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Report On

Specific Absorption Rate Testing of the
Sepura Ltd STP8240 TETRA Portable

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FCC ID: XX6STP8240
IC ID: 8739A-STP8240

Document 75916872 Report 01 Issue 2 August 2012

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REPORT ON	Specific Absorption Rate Testing of the Sepura Ltd STP8240 TETRA Portable Document 75916872 Report 01 Issue 2 August 2012
PREPARED FOR	Sepura Ltd Radio House St Andrews Road Cambridge CB4 1GR
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APPROVED BY	**M Jenkins** Authorised Signatory
DATED	30 August 2012

This report has been up-issued to Issue 2 to include additional information.

UKAS TESTING 0141

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SECTION 1

REPORT SUMMARY

Specific Absorption Rate Testing of the Sepura Ltd
STP8240 TETRA Portable

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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 Sepura Ltd STP82401 TETRA Portable to the requirements of RSS-102 Issue 4 March 2010 and FCC CFR 47 Part 2.1093 October 2011.

Objective	To perform Specific Absorption Rate Testing to determine the Equipment Under Test's (EUT's) compliance with the requirements specified of RSS-102 Issue 4 March 2010 and FCC CFR 47 Part 2.1093 October 2011 for the series of tests carried out.
Applicant	Sepura Ltd
Manufacturer	Sepura Ltd
Manufacturing Description	TETRA Portable
Power Output	32.5 dBm
Serial Number(s)	2PN000951G429L0
Model Number	STP8240
Hardware Version	PSWUW00IT300M0001
Software Version	1667 020 02937
Antenna Type & Model(s)	300-00663
Battery Cell Manufacturer	Sepura
Battery Model Number	300-00634
High Capacity Battery Model Number	300-00635
Test Specification/Issue/Date	RSS-102 Issue 4 March 2010 FCC CFR 47 Part 2.1093 October 2011
Start of Test	16 February 2012
Finish of Test	17 February 2012
Related Document(s)	IEEE 1528 - 2001 OET65 (C) – 2001 KDB 447498 D01 KDB 648474 D01 KDB 450824 D01/D02 KDB 643646 D01
Name of Engineer(s)	Gary Bridle

1.2 BRIEF SUMMARY OF RESULTS

The measurements shown in this report were made in accordance with the procedures specified OET 65(C) – 2001, KDB 447498 D01, KDB 648474 and RSS-102.

The maximum 1g volume averaged SAR found during this Assessment

Max 1g SAR (W/kg)	2.395
The maximum 1g volume averaged SAR level measured for all the tests performed did not exceed the 8.0 W/kg Limit for Occupational (Controlled Exposure). Level defined in RSS-102 Issue 4 March 2010 and FCC CFR 47 Part 2.1093 October 2011.	

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 OET65 (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
15/02/2012	450	450	4.88	-0.31%	3.31	0.25%

*Normalised to a forward power of 1W

1.3.2 Results Summary Tables

Tetra Band 450MHz to 475MHz Head Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sepura STP8240. (Standard Battery)

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	M	460.025	2.230	2.075	1.473	-2.420%	Figure 8
Left	15°	M	460.025	2.390	2.228	1.446	-0.210%	Figure 9
Right	Cheek	M	460.025	2.070	1.932	1.386	-2.960%	Figure 10
Right	15°	M	460.025	2.300	2.099	1.452	1.270%	Figure 11
Limit for Occupation (Controlled Exposure) 8 W/kg (1g)								

Tetra Band 450MHz to 475MHz Head Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sepura STP8240. (High Capacity Battery)

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	15°	M	460.025	2.460	2.395	1.593	0.030%	Figure 12
Limit for Occupation (Controlled Exposure) 8 W/kg (1g)								

Tetra Band 450MHz to 475MHz Body Phantom Head Fluid Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sepura STP8240. Remote Speaker Microphone (RSM), (Standard Battery)

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 From Phantom	Position							
25mm	Front Facing	M	460.025	0.140	0.166	0.114	0.050%	Figure 13
Limit for Occupation (Controlled Exposure) 8 W/kg (1g)								

Tetra Band 450MHz to 475MHz Body Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sepura STP8240.(Headset) (Belt Clip, Standard Battery)

Position		Channel	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							
0mm	Rear Facing	M	460.025	0.630	0.705	0.517	-2.330%	Figure 14
Limit for Occupation (Controlled Exposure) 8 W/kg (1g)								

Tetra Band 450MHz to 475MHz Body Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sepura STP8240.(Headset) (Belt Clip, Standard Battery)

Position		Channel	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							
0mm	Rear Facing	M	460.025	0.520	0.589	0.420	1.050	Figure 15
Limit for Occupation (Controlled Exposure) 8 W/kg (1g)								

Tetra Band 450MHz to 475MHz Body Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the Sepura STP8240. Remote Speaker Microphone (RSM), (Standard Battery)

Position		Channel	Frequency (MHz)	Max Spot SAR (W/kg)	Max 1g SAR (W/kg)	Max 10g SAR (W/kg)	SAR Drift (%)	Area scan (Figure number)
Spacing From Phantom	Position							
0mm	Rear Facing	M	460.025	0.520	0.594	0.399	3.670	Figure 16
Limit for Occupation (Controlled Exposure) 8 W/kg (1g)								

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1.4 PTT DUTY CYCLE MEASURMENTS

1.4.1 Requirement

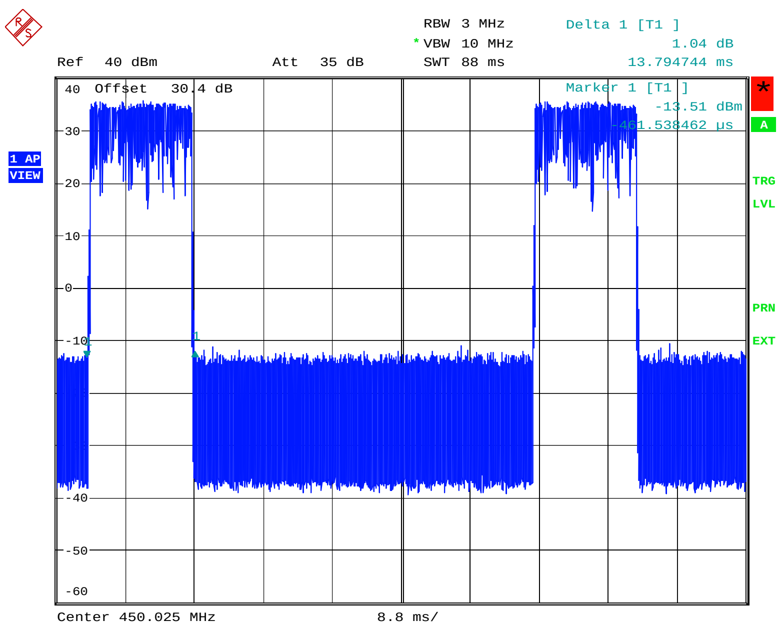
If a device has push-to-talk capability, a minimum duty cycle of 50% (on-time) shall be used in the evaluation. A lower duty cycle is permitted only if the transmission duty cycle is an inherent property of the technology or of the design of the equipment and not under user control. Proof of the various on-off durations and a detailed method of calculation of the average power shall be included in the SAR evaluation.

The EUT was operated in continuous transmit (100% PTT on). However, due to the characteristics of the EUT's TETRA technology the transmitter is only active for 25% of the time.

STP8240

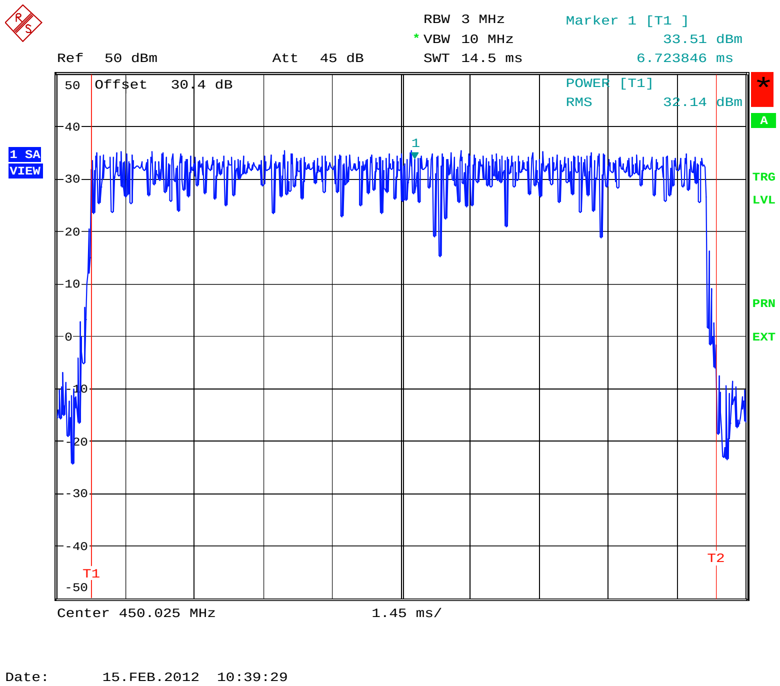
Measurement Parameter	EUT Test Frequency		
	450.025MHz	460.025MHz	469.975MHz
Burst Average Power (dBm)	32.14	32.31	32.33
Average Power (dBm)	25.82	26.11	26.08
Transmit On Time (ms)	13.795	13.795	13.936
Transmit Off + On Time (ms)	56.808	56.667	56.808
Transmission Burst Cycle (%)	24.284	24.343	24.532

