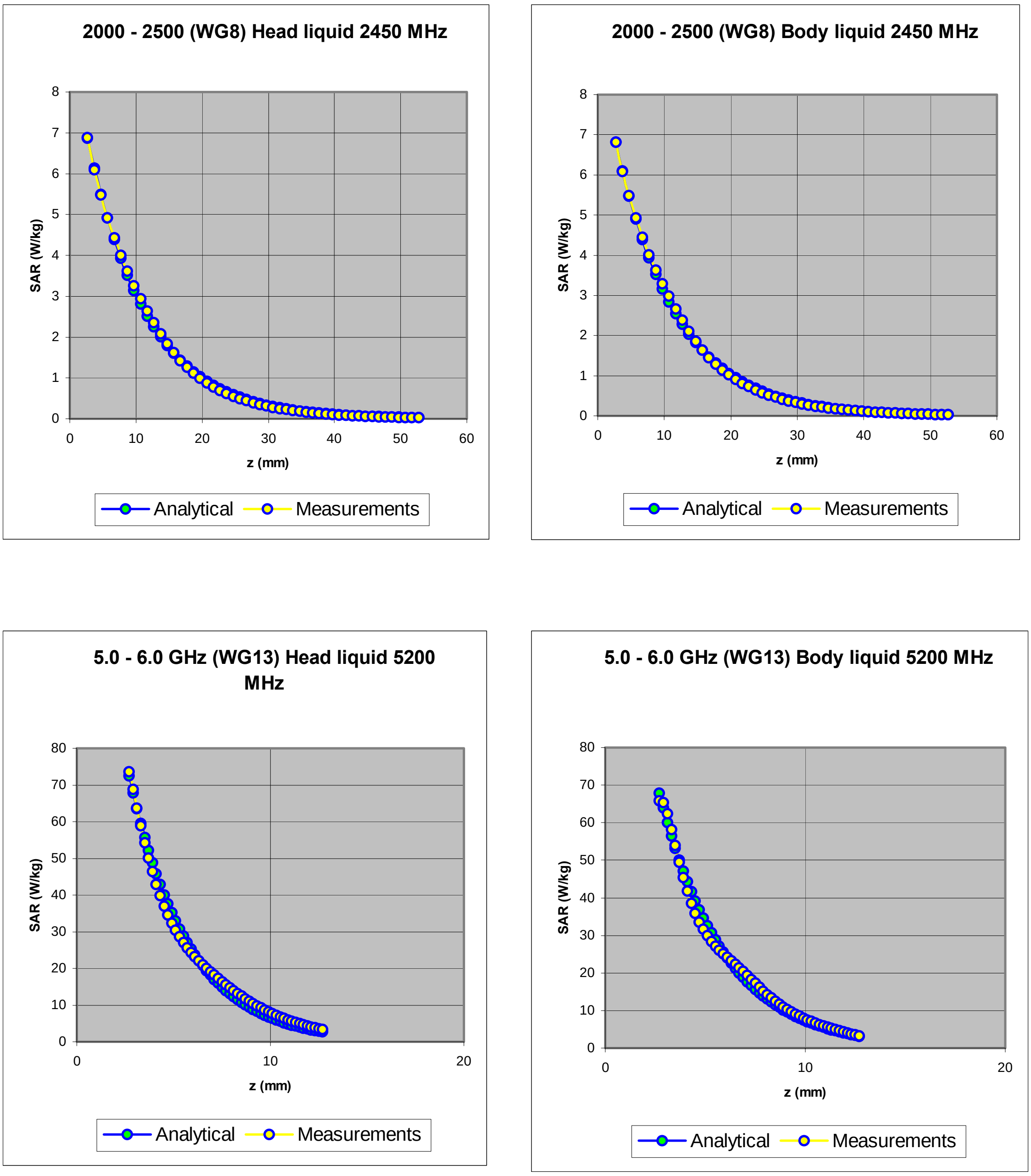


Figure 6c The measured SAR decay function along the centreline of the WG4 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

