REPORT ON

Specific Absorption Rate Testing of the SHL Telemedicine International Ltd
Cardio Sen'C ECG Cardiograph (Recorder/Transmitter)

FCC ID: U6VCBSENC

Doc Number 75900645 Report 02 Issue 3 **September 2007**

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Specific Absorption Rate Testing of the SHL Telemedicine International Ltd Cardio Sen'C ECG Cardiograph (Recorder/Transmitter)

Doc Number 75900645 Report 02 Issue 3

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PREPARED FOR

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Wil House
Shannon Business Park
Shannon
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ATTESTATION

The wireless portable device described within this report has been shown to be capable of compliance for localised specific absorption rate (SAR) for General Population/Uncontrolled Exposure Limits as defined in the FCC standard Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01) 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) and IEEE 1528-2003

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.

PREPARED BY

V Kerai
Telecoms Engineer

APPROVED BY

M Jenkins
Authorised Signatory

DATED

6th September 2007

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

This report has been up-issued to include Input Power Level Values Obtained From CETECOM Report No.: 22345RET, Dated 2005-11-29 and Annex B – Additional Information Regarding the Integration Module.

CONTENTS

SECTION 1

REPORT SUMMARY

Specific Absorption Rate Testing of the SHL Telemedicine International Ltd
Cardio Sen'C ECG Cardiograph (Recorder/Transmitter)

Max 1g SAR (W/kg)	0.127
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	ECG Cardiograph (Recorder/Transmitter)
STATUS OF TEST	Specific Absorption Rate Testing
POWER CLASS	GSM 850 Class 4 / GSM 900 Class 4
	GSM DCS 1800 / PCS 1900 Class 1
GPRS CLASS	Class B
GPRS MULTI-SLOT CLASS	10 (4Dn; 2Up; Sum5)
MANUFACTURER	SHL Telemedicine International Ltd
TYPE OR MODEL NUMBER	Cardio Sen'C
HARDWARE VERSION	V2.0
FIRMWARE VERSION	V2.0
FCC ID	U6VCBSENC
SERIAL NUMBER	08001060
IMEI NUMBER	3582830011743501
BATTERY MODEL	Energizer AA 2 Lithium - 3Vdc - 1.5Vx2 - max 0.6A
BATTERY MANUFACTURER	Eveready Battery Company

TEST SPECIFICATIONS:

1. 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.

REFERENCES:

2. US Federal Government, Code of Federal Regulations, Title 47 Telecommunication, Chapter I Federal Communications Commission, part 2, section 1093.
3. 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.
4. CETECOM Report N0.: 22345RET Dated 2005-11-29.

TUV REGISTRATION NUMBER:	75900645
RECEIPT OF TEST SAMPLES:	19th February 2007
START OF TEST:	19th February 2007
FINISH OF TEST:	20th February 2007

1.2 SUMMARY

The unit supplied for testing is a SHL Telemedicine International Ltd Cardio Sen'C ECG Cardiograph (Recorder/Transmitter), which offers Quad-Band (GPRS 850/900/1800/1900) connectivity.

For Body SAR assessment, the device was tested for typical body-worn operation operated from batteries supplied by the client. The batteries were changed for each scan. Flat Phantom dimensions 220mmx200mmx150mm and with a sidewall thickness of 2.0mm. 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 Supplement C (Edition 01-01) to OET Bulletin 65 (Edition 97-01).

For Body SAR assessment the device was placed into a GPRS Multislot Class 10 configuration, with 2 timeslots transmitting at maximum power for both the GSM850 and GSM1900 bands. This was achieved using a Universal Radio Communication Tester (CMU200), which controlled the number of transmit slots and the handset power at level 5 (GSM850), and power level 0 (GSM1900) respectively. The Cardio Sen'C ECG Cardiograph (Recorder/Transmitter) was first configured with the rear of the device with holster placed to the 'side to phantom' (body). The device was then positioned in its intended user position whilst SAR assessment was carried out in the bottom, middle and top channel for each band assessed.

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).

The client provided a declaration that the Cardio Sen 'C integrates without any modification and following the manufacturers instructions the following product; GE863-QUAD By Telit Communications S.p.A. FCCID: R17GE863L. The input power level measurement values recorded in this report (Body SAR Test Result Including Course Area Scan – 2d pages 13 to 18 refer) were obtained from the CETECOM Report No.: 22345RET dated 2005-11-29. For further information on the Telit GE863-QUAD integrated module, please refer to Annex B of this report.

1.3 TEST RESULT SUMMARY

SYSTEM PERFORMANCE / VALIDATION CHECK RESULTS

Prior to formal testing being performed a System Check was performed in accordance with OET 65 Supplement C (Edition 01-01) [1] and the results were compared against published data in Standard IEEE 1528-2003 [3]. The following results were obtained: -

Date	Dipole Used	Frequency (MHz)	Max 1g SAR (W/kg)*	Percentage Drift on Reference (%)	Max 10g SAR (W/kg)*	Percentage Drift on Reference (%)
19/02/2007	850	844.4	9.94*	4.60%	6.49*	4.66%
20/02/2007	1900	1883.6	40.70*	2.51%	21.45*	4.65%

*Normalised to a forward power of 1W

GPRS 850MHz BODY Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the SHL Telemedicine International Ltd Cardio Sen'C ECG Cardiograph (Recorder/Transmitter)

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	Device Position to Phantom							
0mm	Holster Facing	189	836.4	0.000	0.003	0.002	0.000	Figure 4
0mm	Holster Facing	128	824.2	0.000	0.002	0.002	0.000	Figure 5
0mm	Holster Facing	251	848.8	0.000	0.003	0.002	0.000	Figure 6
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g) & 2.0 W/kg (10g)								

GPRS 1900MHz BODY Specific Absorption Rate (Maximum SAR) 1g & 10g Results for the SHL Telemedicine International Ltd Cardio Sen'C ECG Cardiograph (Recorder/Transmitter)

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	Device Position to Phantom							
0mm	Holster Facing	661	1880.0	0.070	0.087	0.054	-0.590	Figure 7
0mm	Holster Facing	512	1850.2	0.070	0.090	0.055	-0.720	Figure 8
0mm	Holster Facing	810	1909.8	0.100	0.127	0.072	-5.150	Figure 9
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 SHL Telemedicine International Ltd
Cardio Sen'C ECG Cardiograph (Recorder/Transmitter)

2.1 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.

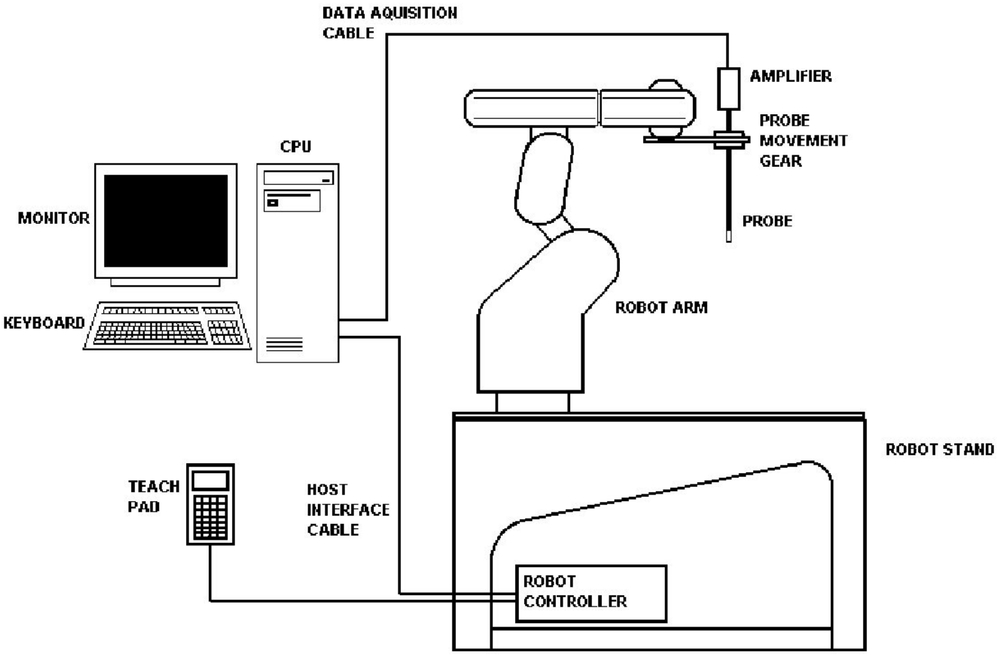


Figure 1: Schematic diagram of the SAR measurement system

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 SAR MEASUREMENT SYSTEM - Continued

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.

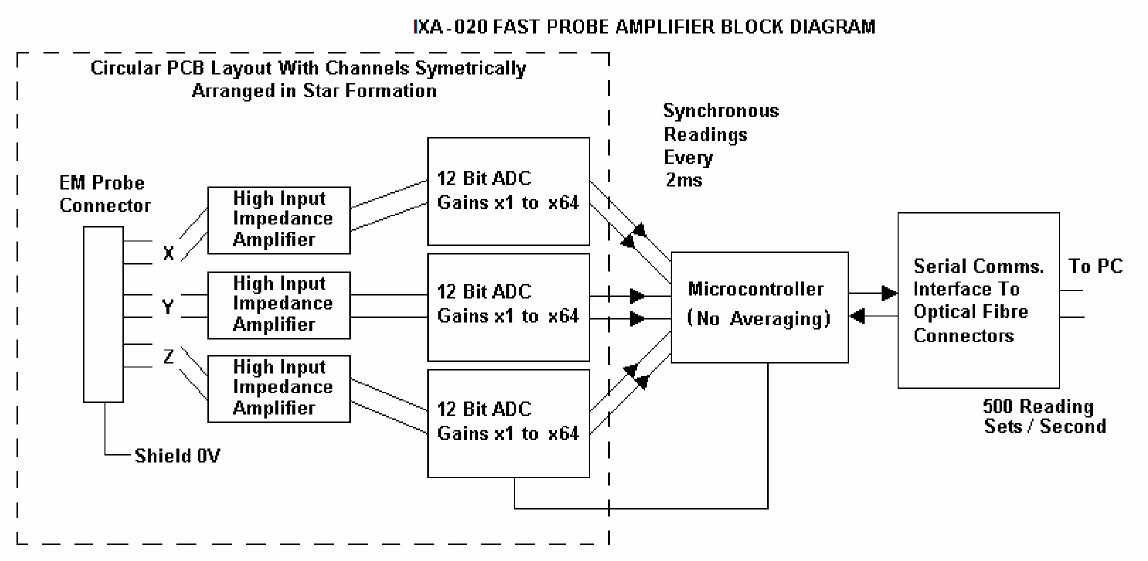


Figure 2: Block diagram of the fast probe amplifier electronic

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 linearization procedure separately to each reading, so no linearization 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 Cube phantom used is a Perspex Box IndexSAR item IXB-070. Dimensions of 200w x 200d x 200h (mm). This phantom is used with IndexSAR side bench IXM-030.