Burst Power 450.025MHz

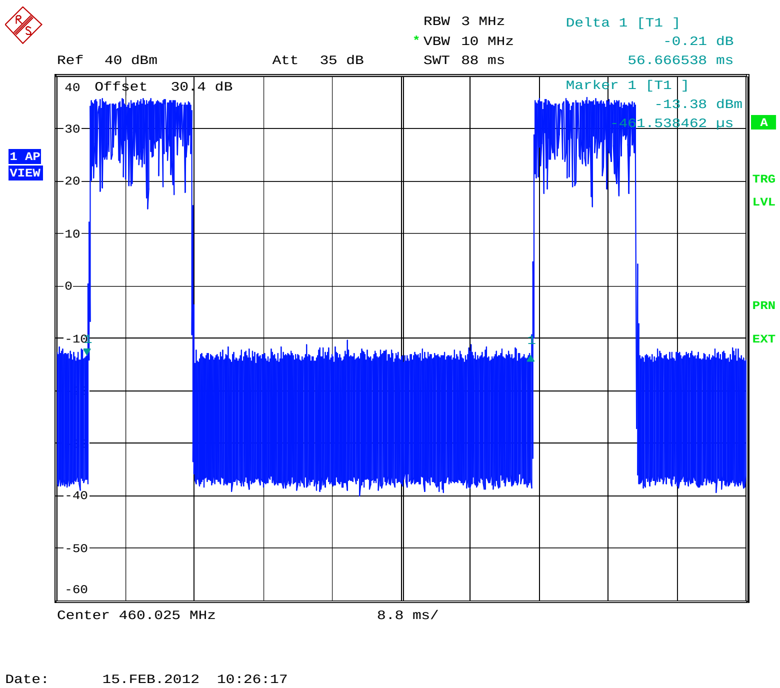


Date: 15.FEB.2012 10:30:00

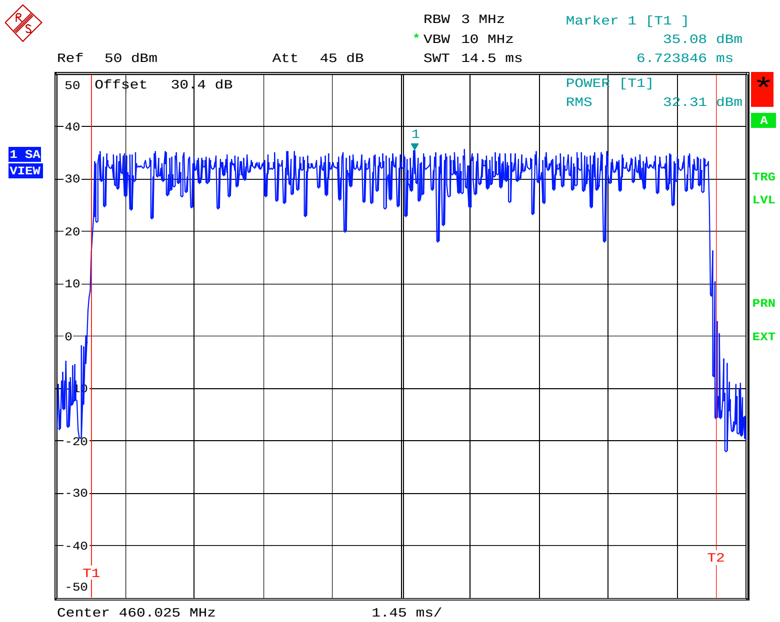
Duty Cycle 450.025MHz



Burst Power 460.025MHz



Duty Cycle 460.025MHz



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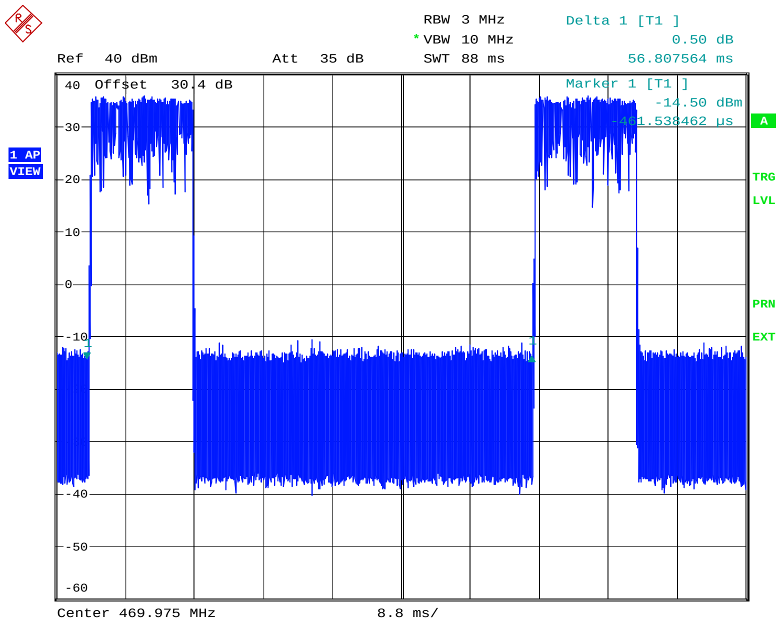
Burst Power 469.975MHz



Date: 15.FEB.2012 10:24:16

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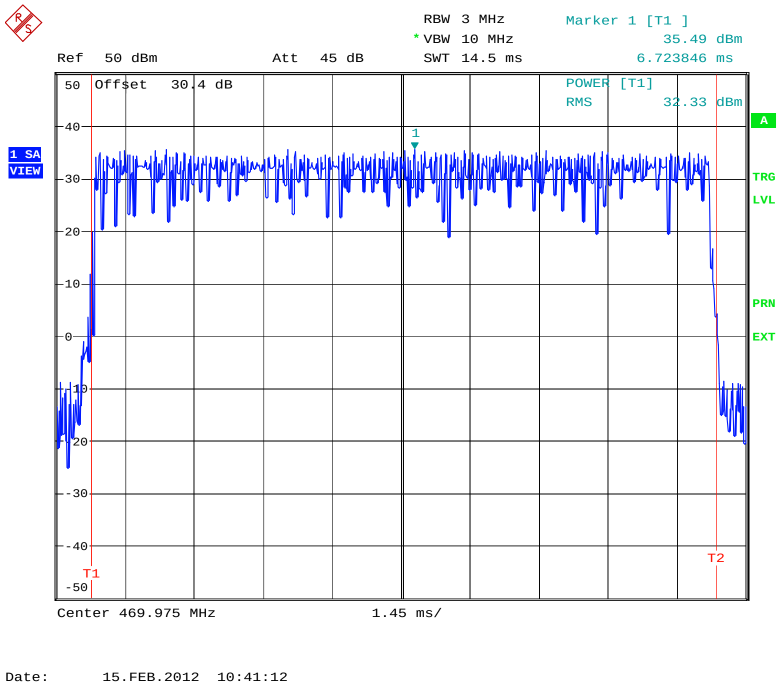
Duty Cycle 469.975MHz



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1.5 PRODUCT INFORMATION

1.5.1 Technical Description

The equipment under test (EUT) was a Sepura STP8240. A full technical description can be found in the manufacturer’s documentation.

1.5.2 Test Configuration and Modes of Operation

The Sepura STP8240 portable device supplied for Specific Absorption Rate (SAR) testing was a TETRA portable operating in the frequency range 450MHz to 470MHz. The device output power was set to 1.8W nominal. The portable was supplied with one antenna, part number 300-00663.

The STP8240 was tested in each position at the frequency that gave the highest output power for the band. The frequencies and positions that yielded the worst case SAR were then tested with various accessories which included Remote Speaker Microphone (RSM), various cases, belt clip and a standard headset. To determine which case was to be tested each case (300-00233, 300-00440, 300-00439) and the belt clip were fitted to the radio and 2D scans were carried out to find which case allowed the highest SAR from the radio. This was then subjected to full scans. Of the three cases and belt-clip which were subject of assessment, the belt-clip body accessory was found to provide the worst case SAR level and was therefore subject to full SAR testing.

The testing was performed with batteries supplied by Sepura Limited and manufactured by Sepura Limted. Two battery types were supplied, standard battery, part number 300-00634 and High Capacity battery, part number 300-00635.

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 frequency bands at maximum power. The device was placed against a Specific Anthropomorphic Mannequin (SAM) phantom as specified in the CENELEC standard OET65 (C)-2001. 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 IEEE 1528-2003.

For body SAR assessment, the device was tested for typical body-worn operation in accordance with the requirements of OET65 (C) - 2001 with the exception of SAR limits applied, these were obtained from RSS-102 Issue 4 March 2010 SAR limits for Controlled Use Devices (Controlled Environment). The Handset was placed at a distance of 0mm from the bottom of the flat phantom for all body testing. Flat phantom dimensions are 410mmx270mmx200mm 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 for the dielectric properties specified in IEEE 1528-2003.

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.

SECTION 2

TEST DETAILS

Specific Absorption Rate Testing of the Sepura Ltd
STP8240 TETRA Portable

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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

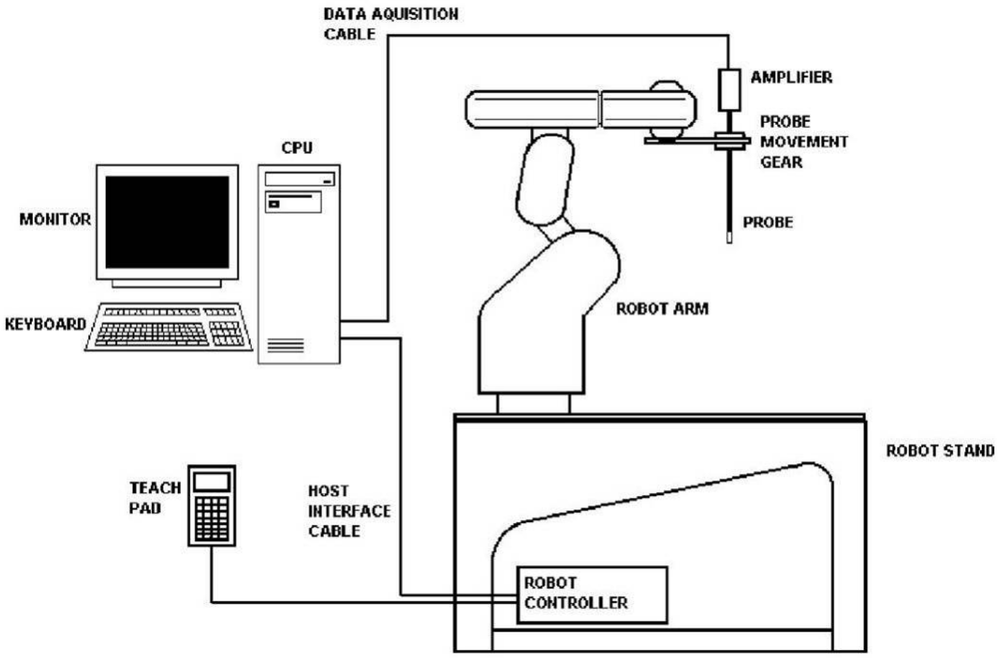

Figure 1

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

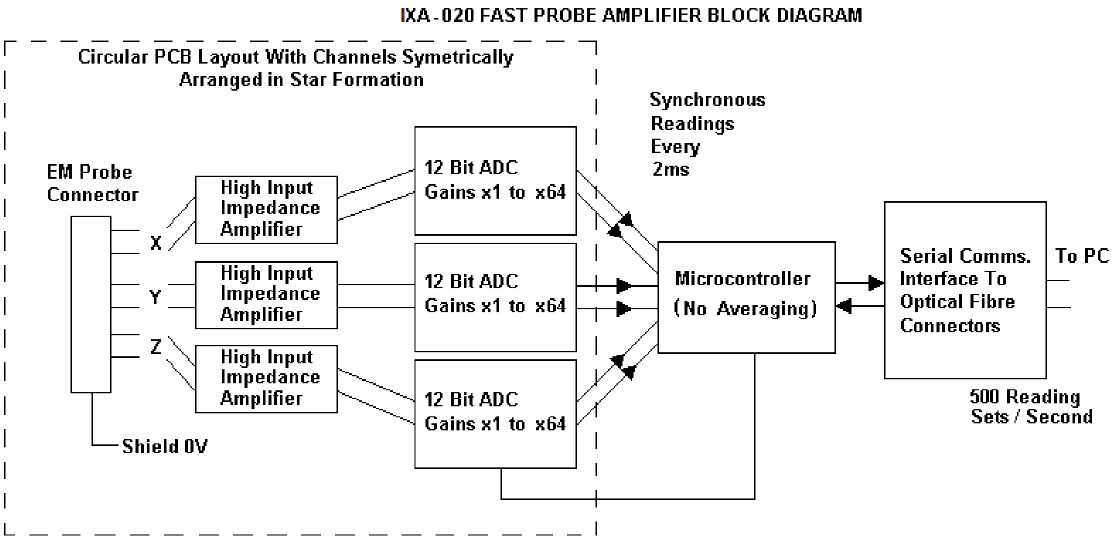

Figure 2

This amplifier has a time constant of approx. 50µs, which is much faster than the SAR probe response time. The overall system time constant is therefore that of the probe (<1ms) and reading sets for all three channels (simultaneously) are returned every 2ms to the PC. The conversion period is approx. 1 µs at the start of each 2ms period. This enables the probe to follow pulse modulated signals of periods >>2ms. 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.