SAR DECAY FUNCTION – Analytical And Measurements

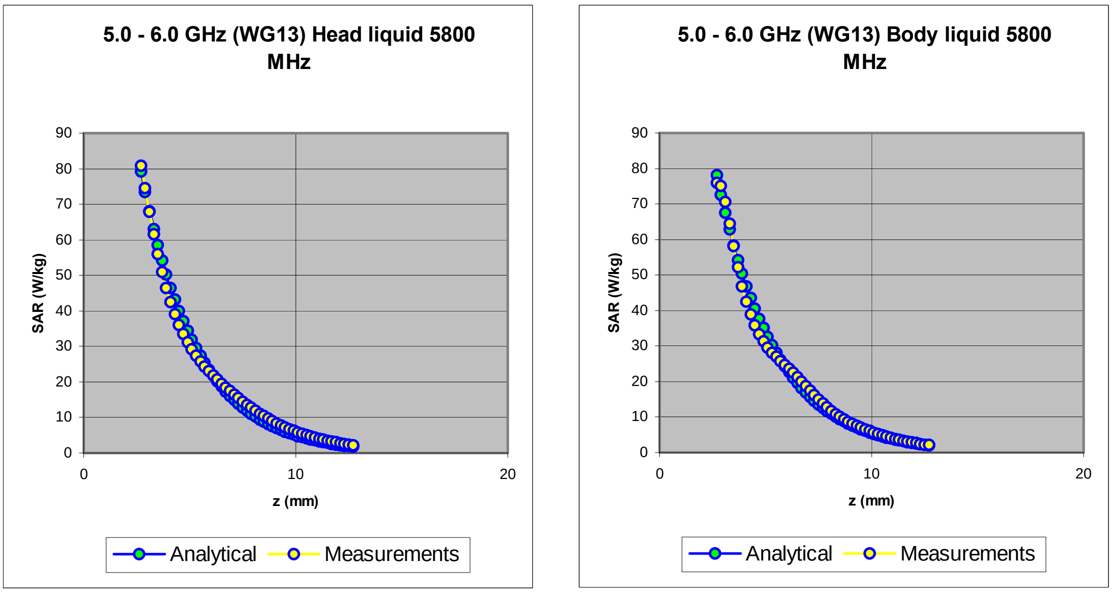


Figure 7. The measured SAR decay function along the centreline of the R22 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

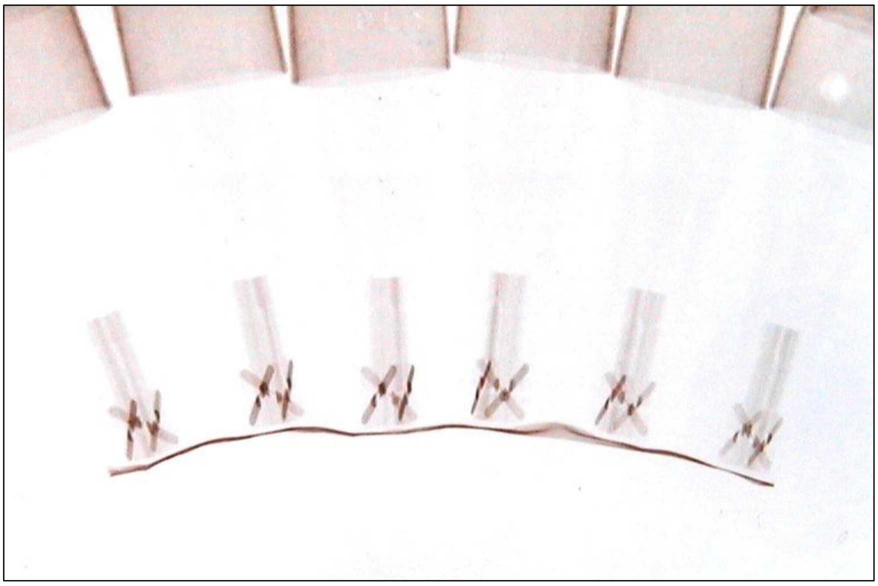


Figure 8: X-ray positive image of 5mm probes

TABLE INDICATING THE DIELECTRIC PARAMETERS OF THE LIQUIDS USED FOR CALIBRATIONS AT EACH FREQUENCY

Liquid used	***Relative permittivity (measured)***	***Conductivity (S/m) (measured)***
835 MHz BRAIN	*41.07*	*0.89*
835 MHz BODY	*56.83*	*0.94*
900 MHz BRAIN	*40.28*	*0.95*
900 MHz BODY	*56.27*	*1.01*
1800 MHz BRAIN	*39.79*	*1.40*
1800 MHz BODY	*54.70*	*1.56*
1900 MHz BRAIN	*39.38*	*1.50*
1900 MHz BODY	*54.34*	*1.66*
2450 MHz BRAIN	*39.89*	*1.91*
2450 MHz BODY	*54.63*	*2.18*
5200 MHz BRAIN	*32.27*	*5.18*
5200 MHz BODY	*52.98*	*6.04*
5800 MHz BRAIN	*31.09*	*5.87*
5800 MHz BODY	*51.21*	*7.10*