The Flat phantom used is a Rectangular Perspex Box IndexSAR item. Dimensions of 210w x 150d x 200h (mm). This phantom is used with IndexSAR upright bench. The phantom and robot alignment is assured by both mechanical and laser registration systems.

2.1 SAR MEASUREMENT SYSTEM - Continued

2.1.3 SAR MEASUREMENT PROCEDURE

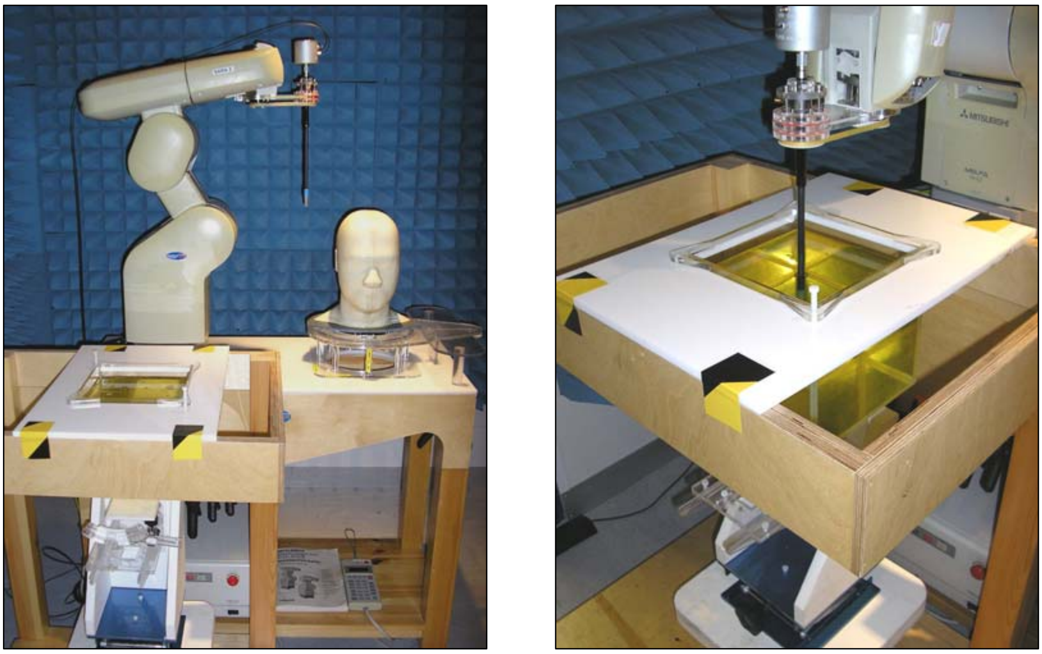


Figure 3: Principal components of the SAR measurement test bench

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. 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.

2.1 SAR MEASUREMENT SYSTEM - Continued

2.1.3 SAR MEASUREMENT PROCEDURE

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 50361:2001). 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 50361:2001.

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 50361:2001) 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 EN50361:2001) is +/- 0.04mm.

2.1 SAR MEASUREMENT SYSTEM - Continued

2.1.3 SAR MEASUREMENT PROCEDURE

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).

2.2 850MHz GPRS BODY SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	20/02/2007 14:09:04	**DUT BATTERY MODEL/NO:**	Energiser AA2
FILENAME:	75900645_07.txt	**PROBE SERIAL NUMBER:**	0171
AMBIENT TEMPERATURE:	22.5°C	**LIQUID SIMULANT:**	835 Body
DEVICE UNDER TEST:	Cardio Sen'C	**RELATIVE PERMITTIVITY:**	57.28
RELATIVE HUMIDITY:	42.1%	**CONDUCTIVITY:**	0.98
PHANTOM S/NO:	HeadBox170.csv	**LIQUID TEMPERATURE:**	21.3°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	14.00 mm
DUT POSITION:	Holster Facing 0mm	**MAX SAR Y-AXIS LOCATION:**	-17.00 mm
ANTENNA CONFIGURATION:	Fixed (Integral)	**MAX E FIELD:**	1.59 V/m
TEST FREQUENCY:	836.4MHz	**SAR 1g:**	0.003 W/kg
AIR FACTORS:	344 / 473 / 382	**SAR 10g:**	0.002 W/kg
CONVERSION FACTORS:	0.267 / 0.267 / 0.267	**SAR START:**	0.000 W/kg
TYPE OF MODULATION:	GMSK	**SAR END:**	0.000 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	0.00 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	20/02/2007
INPUT POWER LEVEL:	31.84 dBm	**EXTRAPOLATION:**	poly4

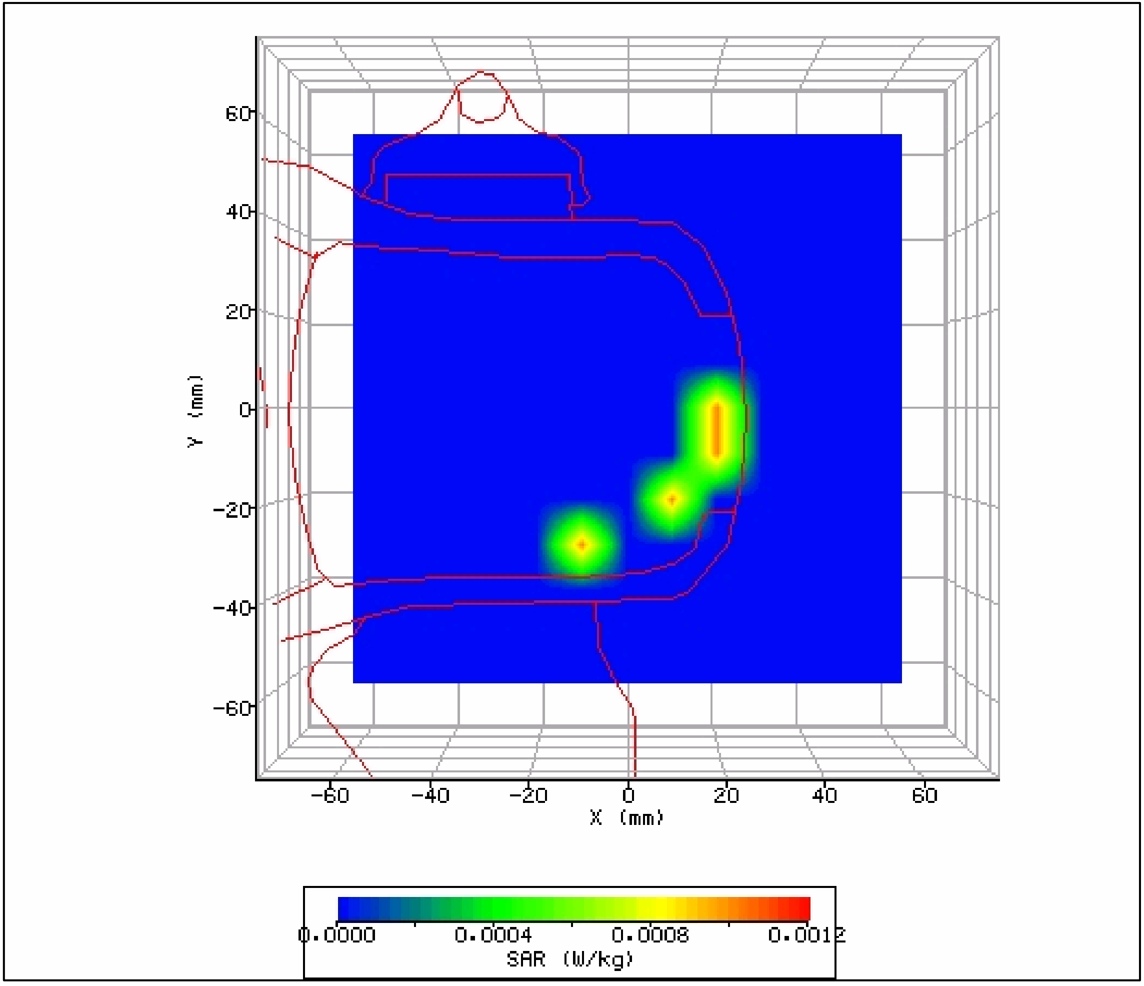
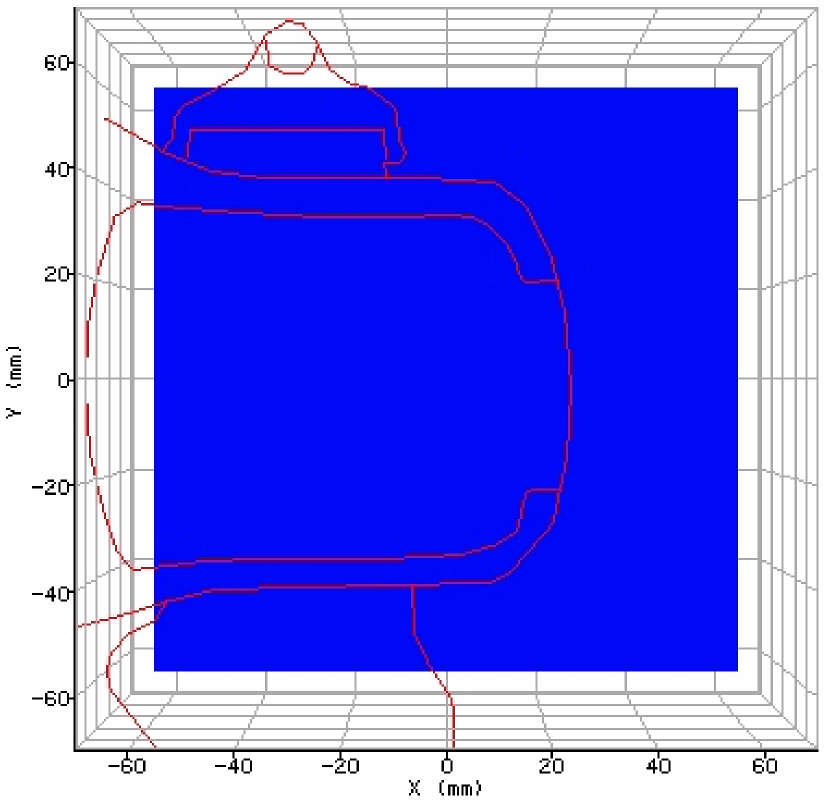


Figure 4: SAR Body Testing Results for the SHL Telemedicine International Ltd Cardio Sen'C ECG Cardiograph (Recorder/Transmitter) in Holster Facing Phantom Position; Tested at 836.4MHz (850MHz GSM Middle Channel) with 0.0mm Separation.