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2.1.3 SAR Measurement Procedure

Principal components of the SAR measurement test bench

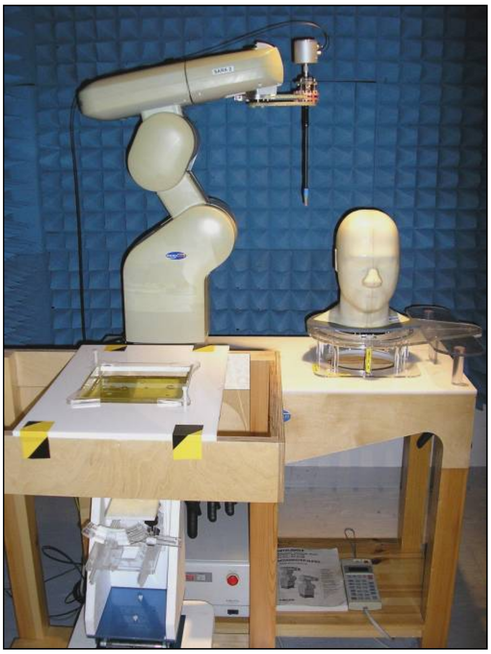

Figure 3

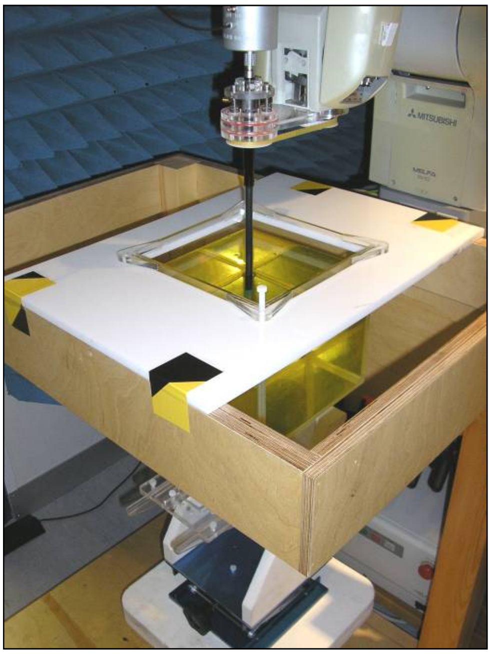

Figure 4

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 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.

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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.

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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).

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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.

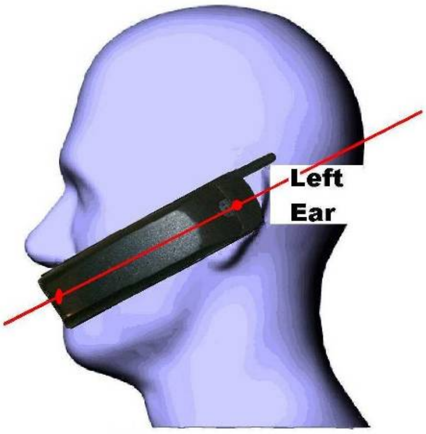

Figure 5. – Side View of Mobile next to head showing alignment.

<u>The Cheek Position</u>
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.

<u>The 15° Position</u>
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°.

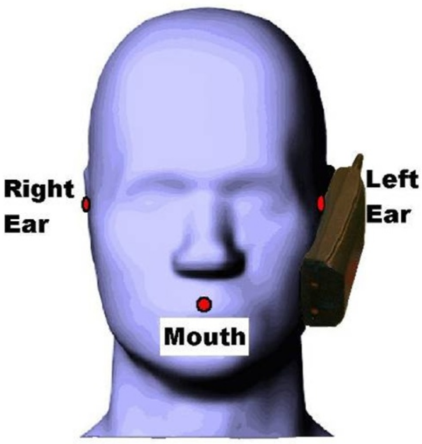

Figure 6. – Cheek Position.

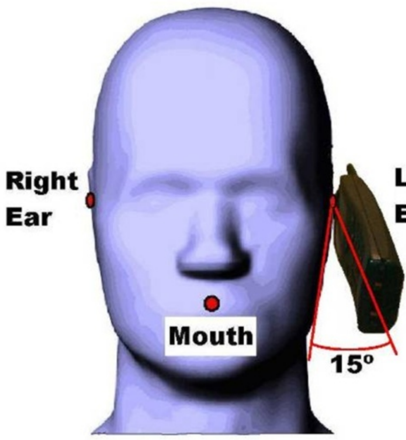

Figure 7. – 15º Tilt Position.

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2.2 GSM 450MHz HEAD SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	16/02/2012 11:41:46	DUT BATTERY MODEL/NO:	300-00634
FILENAME:	01.txt	PROBE SERIAL NUMBER:	190
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	450Head
DEVICE UNDER TEST:	STP8240	RELATIVE PERMITTIVITY:	43.02
RELATIVE HUMIDITY:	24.50%	CONDUCTIVITY:	0.853
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.30°C
PHANTOM ROTATION:	0°	MAX SAR Y-AXIS LOCATION:	-8.80mm
DUT POSITION:	Left-Cheek	MAX SAR Z-AXIS LOCATION:	-117.20mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	44.110
TEST FREQUENCY:	460.025MHz	SAR 1g:	2.075 W/kg
AIR FACTORS:	513.08 / 463.99 / 518.85	SAR 10g:	1.473 W/kg
CONVERSION FACTORS:	0.196 / 0.258 / 0.197	SAR START:	0.943 W/kg
TYPE OF MODULATION:	DQPSK (TETRA)	SAR END:	0.920 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	-2.420 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	16/02/2012
INPUT POWER LEVEL:	35dBm	EXTRAPOLATION:	poly4

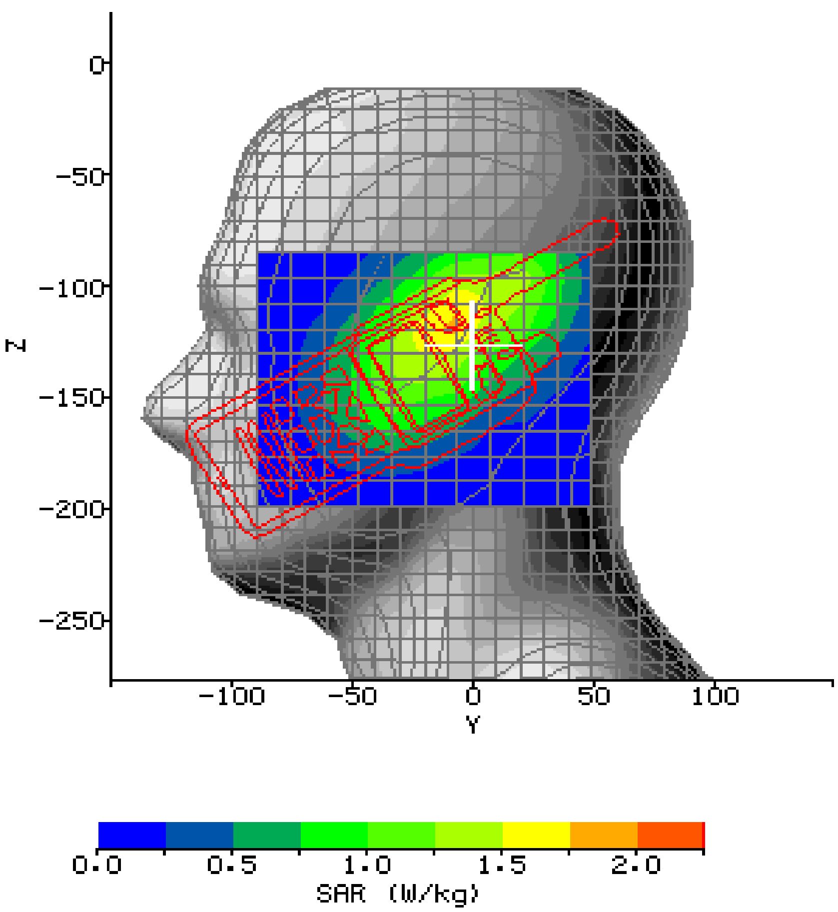

Figure 8: SAR Head Testing Results for the STP8240 TETRA Portable at 460.025MHz.

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SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	16/02/2012 12:19:38	DUT BATTERY MODEL/NO:	300-00634
FILENAME:	02.txt	PROBE SERIAL NUMBER:	190
AMBIENT TEMPERATURE:	22.10°C	LIQUID SIMULANT:	450Head
DEVICE UNDER TEST:	STP8240	RELATIVE PERMITTIVITY:	43.02
RELATIVE HUMIDITY:	24.90%	CONDUCTIVITY:	0.853
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.30°C
PHANTOM ROTATION:	0°	MAX SAR Y-AXIS LOCATION:	23.40mm
DUT POSITION:	Left-15°	MAX SAR Z-AXIS LOCATION:	-98.80mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	42.720
TEST FREQUENCY:	460.025MHz	SAR 1g:	2.228 W/kg
AIR FACTORS:	513.08 / 463.99 / 518.85	SAR 10g:	1.446 W/kg
CONVERSION FACTORS:	0.196 / 0.258 / 0.197	SAR START:	0.799 W/kg
TYPE OF MODULATION:	DQPSK (TETRA)	SAR END:	0.797 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	-0.210 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	16/02/2012
INPUT POWER LEVEL:	35dBm	EXTRAPOLATION:	poly4

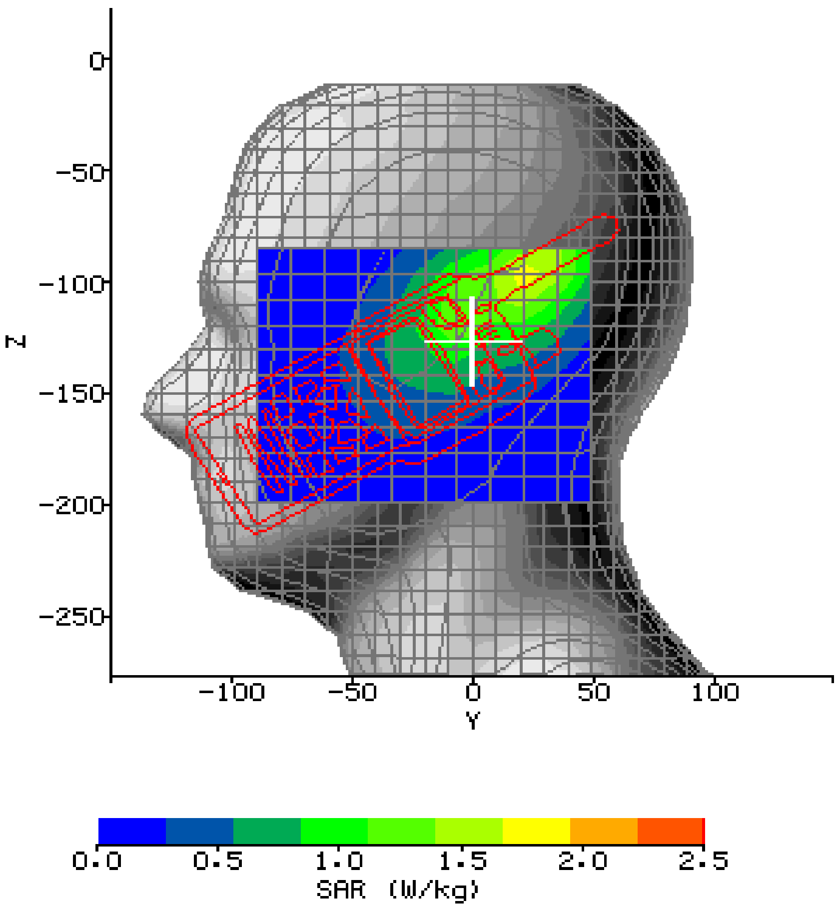

Figure 9: SAR Head Testing Results for the STP8240 TETRA Portable at 460.025MHz.

Product Service

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	16/02/2012 13:38:20	DUT BATTERY MODEL/NO:	300-00634
FILENAME:	03.txt	PROBE SERIAL NUMBER:	190
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	450Head
DEVICE UNDER TEST:	STP8240	RELATIVE PERMITTIVITY:	43.02
RELATIVE HUMIDITY:	23.30%	CONDUCTIVITY:	0.853
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.50°C
PHANTOM ROTATION:	180°	MAX SAR Y-AXIS LOCATION:	7.40mm
DUT POSITION:	Right-Cheek	MAX SAR Z-AXIS LOCATION:	-133.30mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	42.760
TEST FREQUENCY:	460.025MHz	SAR 1g:	1.932 W/kg
AIR FACTORS:	513.08 / 463.99 / 518.85	SAR 10g:	1.386 W/kg
CONVERSION FACTORS:	0.196 / 0.258 / 0.197	SAR START:	0.990 W/kg
TYPE OF MODULATION:	DQPSK (TETRA)	SAR END:	0.960 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	-2.960 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	16/02/2012
INPUT POWER LEVEL:	35dBm	EXTRAPOLATION:	poly4

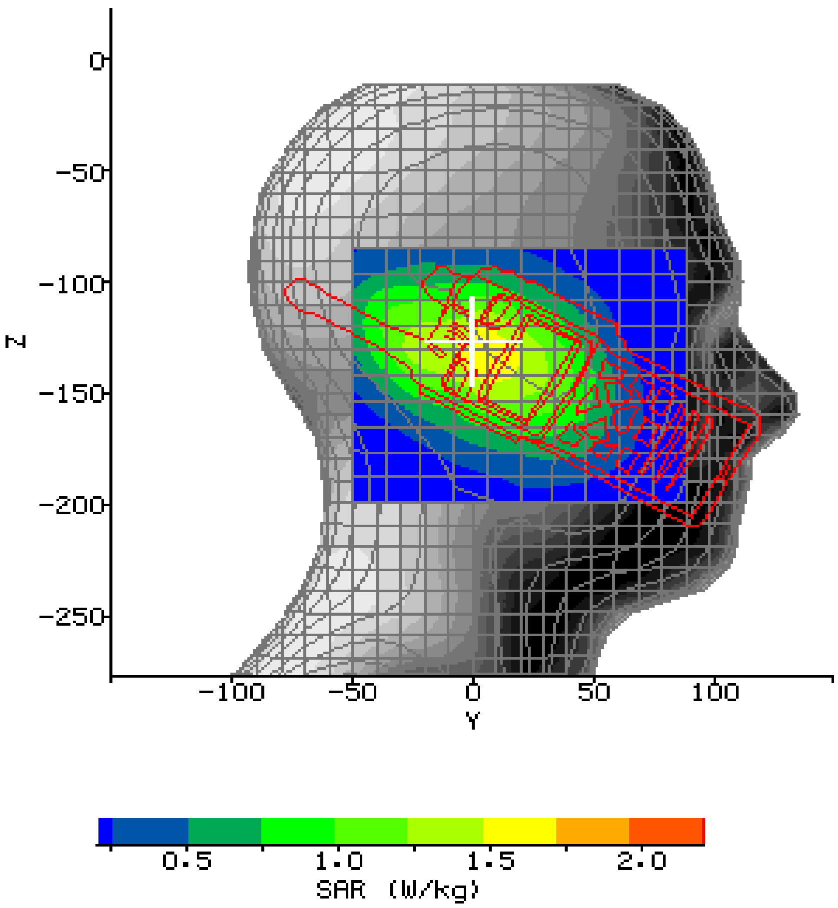

Figure 10: SAR Head Testing Results for the STP8240 TETRA Portable at 460.025MHz.

Product Service

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	16/02/2012 15:57:47	DUT BATTERY MODEL/NO:	300-00634
FILENAME:	temp.txt	PROBE SERIAL NUMBER:	190
AMBIENT TEMPERATURE:	22.10°C	LIQUID SIMULANT:	450Head
DEVICE UNDER TEST:	STP8240	RELATIVE PERMITTIVITY:	43.02
RELATIVE HUMIDITY:	23.50%	CONDUCTIVITY:	0.853
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.50°C
PHANTOM ROTATION:	180°	MAX SAR Y-AXIS LOCATION:	-26.20mm
DUT POSITION:	Right-15°	MAX SAR Z-AXIS LOCATION:	-122.95mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	43.830
TEST FREQUENCY:	460.025MHz	SAR 1g:	2.099 W/kg
AIR FACTORS:	513.08 / 463.99 / 518.85	SAR 10g:	1.452 W/kg
CONVERSION FACTORS:	0.196 / 0.258 / 0.197	SAR START:	0.966 W/kg
TYPE OF MODULATION:	DQPSK (TETRA)	SAR END:	0.978 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	1.270 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	16/02/2012
INPUT POWER LEVEL:	35dBm	EXTRAPOLATION:	poly4

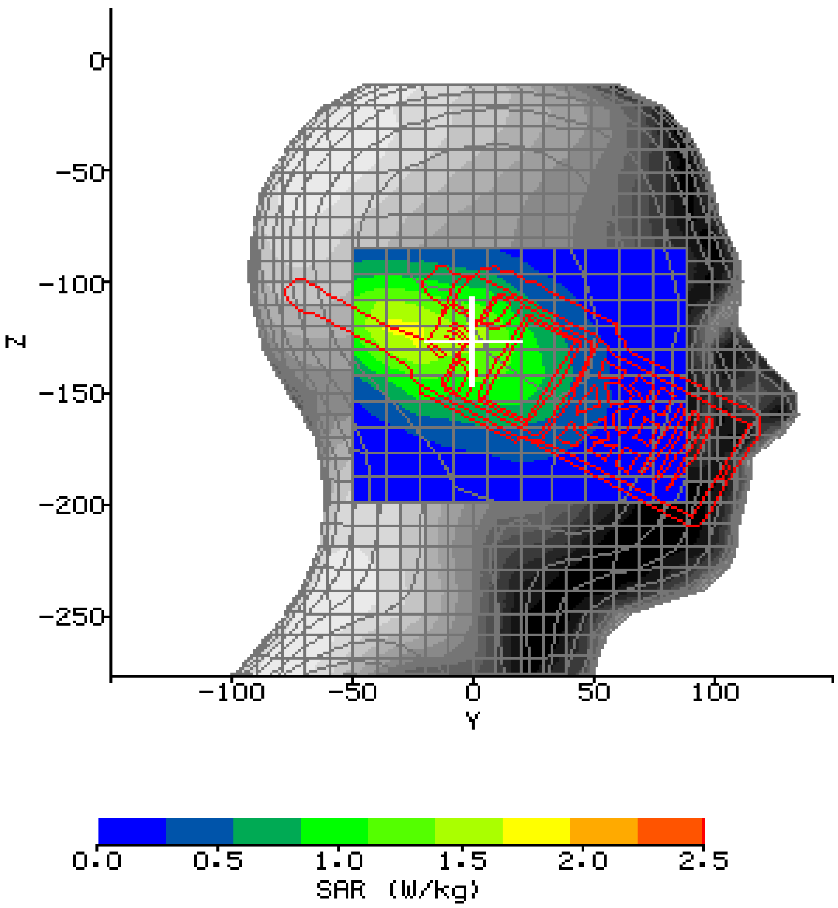

Figure 11: SAR Head Testing Results for the STP8240 TETRA Portable at 460.025MHz.

Product Service

2.3 GSM 450MHz HEAD SAR TEST RESULTS AND COURSE AREA SCANS – 2D USING HIGH CAPACITY BATTERY

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	16/02/2012 14:47:42	DUT BATTERY MODEL/NO:	300-00635
FILENAME:	05.txt	PROBE SERIAL NUMBER:	190
AMBIENT TEMPERATURE:	22.00°C	LIQUID SIMULANT:	450Head
DEVICE UNDER TEST:	STP8240	RELATIVE PERMITTIVITY:	43.02
RELATIVE HUMIDITY:	25.20%	CONDUCTIVITY:	0.853
PHANTOM S/NO:	Head_04_35.csv	LIQUID TEMPERATURE:	22.40°C
PHANTOM ROTATION:	0°	MAX SAR Y-AXIS LOCATION:	20.60mm
DUT POSITION:	Left-15°	MAX SAR Z-AXIS LOCATION:	-101.10mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	44.440
TEST FREQUENCY:	460.025MHz	SAR 1g:	2.395 W/kg
AIR FACTORS:	513.08 / 463.99 / 518.85	SAR 10g:	1.593 W/kg
CONVERSION FACTORS:	0.196 / 0.258 / 0.197	SAR START:	0.892 W/kg
TYPE OF MODULATION:	DQPSK (TETRA)	SAR END:	0.893 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	0.030 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	16/02/2012
INPUT POWER LEVEL:	35dBm	EXTRAPOLATION:	poly4

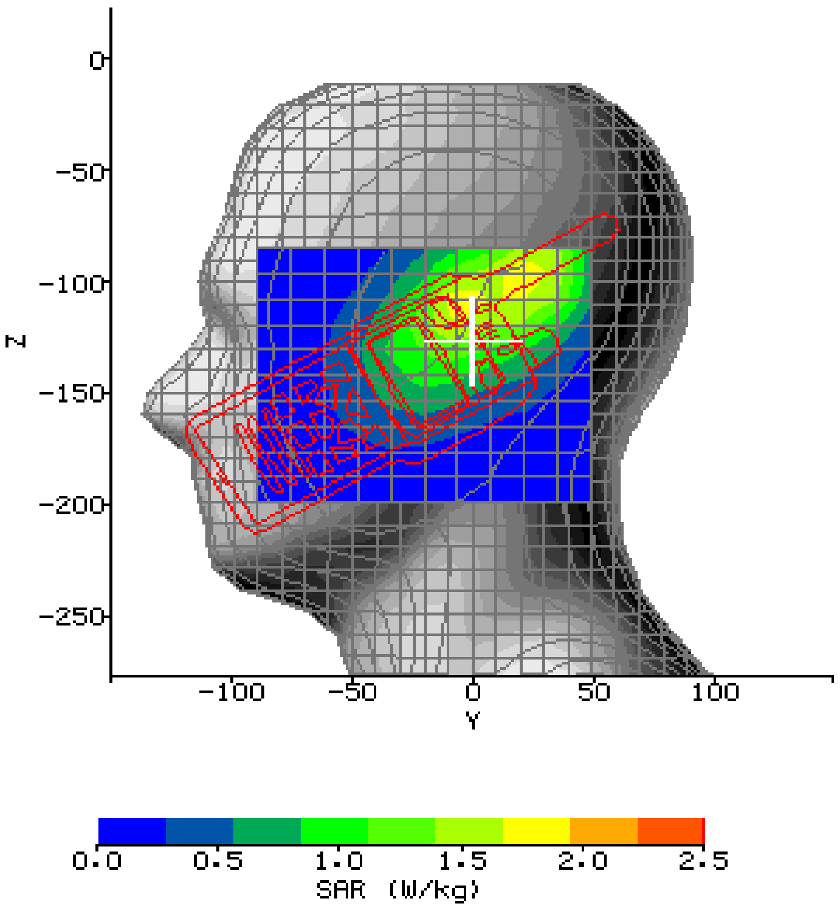

Figure 12: SAR Head Testing Results for the STP8240 TETRA Portable at 460.025MHz.