2.2 850MHz GPRS BODY SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	20/02/2007 14:33:38	**DUT BATTERY MODEL/NO:**	Energiser AA2
FILENAME:	75900645_08.txt	**PROBE SERIAL NUMBER:**	0171
AMBIENT TEMPERATURE:	22.3°C	**LIQUID SIMULANT:**	835 Body
DEVICE UNDER TEST:	Cardio Sen'C	**RELATIVE PERMITTIVITY:**	57.28
RELATIVE HUMIDITY:	41.3%	**CONDUCTIVITY:**	0.98
PHANTOM S/NO:	HeadBox170.csv	**LIQUID TEMPERATURE:**	21.3°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	15.00 mm
DUT POSITION:	Holster Facing 0mm	**MAX SAR Y-AXIS LOCATION:**	-16.00 mm
ANTENNA CONFIGURATION:	Fixed (Integral)	**MAX E FIELD:**	1.50 V/m
TEST FREQUENCY:	824.2MHz	**SAR 1g:**	0.002 W/kg
AIR FACTORS:	344 / 473 / 382	**SAR 10g:**	0.002 W/kg
CONVERSION FACTORS:	0.267 / 0.267 / 0.267	**SAR START:**	0.000 W/kg
TYPE OF MODULATION:	GMSK	**SAR END:**	0.000 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	0.00 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	20/02/2007
INPUT POWER LEVEL:	32.28 dBm	**EXTRAPOLATION:**	poly4



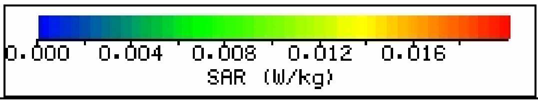


Figure 5: SAR Body Testing Results for the SHL Telemedicine International Ltd Cardio Sen'C ECG Cardiograph (Recorder/Transmitter) in Holster Facing Phantom Position; Tested at 824.2MHz (850MHz GSM Low Channel) with 0.0mm Separation.

2.2 850MHz GPRS BODY SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	INPUT POWER DRIFT:	0.0dB
DATE / TIME:	20/02/2007 14:58:05	DUT BATTERY MODEL/NO:	Energiser AA2
FILENAME:	75900645_09.txt	PROBE SERIAL NUMBER:	0171
AMBIENT TEMPERATURE:	22.6°C	LIQUID SIMULANT:	835 Body
DEVICE UNDER TEST:	Cardio Sen'C	RELATIVE PERMITTIVITY:	57.28
RELATIVE HUMIDITY:	40.9%	CONDUCTIVITY:	0.98
PHANTOM S/NO:	HeadBox170.csv	LIQUID TEMPERATURE:	21.3°C
PHANTOM ROTATION:	0°	MAX SAR X-AXIS LOCATION:	13.00 mm
DUT POSITION:	Holster Facing 0mm	MAX SAR Y-AXIS LOCATION:	-12.00 mm
ANTENNA CONFIGURATION:	Fixed (Integral)	MAX E FIELD:	1.58 V/m
TEST FREQUENCY:	848.8MHz	SAR 1g:	0.003 W/kg
AIR FACTORS:	344 / 473 / 382	SAR 10g:	0.002 W/kg
CONVERSION FACTORS:	0.267 / 0.267 / 0.267	SAR START:	0.000 W/kg
TYPE OF MODULATION:	GMSK	SAR END:	0.000 W/kg
MODN. DUTY CYCLE:	25%	SAR DRIFT DURING SCAN:	0.00 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	PROBE BATTERY LAST CHANGED:	20/02/2007
INPUT POWER LEVEL:	31.95 dBm	EXTRAPOLATION:	poly4

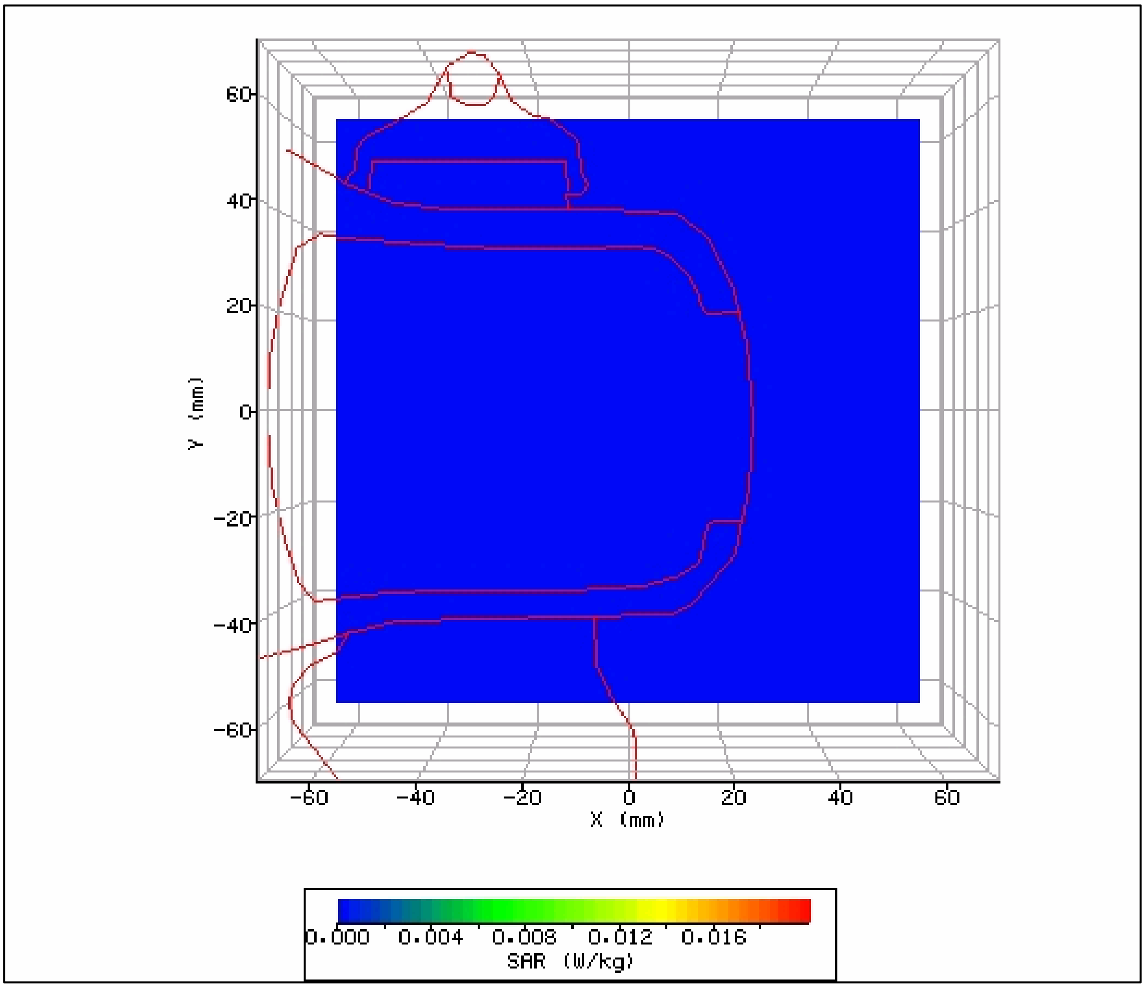


Figure 6: SAR Body Testing Results for the SHL Telemedicine International Ltd Cardio Sen'C ECG Cardiograph (Recorder/Transmitter) in Holster Facing Phantom Position; Tested at 848.8MHz (850MHz GSM High Channel) with 0.0mm Separation.