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Product Service

2.4 GSM 450MHz HEAD SAR TEST RESULTS AND COURSE AREA SCANS – 2D REMOTE SPEAKER MICROPHONE-STANDARD CAPACITY BATTERY

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	16/02/2012 10:09:53	DUT BATTERY MODEL/NO:	300-00634
FILENAME:	06.txt	PROBE SERIAL NUMBER:	190
AMBIENT TEMPERATURE:	22.50°C	LIQUID SIMULANT:	450Head
DEVICE UNDER TEST:	STP8240	RELATIVE PERMITTIVITY:	43.02
RELATIVE HUMIDITY:	23.40%	CONDUCTIVITY:	0.853
PHANTOM S/NO:	HeadBigBox.csv	LIQUID TEMPERATURE:	22.60°C
PHANTOM ROTATION:	N/A	MAX SAR Y-AXIS LOCATION:	-24.00mm
DUT POSITION:	25mm-Front Facing	MAX SAR Z-AXIS LOCATION:	14.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	12.250
TEST FREQUENCY:	460.025MHz	SAR 1g:	0.166 W/kg
AIR FACTORS:	513.08 / 463.99 / 518.85	SAR 10g:	0.114 W/kg
CONVERSION FACTORS:	0.196 / 0.258 / 0.197	SAR START:	0.033 W/kg
TYPE OF MODULATION:	DQPSK (TETRA)	SAR END:	0.033 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	0.050 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	16/02/2012
INPUT POWER LEVEL:	35dBm	EXTRAPOLATION:	poly4

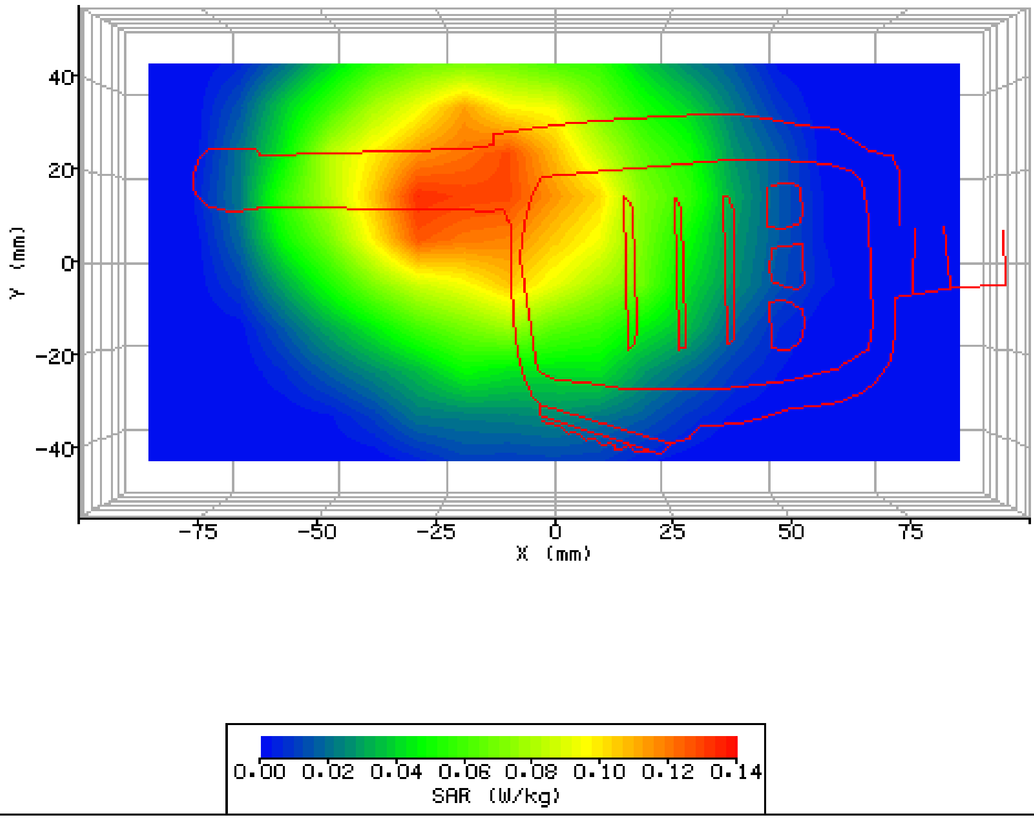

Figure 13: SAR Head Testing Results for the STP8240 TETRA Portable at 460.025MHz.

Product Service

2.5 ACCESSORY WORSE CASE FULL SCAN (WITH CLIP) SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	17/02/2012 13:23:23	DUT BATTERY MODEL/NO:	300-00634
FILENAME:	07.txt	PROBE SERIAL NUMBER:	190
AMBIENT TEMPERATURE:	22.40°C	LIQUID SIMULANT:	450Body
DEVICE UNDER TEST:	STP8240	RELATIVE PERMITTIVITY:	55.28
RELATIVE HUMIDITY:	35.60%	CONDUCTIVITY:	0.902
PHANTOM S/NO:	HeadBigBox.csv	LIQUID TEMPERATURE:	22.30°C
PHANTOM ROTATION:	N/A	MAX SAR X-AXIS LOCATION:	-15.00mm
DUT POSITION:	0mm-Rear Facing with Clip	MAX SAR Y-AXIS LOCATION:	-5.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	25.080
TEST FREQUENCY:	460.025MHz	SAR 1g:	0.705 W/kg
AIR FACTORS:	513.08 / 463.99 / 518.85	SAR 10g:	0.517 W/kg
CONVERSION FACTORS:	0.200 / 0.267 / 0.201	SAR START:	0.240 W/kg
TYPE OF MODULATION:	DQPSK (TETRA)	SAR END:	0.234 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	-2.330 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	17/02/2012
INPUT POWER LEVEL:	35dBm	EXTRAPOLATION:	poly4

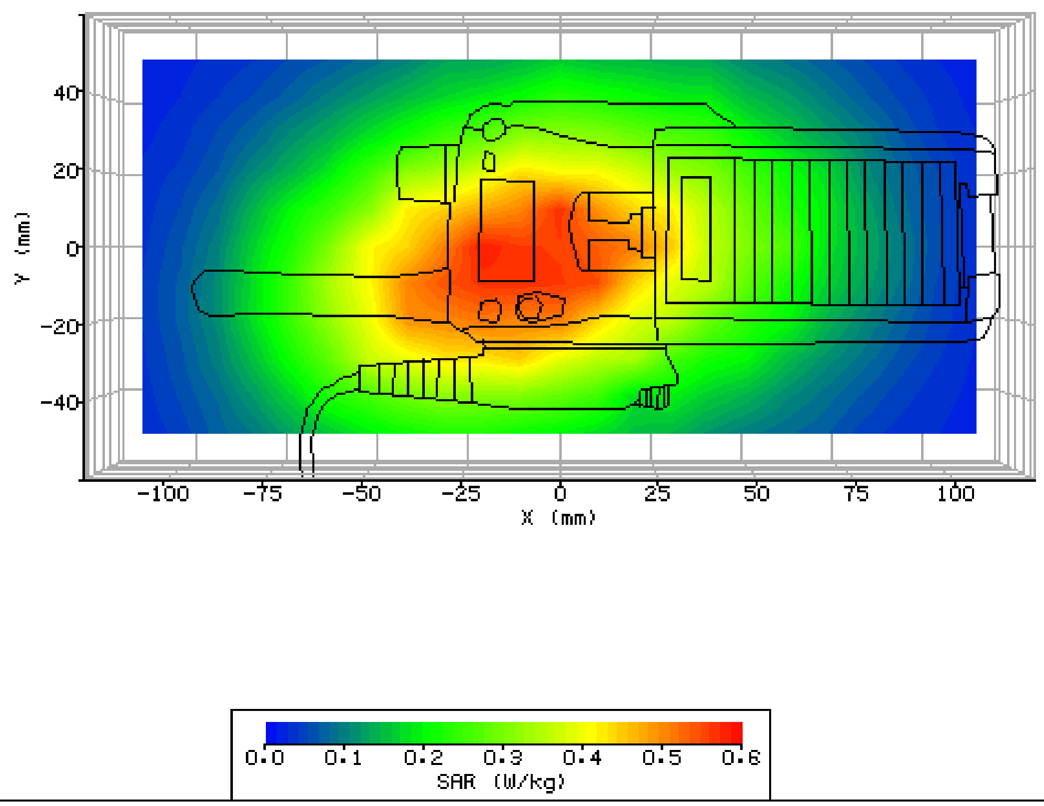

Figure 14: SAR Body Testing Results for the STP8240 TETRA Portable at 460.025MHz.