2.3 1900MHz GPRS BODY SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dBm
DATE / TIME:	20/02/2007 10:32:42	**DUT BATTERY MODEL/NO:**	Energiser AA2
FILENAME:	75900645_10.txt	**PROBE SERIAL NUMBER:**	0171
AMBIENT TEMPERATURE:	22.4°C	**LIQUID SIMULANT:**	1900 Body
DEVICE UNDER TEST:	Cardio Sen'C	**RELATIVE PERMITTIVITY:**	52.86
RELATIVE HUMIDITY:	34.9%	**CONDUCTIVITY:**	1.516
PHANTOM S/NO:	HeadBox170.csv	**LIQUID TEMPERATURE:**	21.2°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	42.00 mm
DUT POSITION:	Holster Facing 0mm	**MAX SAR Y-AXIS LOCATION:**	-26.00 mm
ANTENNA CONFIGURATION:	Fixed (Integral)	**MAX E FIELD:**	6.92 V/m
TEST FREQUENCY:	1880.0MHz	**SAR 1g:**	0.087 W/kg
AIR FACTORS:	344 / 473 / 382	**SAR 10g:**	0.054 W/kg
CONVERSION FACTORS:	0.368 / 0.368 / 0.368	**SAR START:**	0.015 W/kg
TYPE OF MODULATION:	GMSK	**SAR END:**	0.015 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	-0.59 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	16/02/2007
INPUT POWER LEVEL:	24.72 dBm	**EXTRAPOLATION:**	poly4

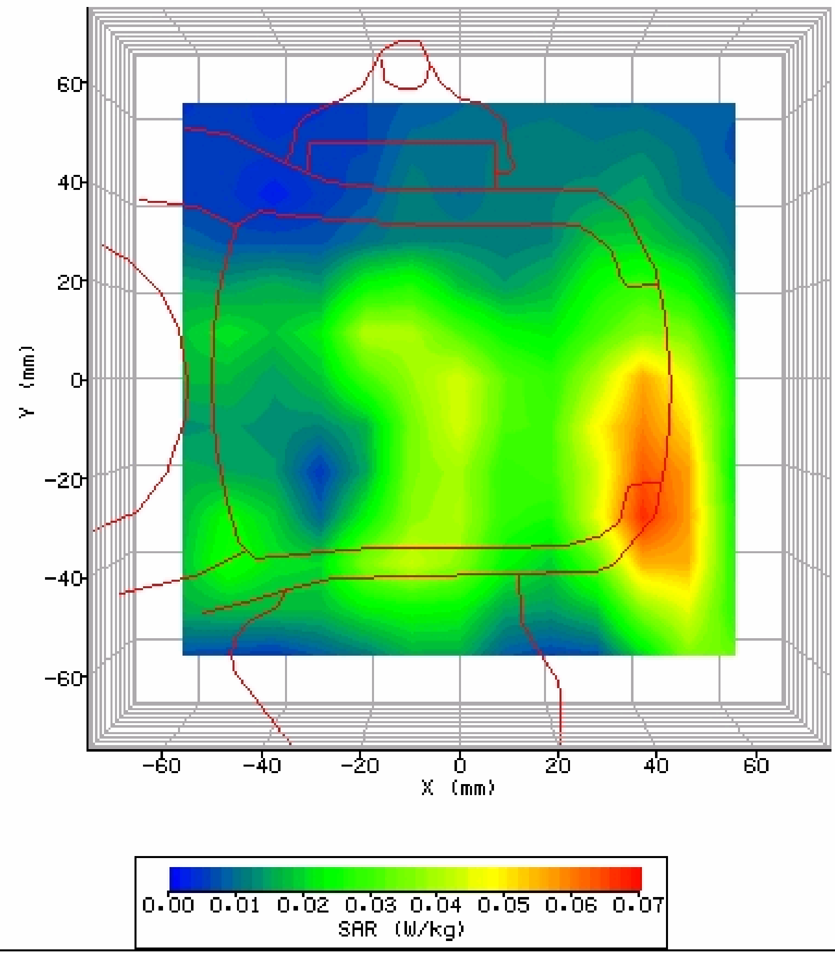


Figure 7: SAR Body Testing Results for the SHL Telemedicine International Ltd Cardio Sen'C ECG Cardiograph (Recorder/Transmitter) in Holster Facing Phantom Position; Tested at 1880.0MHz (1900MHz GSM Middle Channel) with 0.0mm Separation.

2.3 1900MHz GPRS BODY SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	20/02/2007 10:58:20	**DUT BATTERY MODEL/NO:**	Energiser AA2
FILENAME:	75900645_11.txt	**PROBE SERIAL NUMBER:**	0171
AMBIENT TEMPERATURE:	22.6°C	**LIQUID SIMULANT:**	1900 Body
DEVICE UNDER TEST:	Cardio Sen'C	**RELATIVE PERMITTIVITY:**	52.86
RELATIVE HUMIDITY:	36.3%	**CONDUCTIVITY:**	1.516
PHANTOM S/NO:	HeadBox170.csv	**LIQUID TEMPERATURE:**	21.2°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	42.00 mm
DUT POSITION:	Holster Facing 0mm	**MAX SAR Y-AXIS LOCATION:**	-27.00 mm
ANTENNA CONFIGURATION:	Fixed (Integral)	**MAX E FIELD:**	7.02 V/m
TEST FREQUENCY:	1850.2MHz	**SAR 1g:**	0.090W/kg
AIR FACTORS:	344 / 473 / 382	**SAR 10g:**	0.055 W/kg
CONVERSION FACTORS:	0.368 / 0.368 / 0.368	**SAR START:**	0.016 W/kg
TYPE OF MODULATION:	GMSK	**SAR END:**	0.016 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	-0.72 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	16/02/2007
INPUT POWER LEVEL:	24.14 dBm	**EXTRAPOLATION:**	poly4

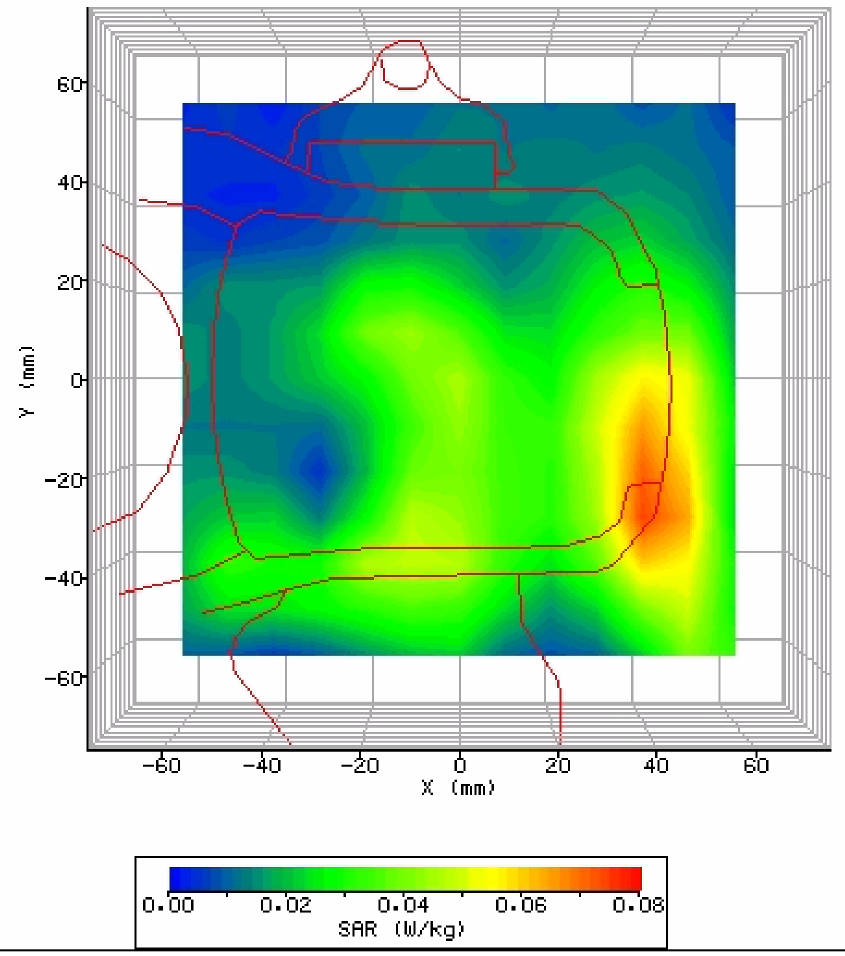


Figure 8: SAR Body Testing Results for the SHL Telemedicine International Ltd Cardio Sen’C ECG Cardiograph (Recorder/Transmitter) in Holster Facing Phantom Position; Tested at 1850.2MHz (1900MHz GSM Low Channel) with 0.0mm Separation.

2.3 1900MHz GPRS BODY SAR TEST RESULT INCLUDING COURSE AREA SCAN – 2D

SYSTEM / SOFTWARE:	SARA2 / 2.39 VPM	**INPUT POWER DRIFT:**	0.0dB
DATE / TIME:	20/02/2007 11:30:19	**DUT BATTERY MODEL/NO:**	Energiser AA2
FILENAME:	75900645_12.txt	**PROBE SERIAL NUMBER:**	0171
AMBIENT TEMPERATURE:	22.5°C	**LIQUID SIMULANT:**	1900 Body
DEVICE UNDER TEST:	Cardio Sen'C	**RELATIVE PERMITTIVITY:**	52.86
RELATIVE HUMIDITY:	34.5%	**CONDUCTIVITY:**	1.516
PHANTOM S/NO:	HeadBox170.csv	**LIQUID TEMPERATURE:**	21.2°C
PHANTOM ROTATION:	0°	**MAX SAR X-AXIS LOCATION:**	8.00 mm
DUT POSITION:	Holster Facing 0mm	**MAX SAR Y-AXIS LOCATION:**	-26.00 mm
ANTENNA CONFIGURATION:	Fixed (Integral)	**MAX E FIELD:**	8.16 V/m
TEST FREQUENCY:	1909.8MHz	**SAR 1g:**	0.127 W/kg
AIR FACTORS:	344 / 473 / 382	**SAR 10g:**	0.072 W/kg
CONVERSION FACTORS:	0.368 / 0.368 / 0.368	**SAR START:**	0.018 W/kg
TYPE OF MODULATION:	GMSK	**SAR END:**	0.017 W/kg
MODN. DUTY CYCLE:	25%	**SAR DRIFT DURING SCAN:**	-5.15 %
DIODE COMPRESSION FACTORS (V*200):	20 / 20 / 20	**PROBE BATTERY LAST CHANGED:**	16/02/2007
INPUT POWER LEVEL:	25.51 dBm	**EXTRAPOLATION:**	poly4