Product Service

2.6 ACCESSORY WORSE CASE FULL SCAN (WITH CLIP)-STANDARD CAPACITY BATTERY SAR TEST RESULTS AND COURSE AREA SCANS – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	17/02/2012 13:53:29	DUT BATTERY MODEL/NO:	300-00634
FILENAME:	08.txt	PROBE SERIAL NUMBER:	190
AMBIENT TEMPERATURE:	22.40°C	LIQUID SIMULANT:	450Body
DEVICE UNDER TEST:	STP8240	RELATIVE PERMITTIVITY:	55.28
RELATIVE HUMIDITY:	35.60%	CONDUCTIVITY:	0.902
PHANTOM S/NO:	HeadBigBox.csv	LIQUID TEMPERATURE:	22.30°C
PHANTOM ROTATION:	N/A	MAX SAR X-AXIS LOCATION:	-22.00mm
DUT POSITION:	0mm-Rear Facing with Clip	MAX SAR Y-AXIS LOCATION:	-8.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	22.820
TEST FREQUENCY:	460.025MHz	SAR 1g:	0.589 W/kg
AIR FACTORS:	513.08 / 463.99 / 518.85	SAR 10g:	0.420 W/kg
CONVERSION FACTORS:	0.200 / 0.267 / 0.201	SAR START:	0.190 W/kg
TYPE OF MODULATION:	DQPSK (TETRA)	SAR END:	0.192 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	1.050 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	17/02/2012
INPUT POWER LEVEL:	35dBm	EXTRAPOLATION:	poly4

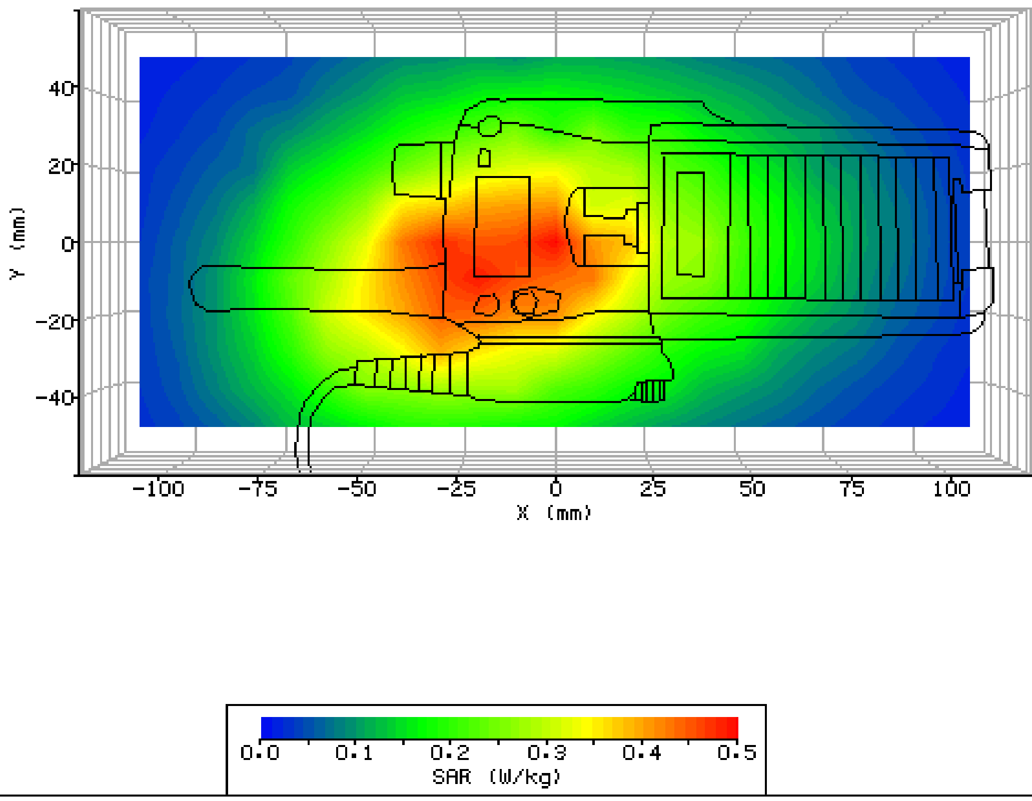

Figure 15: SAR Body Testing Results for the STP8240 TETRA Portable at 460.025MHz.

Product Service

2.7 GSM 450 BODY SAR TEST RESULTS AND COURSE AREA SCANS – 2D ACCESSORY REMOTE SPEAKER MICROPHONE-STANDARD CAPACITY BATTERY

SYSTEM / SOFTWARE:	SARA2 / 2.53 VPM	INPUT POWER DRIFT:	0 dB
DATE / TIME:	17/02/2012 14:22:22	DUT BATTERY MODEL/NO:	300-00634
FILENAME:	09.txt	PROBE SERIAL NUMBER:	190
AMBIENT TEMPERATURE:	22.50°C	LIQUID SIMULANT:	450Body
DEVICE UNDER TEST:	STP8240	RELATIVE PERMITTIVITY:	55.28
RELATIVE HUMIDITY:	35.90%	CONDUCTIVITY:	0.902
PHANTOM S/NO:	HeadBigBox.csv	LIQUID TEMPERATURE:	22.50°C
PHANTOM ROTATION:	N/A	MAX SAR X-AXIS LOCATION:	-22.00mm
DUT POSITION:	0mm-Rear Facing	MAX SAR Y-AXIS LOCATION:	19.00mm
ANTENNA CONFIGURATION:	N/A	MAX E FIELD:	22.640
TEST FREQUENCY:	460.025MHz	SAR 1g:	0.594 W/kg
AIR FACTORS:	513.08 / 463.99 / 518.85	SAR 10g:	0.399 W/kg
CONVERSION FACTORS:	0.200 / 0.267 / 0.201	SAR START:	0.153 W/kg
TYPE OF MODULATION:	DQPSK (TETRA)	SAR END:	0.159 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	3.670 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	17/02/2012
INPUT POWER LEVEL:	35dBm	EXTRAPOLATION:	poly4

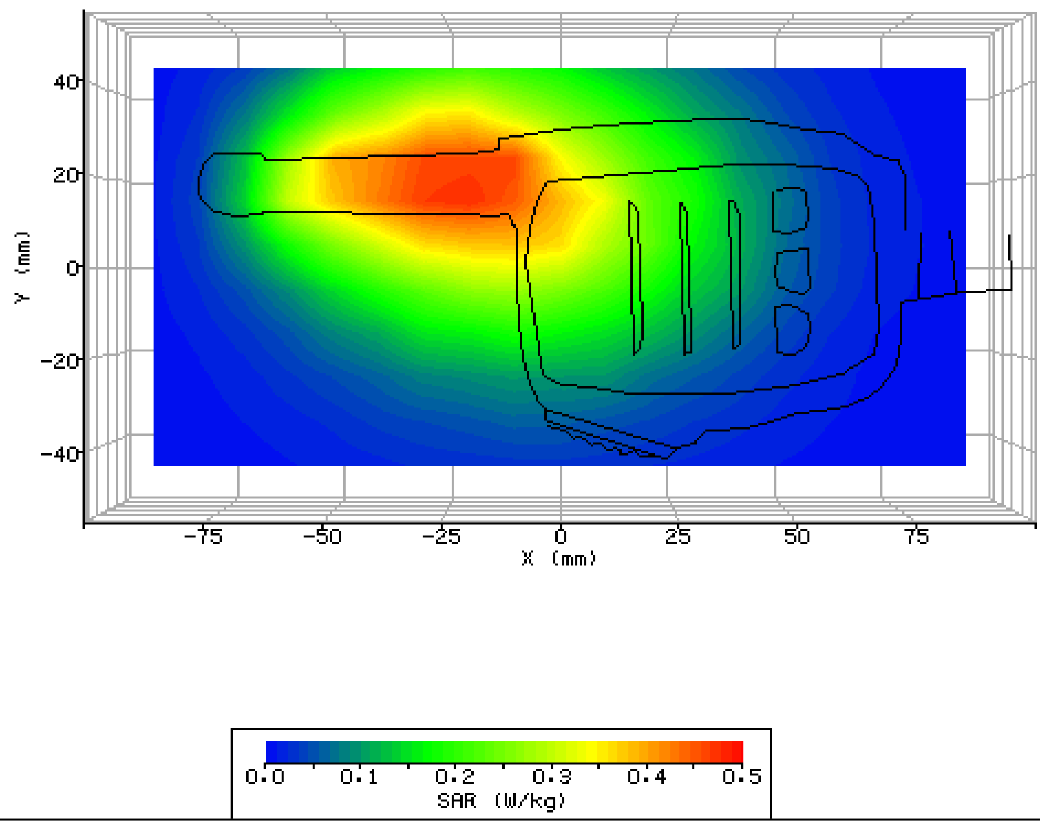

Figure 16: SAR Body Testing Results for the STP8240 TETRA Portable at 460.025MHz.

Product Service

SECTION 3

TEST EQUIPMENT USED

Product Service

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
10MHz - 2.5GHz, 3W, Amplifier	Vectawave Technology	VTL5400	51	-	TU
Directional Coupler	Krytar	1850	58	-	TU
Signal Generator	Hewlett Packard	ESG4000A	61	12	18-May-2012
Industrial Robot	Mitsubishi	RV-E2/CR-E116	63	-	TU
Thermometer	Digitron	T208	64	12	3-May-2012
Attenuator (20dB, 20W)	Narda	766F-20	483	12	9-Jun-2012
Fast Probe Amplifier (3 channels)	IndexSar Ltd	IFA-010	1558	-	TU
410x270x200mm Side Bench Phantom	IndexSar Ltd	IXB-020	1567	-	TU
Side Bench 2 Chamber 2	IndexSar Ltd	IXM-030	1571	-	TU
Power Sensor	Rohde & Schwarz	NRV-Z1	2879	12	25-May-2012
Power Meter	Rohde & Schwarz	NRVD	2979	12	24-May-2012
Power Sensor	Rohde & Schwarz	NRV-Z1	3563	12	25-May-2012
Meter & T/C	R.S Components	Meter 615-8206 & Type K T/C	3612	12	18-Feb-2012
Immersible SAR Probe	IndexSar Ltd	IXP-050	3893	12	23-Feb-2012
450MHz Head Fluid	TUV SÜD Product Service	Batch 3	N/A	1	01-Mar-2012
450MHz Body Fluid	TUV SÜD Product Service	Batch 7	N/A	1	01-Mar-2012
450 MHz Dipole	TUV SÜD Product Service	SN0014	INV4822	12	01-Mar-2013

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	-

Product Service

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 EN 62209-1: 2006 and IEC 62209-2: 2010.

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.

OET 65(c) Recipes

Ingredients (% by weight)	Frequency (MHz)									
	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	2
Ingredients (% by weight)																					
1, 2-Pro-panediol						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 (ºC)	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])

Product Service

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 εR (ε') Target	Relative Permittivity εR (ε') Measured	Conductivity σ Target	Conductivity σ Measured
450 MHz Head	43.5	43.02	0.87	0.853
450 MHz Body	56.7	55.28	0.94	0.902

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 22.0°C to 22.5°C.
The actual humidity during the testing ranged from 23.3% to 36.5% RH.

3.4.2 Test Fluid Temperature Range

Frequency	Body / Head Fluid	Min Temperature °C	Max Temperature °C
450 MHz	Head	22.3	22.6
450 MHz	Body	22.3	22.5

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 3.670% (0.160 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.

Product Service

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}
Measurement System							
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	∞
Test sample related							
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	-2.96	R	1.73	1	-1.71	∞
Phantom and set-up							
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			13.50	
Expanded uncertainty (95% confidence interval)			K=2			27.00	

Product Service

Body SAR Measurements.