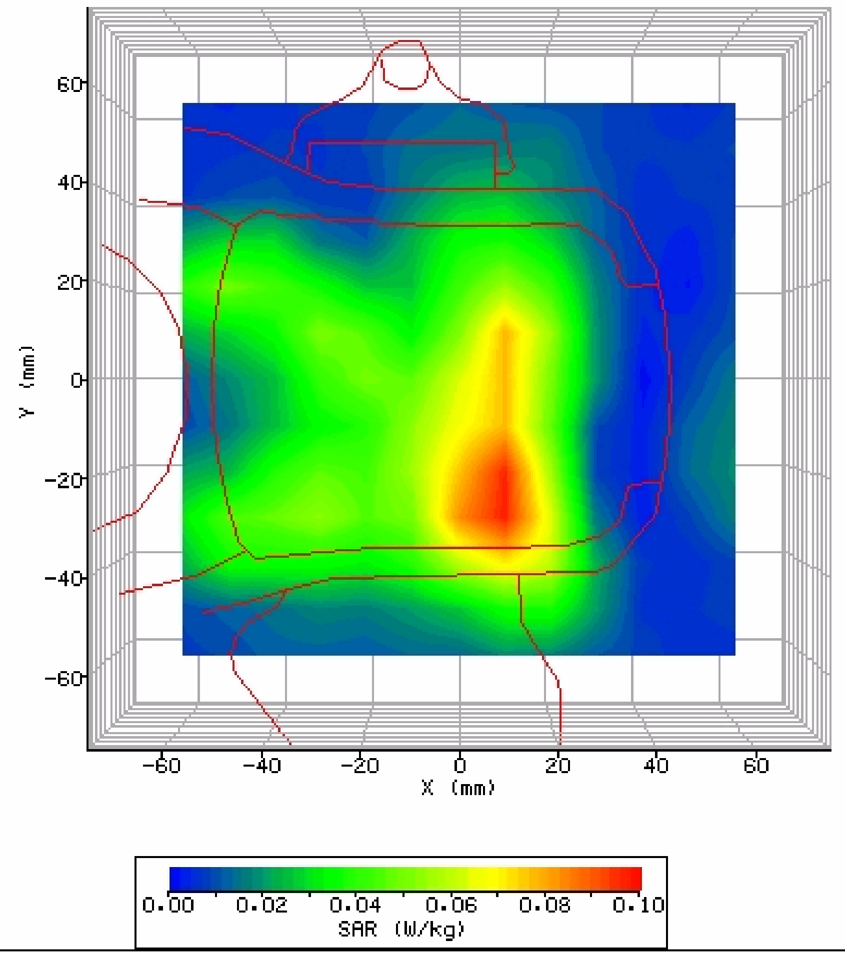


Figure 9: SAR Body Testing Results for the SHL Telemedicine International Ltd Cardio Sen'C ECG Cardiograph (Recorder/Transmitter) in Holster Facing Phantom Position; Tested at 1909.8MHz (1900MHz GSM High Channel) with 0.0mm Separation.

SECTION 3

TEST EQUIPMENT

3.1 TEST EQUIPMENT

The following test equipment was used at TUV Product Service Ltd:

INSTRUMENT DESCRIPTION	MANUFACTURER	MODEL TYPE	TEST EQUIPMENT NO.	CALIBRATION DATES	
Bench-top Robot	Mitsubishi	RV-E2	156	N/A	N/A
Fast Probe Amplifier	IndexSAR Ltd.	IFA-010	1557	N/A	N/A
Side Bench 2	IndexSAR Ltd.	IXM-030	1571	N/A	N/A
Upright Bench 1	IndexSAR Ltd.	SARA2 system	1568	N/A	N/A
SAR Probe	IndexSAR Ltd.	IXP-050	171	19/05/2006	19/05/2007
Radio Communication Tester	Rohde & Schwarz	CMU 200	3035	11/03/2006	11/03/2007
Signal Generator	Hewlett Packard	E4422A	61	02/03/2006	02/03/2007
Power Meter	Rohde & Schwarz	NRVD	3259	06/11/2006	06/11/2007
RF Pre-Amplifier	IndexSAR Ltd.	0.8-3G	2415	N/A	N/A
Bi-Directional Coupler	Indexsar	1850	2414	29/01/2007	29/01/2008
20dB Attenuator	Narda	766F-10	483	01/06/2006	01/06/2007
Hygrometer	Rotronic	I-1000	2783	15/06/2006	15/06/2007
Digital Thermometer	Digitron	T208	64	19/10/2006	19/10/2007
Thermocouple	Rohde & Schwarz	K	65	19/10/2006	19/10/2007
835MHz Body TEM	TUV	Batch 5	N/A	16/02/2007	28/02/2007
835MHz Head TEM	TUV	Batch 11	N/A	16/02/2007	28/02/2007
1900MHz Head TEM	TUV	Batch 2	N/A	16/02/2007	28/02/2007
1900MHz Body TEM	TUV	Batch 3	N/A	16/02/2007	28/02/2007
844.4 MHz Dipole	IndexSAR Ltd.	IEEE1528	N/A	19/02/2007	20/02/2007
1929 MHz Dipole	IndexSAR Ltd.	IEEE1528	N/A	20/02/2007	21/02/2007
Flat Phantom 2mm Side	IndexSAR Ltd.	HeadBox01	1563	N/A	N/A
200mm Cube Box Phantom	IndexSAR Ltd.	IXB-070	1565	N/A	N/A

3.2 TEST SOFTWARE

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

INSTRUMENT	VERSION NO.	DATE
SARA2 system	v.2.39 VPM	06/07/2005
Mitsubishi robot controller firmware revision	RV-E2 Version C9a	-
IFA-10 Probe amplifier	Version 2.5	-

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 EN50361:2001 & OET Bulletin 65 (Edition 97-01).

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 TUV under controlled conditions from the following OET(65)c formulae and 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

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

FLUID TYPE	FREQUENCY	RELATIVE PERMITTIVITY εr (e') TARGET	RELATIVE PERMITTIVITY εr (e') MEASURED	CONDUCTIVITY σ TARGET	CONDUCTIVITY σ MEASURED
HEAD	835 MHz	**41.5**	42.01	**0.90**	0.919
BODY	835 MHz	**55.0**	57.28	**1.05**	0.980
HEAD	1900 MHz	**40.0**	38.83	**1.40**	1.415
BODY	1900 MHz	**53.3**	52.86	**1.52**	1.516

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 22.3°C to 22.6 °C.
The actual Humidity during the testing ranged from 34.5% to 42.1% RH.

TEST FLUID TEMPERATURE RANGE

FREQUENCY (MHZ)	850	835/900	1900	1900
BODY / HEAD FLUID	HEAD	BODY	HEAD	BODY
MIN TEMPERATURE (°C)	22.3	21.3	22.6	21.2
MAX TEMPERATURE (°C)	22.3	21.3	22.6	21.2

SAR DRIFT

The SAR Drift was within acceptable limits during scans. The maximum SAR Drift, drift due to the handset electronics, was recorded as -5.15 (-0.230dB) for all of the testing. The value of 5.15% has been included in the measurement uncertainty budget.

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	15.3	Rectangular	1.73	0.5	0.25	8.83	78.03	19.51
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	5.15	Rectangular	1.73	1	1	2.97	8.84	8.84
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	11.12						**Total**		**123.76**
Expanded uncertainty = **(confidence interval of 95 %)**	**22.25**	**%** (Using a Coverage Factor of K=2)							

SECTION 4

PHOTOGRAPHS

4.1 TEST POSITIONAL PHOTOGRAPHS

OET65(c) FLAT PHANTOM TEST POSITIONS

Figure 10. Positional photograph of the Cardio Sen'C ECG Cardiograph in normal user position, Holster facing 0.0mm spacing from Phantom (850MHz)

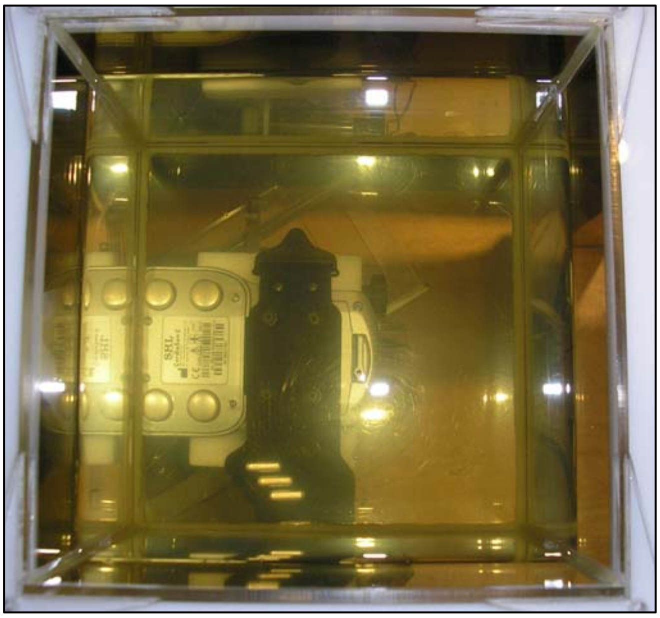


Figure 11. Positional photograph of the Cardio Sen'C ECG Cardiograph in normal user position, Holster facing 0.0mm spacing from Phantom (850MHz)

Figure 12. Positional photograph of the Cardio Sen'C ECG Cardiograph in normal user position, Holster facing 0.0mm spacing from Phantom (1900MHz)

Figure 13. Positional photograph of the Cardio Sen'C ECG Cardiograph in normal user position, Holster facing 0.0mm spacing from Phantom (1900MHz)

4.2 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (EUT)

Figure 14: Front View of the Cardio Sen'C ECG Cardiograph

Figure 15: Front (Opened) View of the Cardio Sen'C ECG Cardiograph

4.2 PHOTOGRAPHS OF EQUIPMENT UNDER TEST (EUT) - Continued

Figure 16: Rear View of the Cardio Sen'C ECG Cardiograph

SECTION 5

ACCREDITATION, DISCLAIMERS AND COPYRIGHT

5.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT

ANNEX A

PROBE 171 (TYPE IXP-050) CALIBRATION INFORMATION

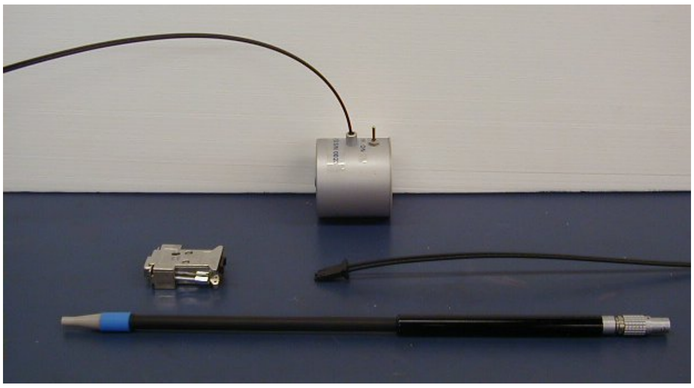
IMMERSIBLE SAR PROBE

CALIBRATION REPORT

Part Number: IXP – 050

S/N 0171

May 2006



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INTRODUCTION

This Report presents measured calibration data for a particular IndexSAR SAR probe (S/N 0171) 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.

CALIBRATION PROCEDURE - Continued

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.

CALIBRATION PROCEDURE - Continued

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:

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

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).

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

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

CALIBRATION PROCEDURE - Continued

4. <u>Determination Of Conversion ("Liquid") Factors At Each Frequency Of Interest</u> - Continued

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. <u>Measurement of Spherical Isotropy</u>

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

CALIBRATION PROCEDURE – Continued

5. Measurement of Spherical Isotropy - Continued

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.

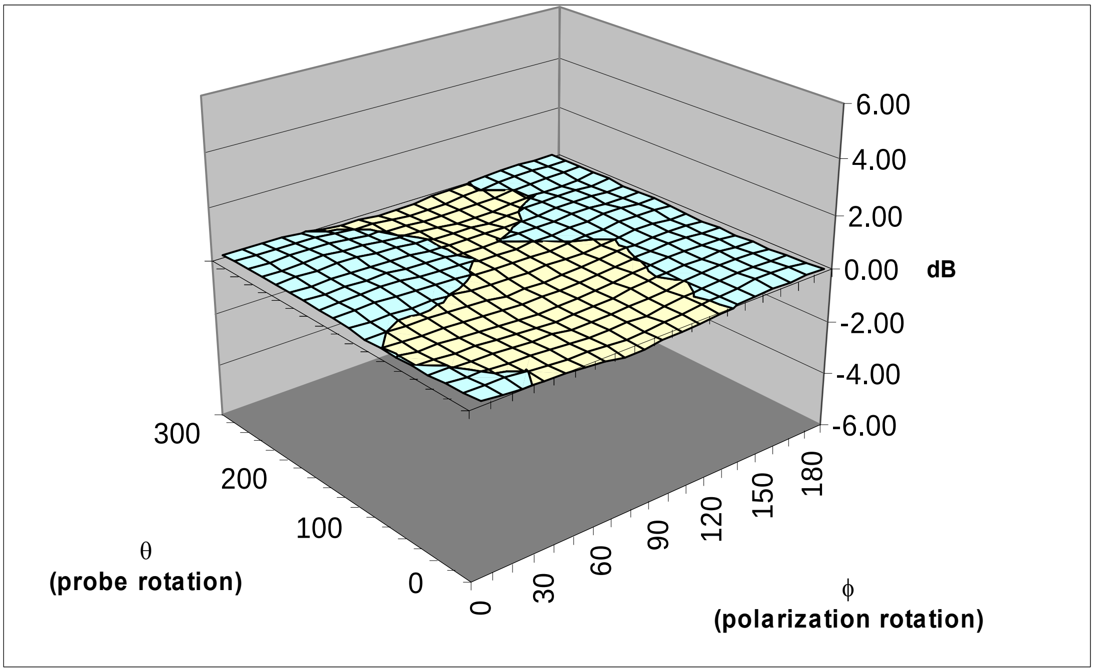
Given the typical dimensions of 3-channel SAR probes presently available, use of the VPM technique extends the satisfactory measurement range to higher frequencies.

CALIBRATION FACTORS MEASURED FOR PROBE S/N 0170

The probe was calibrated at 450, 835, 900, 1800, 1900 and 2450 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 0171 at 900MHz after VPM
(rotational isotropy at side +/-0.05dB, spherical isotropy +/-0.24dB)

Probe tip radius	1.25
X Ch. Angle to red dot	-15

CALIBRATION FACTORS MEASURED FOR PROBE S/N 0170 - Continued

	Head		Body	
Frequency	**Bdy. Corrn. – f(0)**	**Bdy. Corrn. – d(mm)**	**Bdy. Corrn. – f(0)**	**Bdy. Corrn. – d(mm)**
450	-	-	-	-
835	1.21	1.2	1.14	1.3
900	0.96	1.4	1.22	1.2
1800	0.91	1.4	0.83	1.5
1900	0.88	1.4	0.79	1.6
2100	0.81	1.4	0.70	1.7
2450	0.83	1.4	0.62	1.7

SUMMARY OF CALIBRATION FACTORS FOR PROBE IXP-050 S/N 0171

Spherical isotropy measured at 900MHz	0.24	(+/-) dB

	X	Y	Z	
Air Factors	344	473	382	(V*200)
CW DCPs	20	20	20	(V*200)

Freq (MHz)	Axial Isotropy (+/- dB)		SAR ConvF (liq/air)		Notes
	Head	Body	Head	Body	
450	-	-	0.291	0.297	
835	-	-	0.271	0.267	1,2
900	0.05	-	0.278	0.269	1,2
1800	-	-	0.335	0.356	1,2
1900	-	-	0.342	0.368	1,2
2000	-	-	0.354	0.407	1,2
2450	-	-	0.357	0.404	1,2

Notes	
1)	Calibrations done at 22^{o}C +/-2^{o}C
2)	Waveguide calibration

PROBE SPECIFICATIONS

IndexSAR probe 0171, 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 0171	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 0171	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 0171	CENELEC [1]	IEEE [2]
Axial rotation with probe normal to source (+/- dB)	0.05 Max (See table above)	0.5	0.25
Spherical isotropy covering all orientations to source (+/- dB)	0.24	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

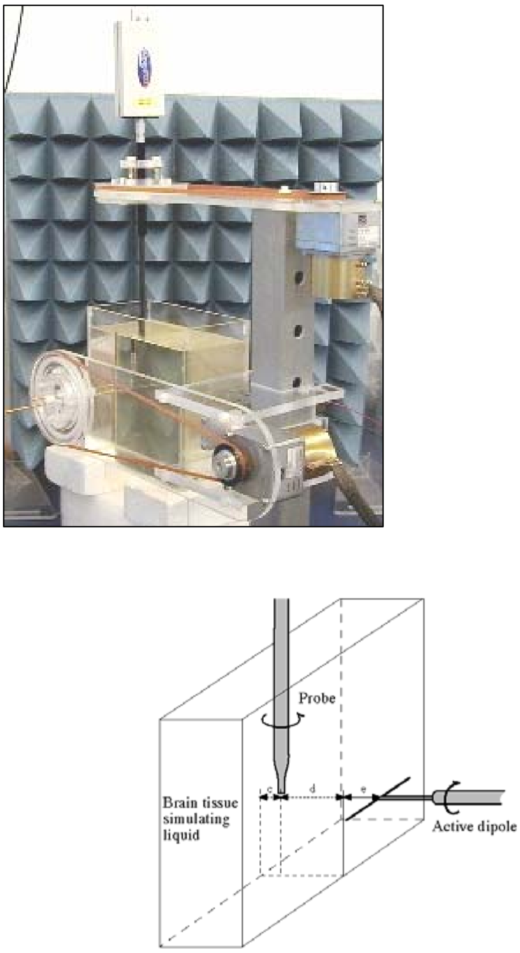


Figure 1. Spherical isotropy jig showing probe, dipole and box filled with simulated brain liquid (see Ref [2], Section A.5.2.1)