Source of Uncertainty	Description	Tolerance / Uncertainty ± %	Probability distribution	Div	c_i (1g)	Standard Uncertainty ± % (1g)	v_i or v_{eff}
Measurement System							
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	∞
Test sample related							
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	3.670	R	1.73	1	2.12	∞
Phantom and set-up							
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			11.01	
Expanded uncertainty (95% confidence interval)			K=2			22.03	

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SECTION 4

PHOTOGRAPHS

4.1 TEST POSITIONAL PHOTOGRAPHS

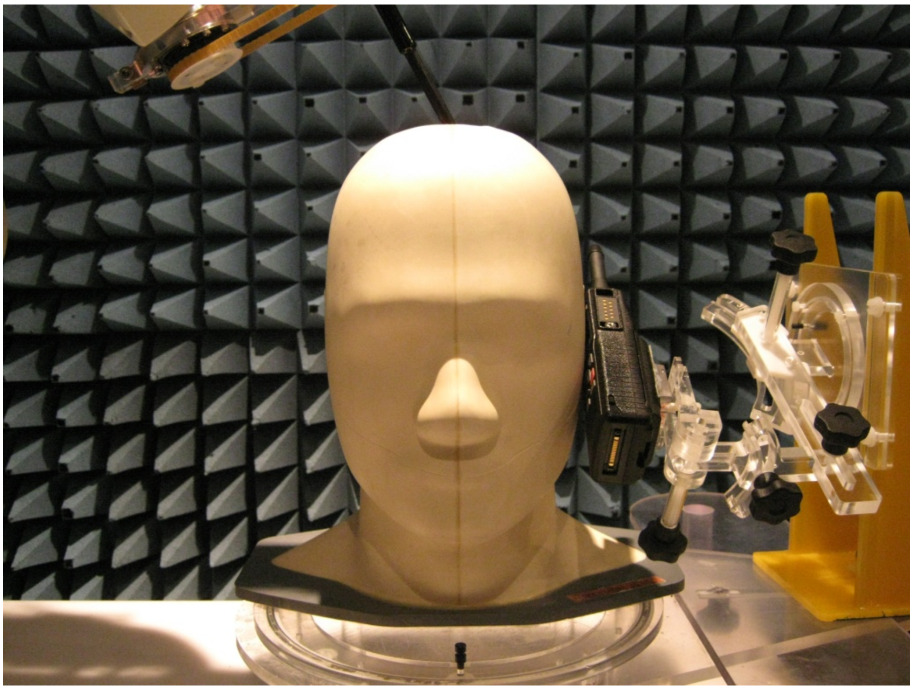

Figure 17
Left Hand Cheek

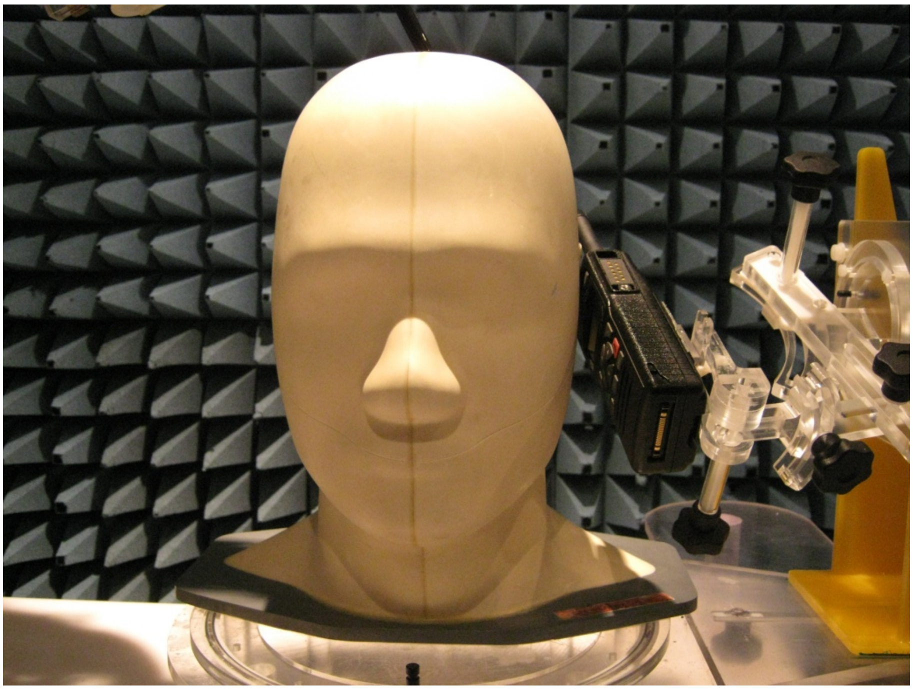

Figure 18
Left Hand Cheek 15°

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Figure 19
Right Hand Cheek

Figure 20
Right Hand Cheek 15°

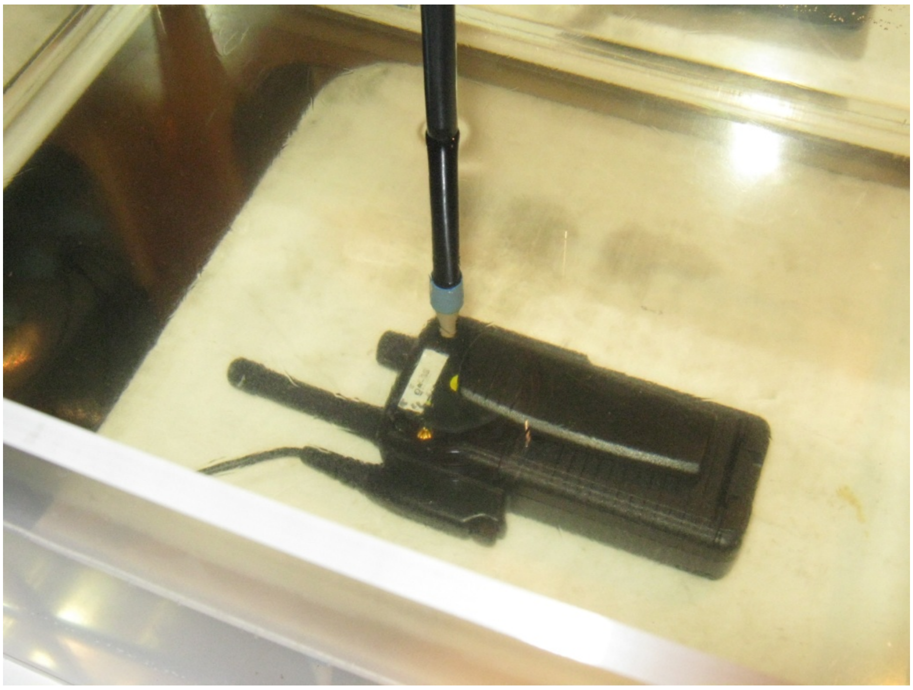

Figure 21
Body Rear

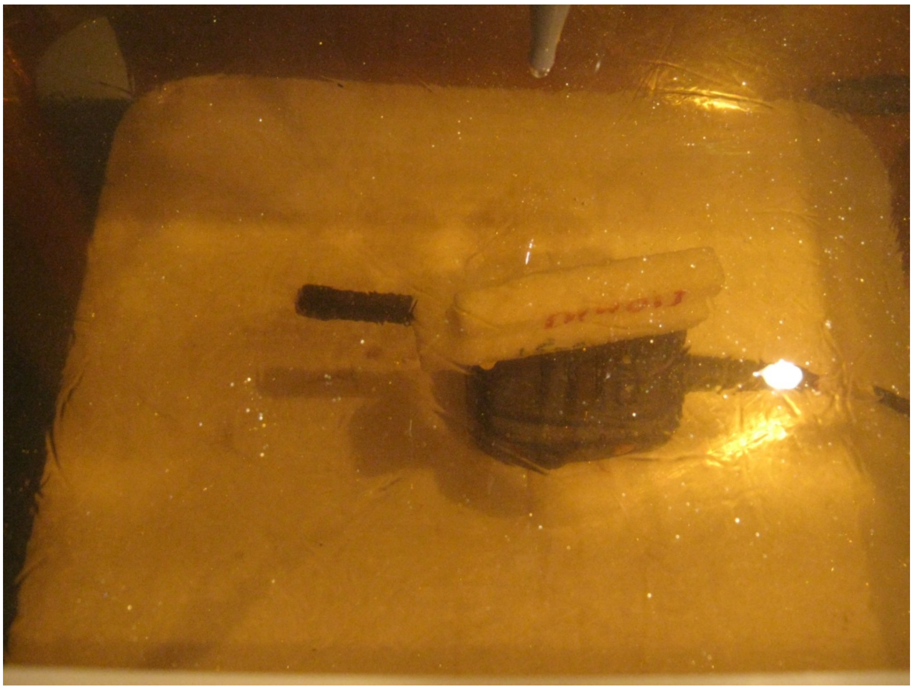

Figure 22
RSM Front Facing

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4.2 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (EUT)

Figure 23
STP8240

Figure 24
STP8240 Battery Removed

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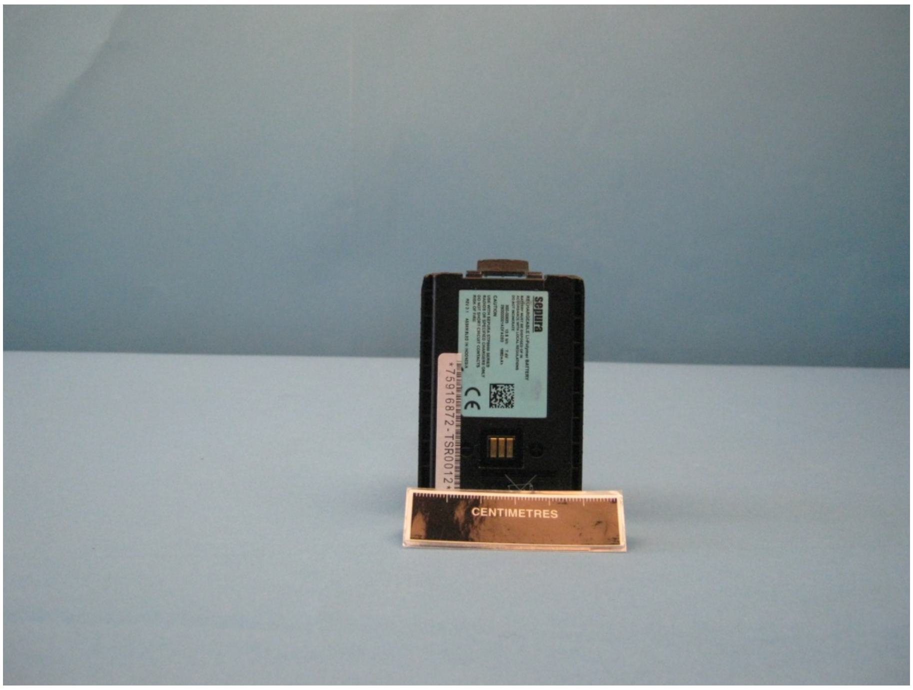

Figure 25
High Capacity Battery 300-00635

Figure 26
Remote Speaker Microphone (RSM)

Figure 27
Headset

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Figure 28
Case 300-00233

Figure 29
Case 300-00440

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Figure 30
Case 300-00439

Figure 31
Belt Clip

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SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

This report relates only to the actual item/items tested.

Our UKAS Accreditation does not cover opinions and interpretations and any expressed are outside the scope of our UKAS Accreditation.

Results of tests not covered by our UKAS Accreditation Schedule are marked NUA (Not UKAS Accredited).

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ANNEX A

PROBE CALIBRATION REPORT

Product Service

NATIONAL PHYSICAL LABORATORY

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

Certificate of Calibration

SAR PROBE

IndexSAR

Model: IXP-050

Serial number: 0190

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 0190

MEASUREMENTS COMPLETED ON: 23rd February 2011

PREVIOUS NPL CERTIFICATE: None

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

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Checked by :

Signed : B. Loader

Name : Mr B G Loader

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(Authorised Signatory)

on behalf of NPLML

NPLC01-05/07

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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 TE_{01} 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

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

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

$$SAR = c\frac{dT}{dt} \tag{2}$$

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.

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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.

ENVIRONMENT

Measurements were made in a temperature-controlled laboratory at 22 ± 1°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 ± 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.

Table 3 contains the values of the boundary correction factors *f(0)* and *d*. These values were supplied by the manufacturer.