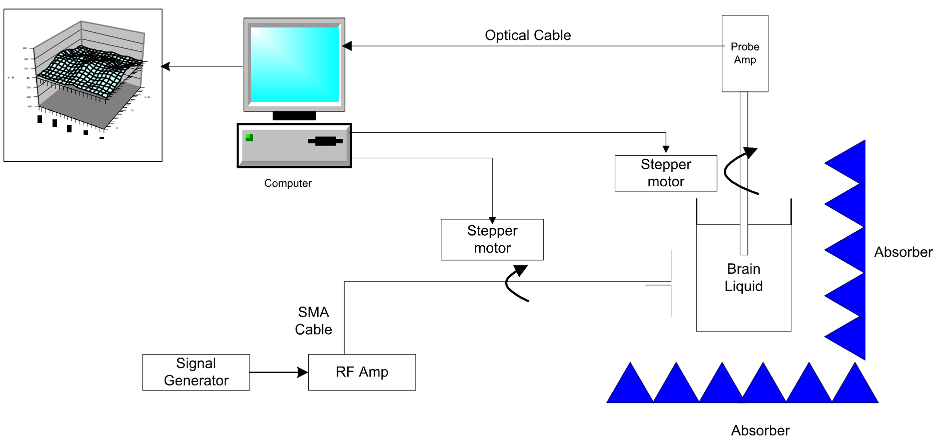


Figure 2. Schematic diagram of the test geometry used for isotropy determination

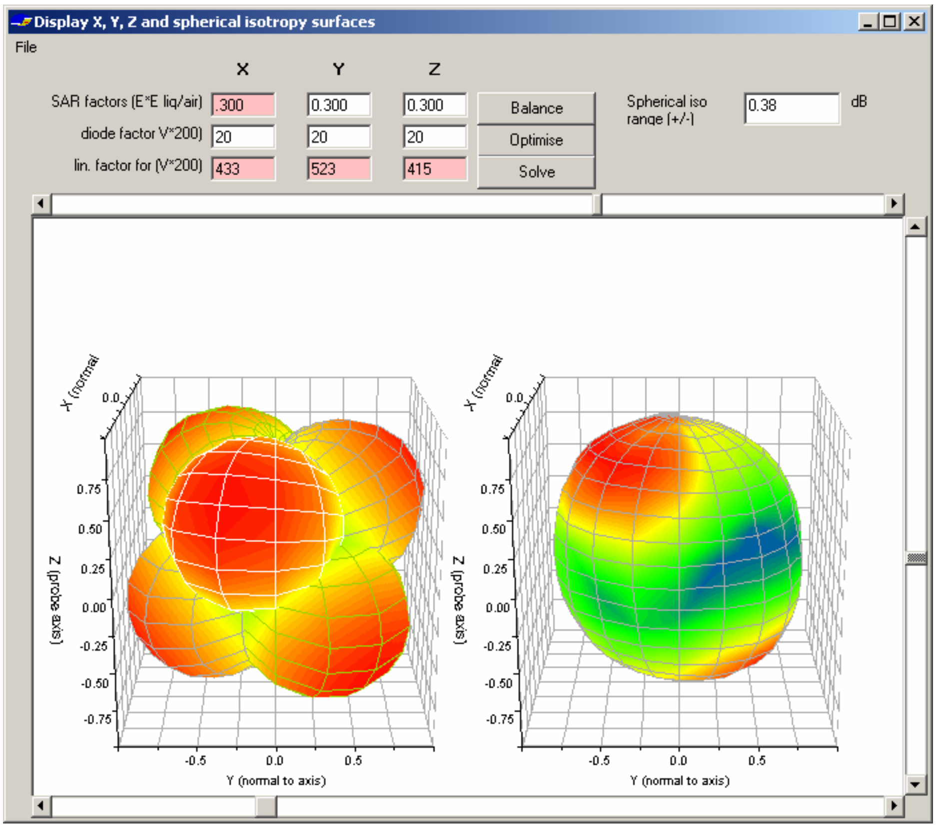


Figure 3. Graphical representation of a probe's response to fields applied from each direction. The diagram on the left shows the individual response characteristics of each of the three channels and the diagram on the right shows the resulting probe sensitivity in each direction. The colour range in the figure images the lowest values as blue and the maximum values as red. For the probe S/N 0171, this range is (+/-) 0.24 dB.

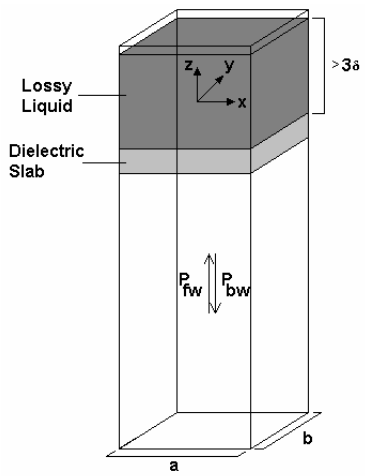
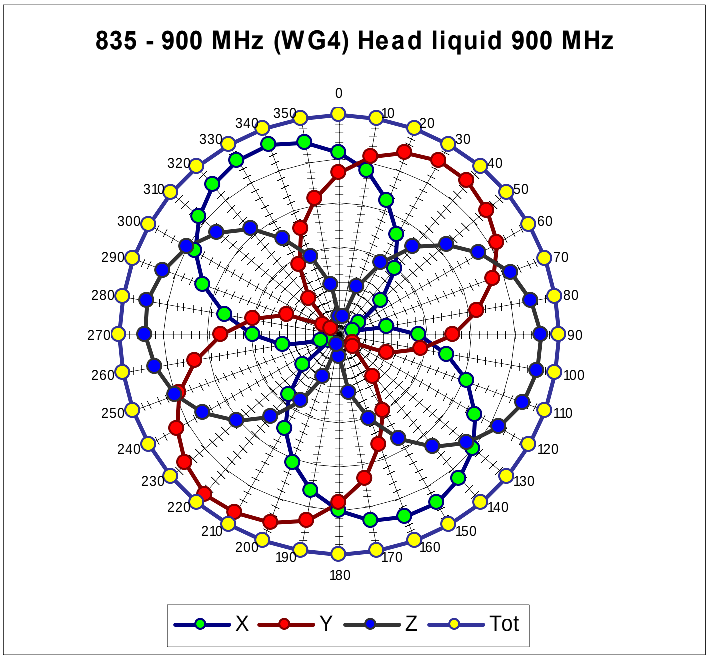


Figure 4. Geometry used for waveguide calibration (after Ref [2]. Section A.3.2.2)



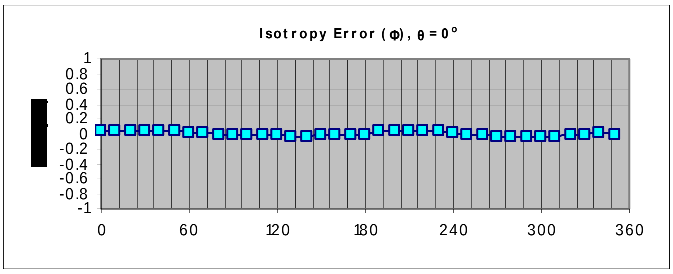


Figure 5. The rotational isotropy of probe S/N 0171 obtained by rotating the probe in a liquid-filled waveguide at 1800 MHz.

SAR DECAY FUNCTION – Analytical and Measurements

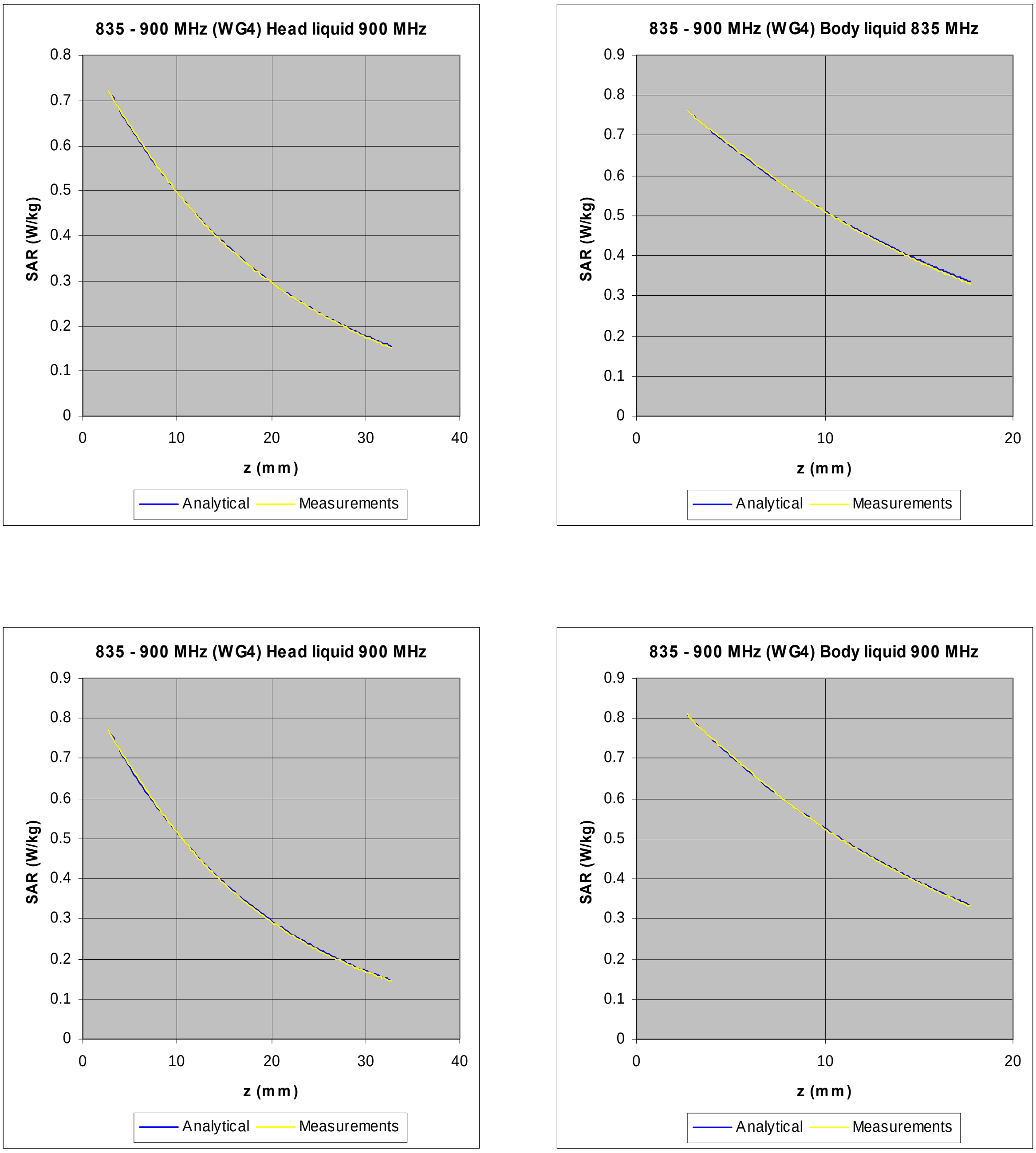


Figure 6a. The measured SAR decay function along the centreline of the WG4 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