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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.

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Table 1
Sensitivity in Head Simulating Liquids.
SAR probe: IXP-050
S/N 0190

Probe settings for calibration		
Sensitivity in free-space[(1)]	**Diode Compression[(2)]**	**Sensor offset from tip of probe[(2)]**
Lin X = 519.61 $(V/m)^2/(V*200)$ Lin Y = 671.10 $(V/m)^2/(V*200)$ Lin Z = 632.34 $(V/m)^2/(V*200)$	DCP_X = 20 (V*200) DCP_Y = 20 (V*200) DCP_Z = 20 (V*200)	2.7 mm

Sensitivity in Head Simulating Liquid.						
Calibration frequency	Liquid Phantom[(3)]		Calibration Factors for E^2_{Liquid} / E^2_{Air}			Axial Isotropy
(MHz)	ε' [(3)]	σ [(3)] (Sm^{-1})	$ConvF_X$	$ConvF_Y$	$ConvF_Z$	(dB)
450	42.2	0.83	**0.198**	**0.174**	**0.202**	±0.01
835	40.8	0.91	**0.230**	**0.199**	**0.232**	±0.01
900	40.4	0.95	**0.240**	**0.207**	**0.243**	±0.01
1800	39.6	1.41	**0.287**	**0.239**	**0.288**	±0.02
1900	39.6	1.43	**0.285**	**0.236**	**0.288**	±0.02
2100	39.0	1.48	**0.319**	**0.263**	**0.320**	±0.03
2450	37.7	1.84	**0.305**	**0.249**	**0.307**	±0.04
2600	37.1	2.00	**0.324**	**0.267**	**0.333**	±0.02

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Table 2

Sensitivity in Body Simulating Liquids.

SAR probe: IXP-050

S/N 0190

Probe settings for calibration		
Sensitivity in free-space[1]	**Diode Compression**[2]	**Sensor offset from tip of probe**[2]
Lin X = 519.61 $(V/m)^2/(V*200)$ Lin Y = 671.10 $(V/m)^2/(V*200)$ Lin Z = 632.34 $(V/m)^2/(V*200)$	DCP_X = 20 (V*200) DCP_Y = 20 (V*200) DCP_Z = 20 (V*200)	2.7 mm

Sensitivity in Body Simulating Liquid.						
Calibration frequency	Liquid Phantom[3]		Calibration Factors for E^2_{Liquid} / E^2_{Air}			Axial Isotropy
(MHz)	ε' [3]	σ [3] (Sm^{-1})	$ConvF_X$	$ConvF_Y$	$ConvF_Z$	(dB)
450	55.0	0.92	**0.202**	**0.177**	**0.205**	±0.02
835	56.5	0.99	**0.233**	**0.201**	**0.235**	±0.01
900	56.2	1.03	**0.244**	**0.209**	**0.245**	±0.01
1800	53.4	1.49	**0.308**	**0.254**	**0.314**	±0.02
1900	53.1	1.58	**0.318**	**0.261**	**0.325**	±0.03
2100	52.7	1.70	**0.348**	**0.270**	**0.347**	±0.02
2450	54.2	2.04	**0.376**	**0.302**	**0.384**	±0.03
2600	51.3	2.22	**0.386**	**0.308**	**0.390**	±0.03

Notes.

Notes.

(1) Measured at 900 MHz

(2) The manufacturer supplied these figures.

(3) Measured at a temperature of 22 ± 1 ^{0}C.

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Table 3
Manufacturer's boundary correction factors for
IXP-050 probes

Frequency	Head Simulating Liquid		Body Simulating Liquid	
(MHz)	*f(0)*	*d*	*f(0)*	*d*
835	1.35	1.30	1.45	1.30
900	1.20	1.30	1.45	1.30
1800	1.15	1.40	1.10	1.40
1900	1.10	1.40	1.10	1.50
2100	0.90	1.60	0.90	1.70
2450	0.85	1.60	0.85	1.80

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ANNEX B

DIPOLE CALIBRATION INFORMATION

450 MHz Validation Dipole Type IXD-450

1. Measurement Conditions

Measurements were performed using a Flat phantom with dimensions of 410mmx270mmx200mm with a sidewall thickness of 6.0mm. The phantom was filled to a depth of 150mm with the appropriate simulant liquid.

A 450MHz reference dipole was used to perform a system validation. The dipole-under-test was then substituted for the reference dipole and the validation repeated. Spacers made from a low-permittivity, low-loss foam material, were fitted to the dipoles' arms to ensure that the spacing between the dipole and the liquid surface is accurately aligned according to the guidance in the relevant standards. The material used is Rohacell, which has a relative permittivity of approx. 1.05 and a negligible loss tangent.

TÜV SÜD Product Service Ltd probe Serial Number 0190 was used.

An Anritsu MS4623B vector network analyser was used for the return loss measurements. The dipole-under-test was placed in a special holder made of low-permittivity, low-loss materials. Balanced dipoles for each frequency required are dimensioned according to the guidelines given in IEEE 1528 [1]. The dipoles are made from semi-rigid 50 Ohm co-ax, which is joined by soldering and is gold-plated subsequently.

2. SAR Validation

SAR validation checks have been performed using a 450MHz dipole (Serial Number SN0014) with the box-phantom located on the SARA C phantom support base on the SARA C cartesian robot system. Tests were then conducted at a feed power level of 0.25W, with an allowance for the transmission loss of the dipole. The ambient temperature was 22C +/- 1oC and the relative humidity was 32%.

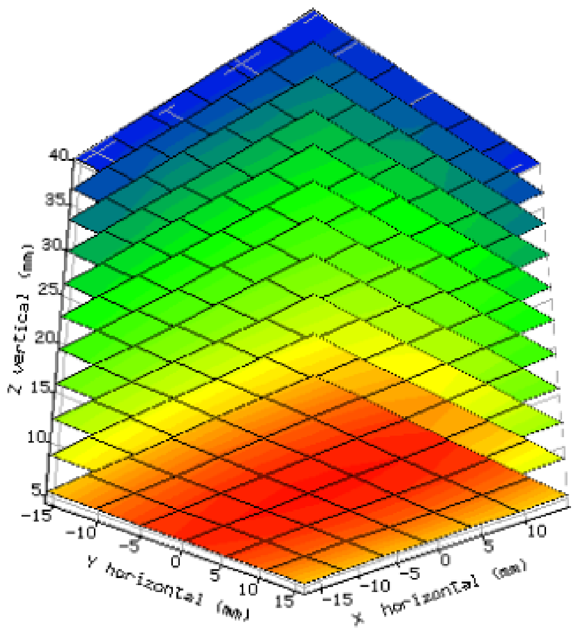
The phantom was filled with a 450MHz brain liquid using a recipe from [1], which has the following electrical parameters (measured using an Indexsar DiLine kit) at 450MHz at 19°C:

	Measured Value	Target Value	Deviation
Relative Permittivity	44.3	43.5	+1.8%
Conductivity	0.83	0.87	-4.6%

Derived by interpolation from Table I.1 EN62209-1[Ref 2]

The SARA C software version 5.002 (current version number) was used with Indexsar IXP_050 probe Serial Number 0190 previously calibrated by the National Physical Laboratory using waveguides.

The 3D measurement made using the dipole at the bottom of the phantom box is shown below:



The results, normalised to an input power of 1W (forward power) were:

	Measured SAR (W/kg)	Target SAR (W/kg) †	Deviation
1g	5.16	4.9	+5.2%
10g	3.57	3.3	+8.1%

†Derived by interpolation from Table D.1 EN62209-1[Ref 2]

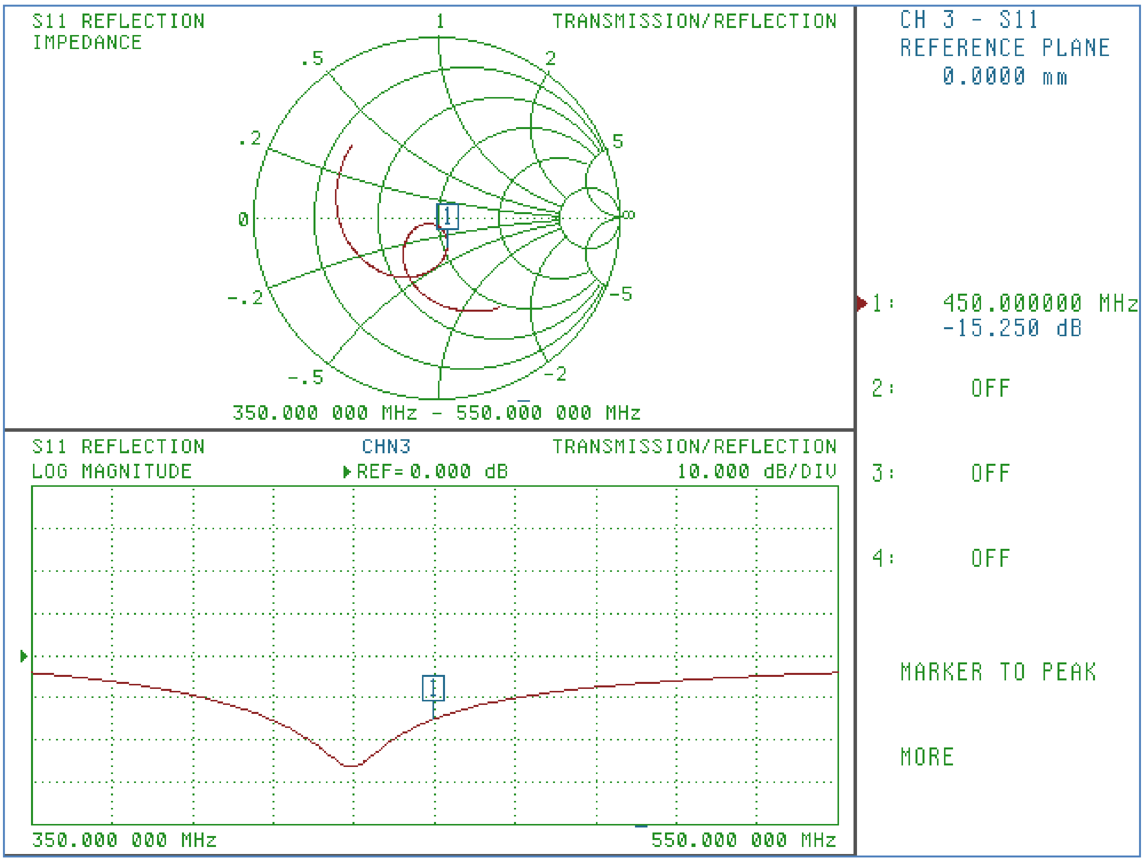
3. Patch Antenna impedance and return loss

A Vector Network Analyser (VNA) was used to perform a return loss measurement on the dipole-under-test when in the measurement location against the box phantom.

The following parameters were measured:

Patch antenna impedance at 450 MHz Re{Z} = **52 Ω**
Im{Z} = **-18 Ω**

Return loss at 450MHz **-15.3 dB**



4. References

[1] IEEE Std 1528-2003. IEEE recommended practice for determining the peak spatial-average specific absorption rate (SAR) in the human body due to wireless communications devices: Measurement Techniques – Description.

[2] BS EN 62209-1:2006. Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices — Human models, instrumentation, and procedures.