SAR DECAY FUNCTION – Analytical and Measurements - Continued

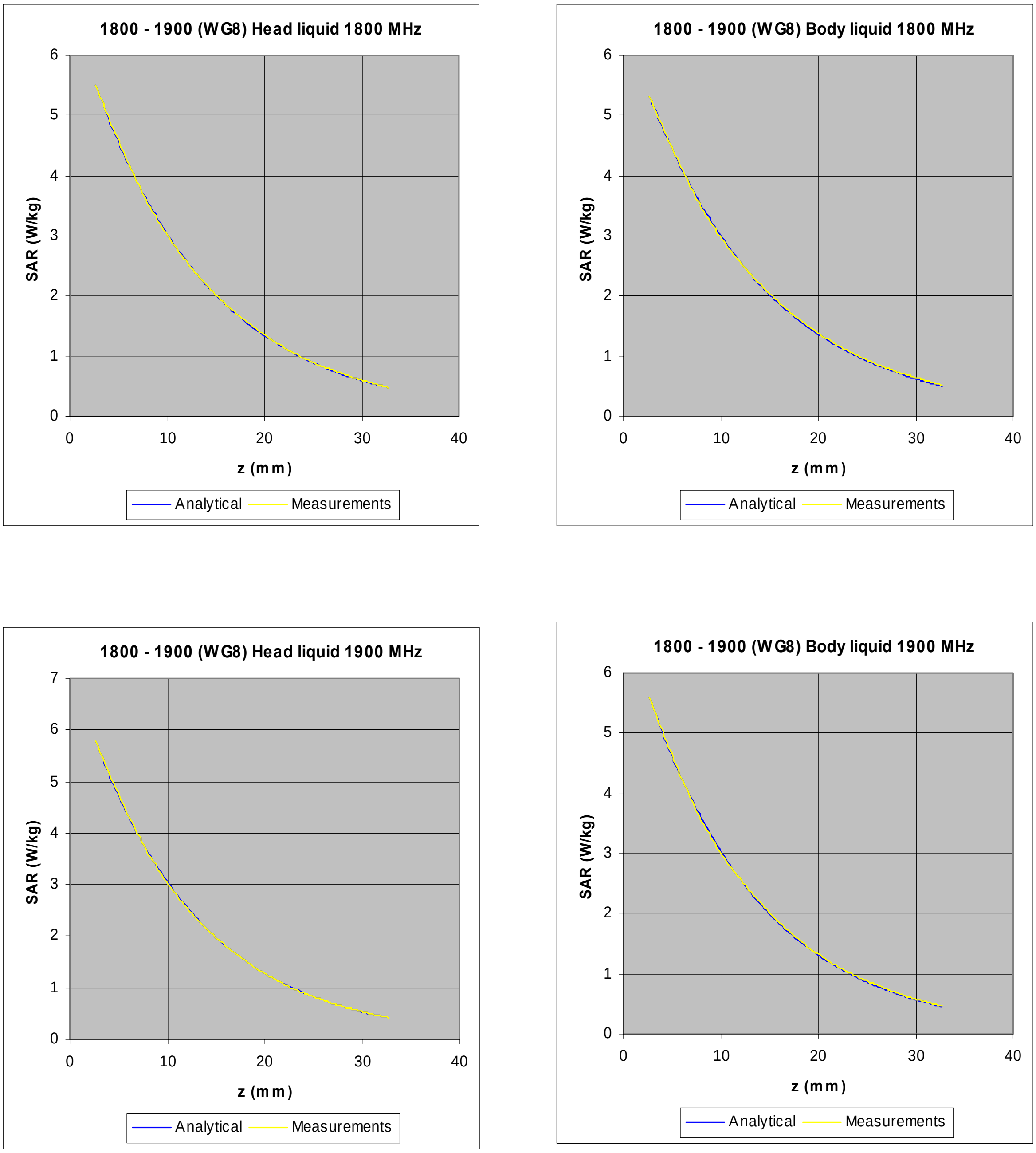
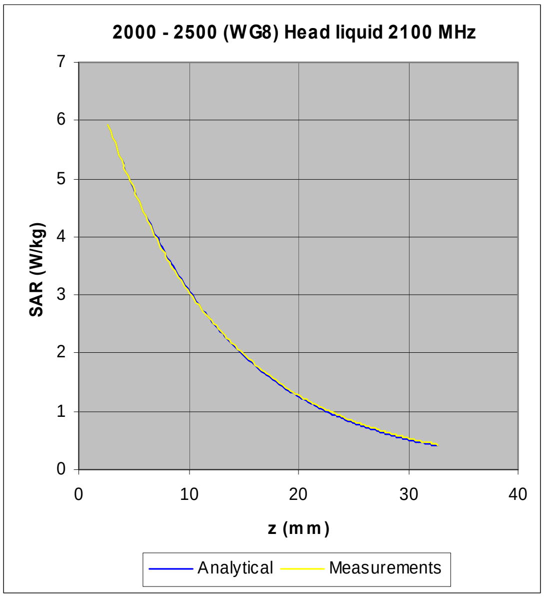
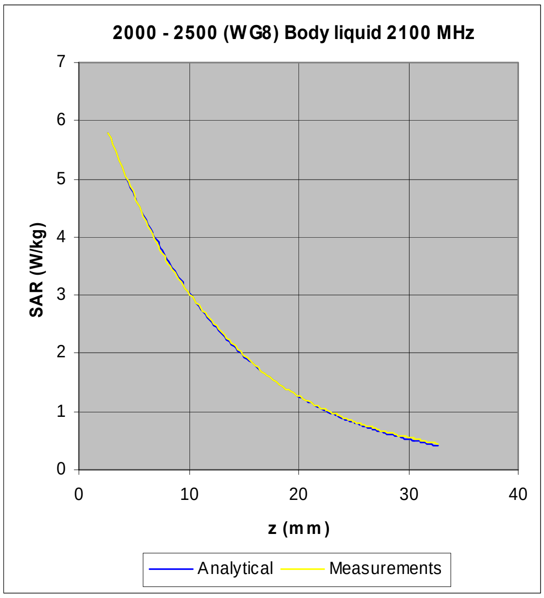
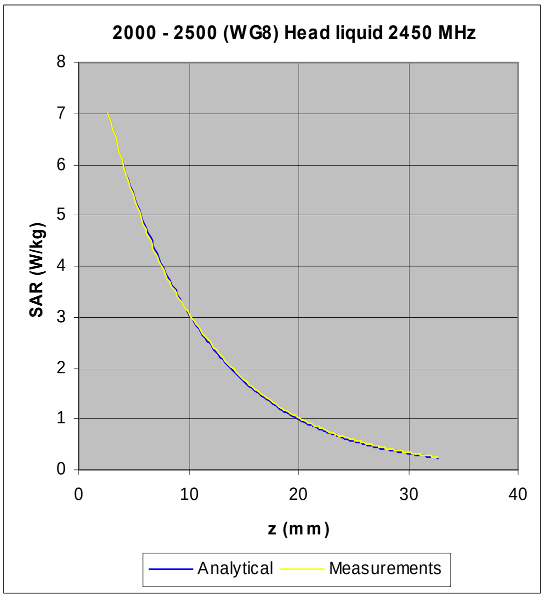


Figure 6b The measured SAR decay function along the centreline of the WG8 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

SAR DECAY FUNCTION – Analytical and Measurements - Continued







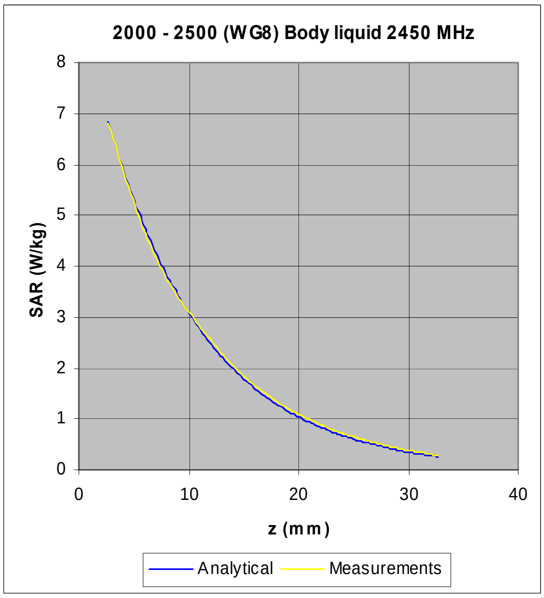


Figure 6c The measured SAR decay function along the centreline of the WG8 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

SAR DECAY FUNCTION – Analytical And Measurements - Continued

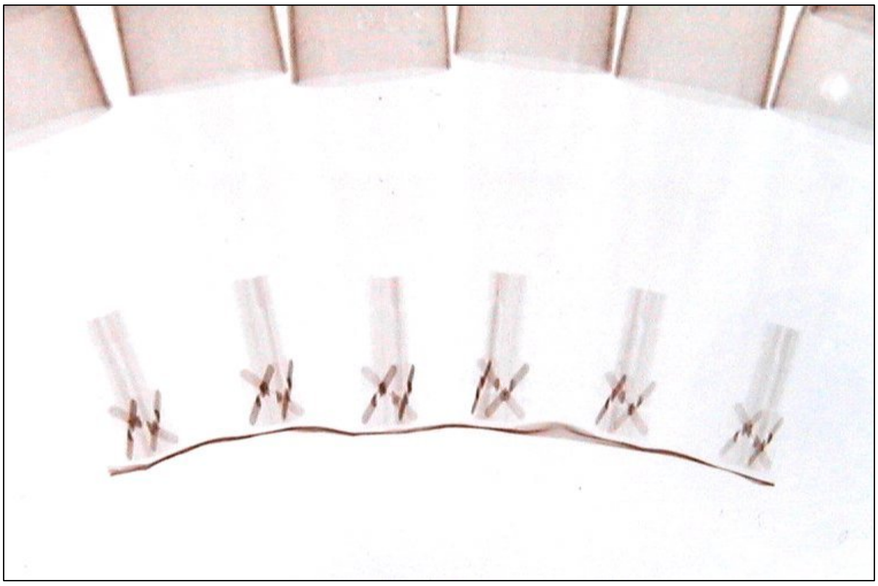


Figure 8: X-ray positive image of 5mm probes

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	*42.05*	*0.91*
835 MHz BODY	*49.30*	*1.05*
900 MHz BRAIN	*40.97*	*0.97*
900 MHz BODY	*48.55*	*1.12*
1800 MHz BRAIN	*38.93*	*1.38*
1800 MHz BODY	*54.32*	*1.56*
1900 MHz BRAIN	*38.50*	*1.47*
1900 MHz BODY	*54.00*	*1.66*
2100 MHz BRAIN	*40.39*	*1.54*
2100 MHz BODY	*53.88*	*1.74*
2450 MHz BRAIN	*39.04*	*1.91*
2450 MHz BODY	*52.83*	*2.13*

ANNEX B

ADDITIONAL INFORMATION
REGARDING THE
INTEGRATION MODULE

TÜV SÜD Product Service

DECLARATION LETTER

SHL Telemedicine International Ltd.

Declaration letter

We, SHL Telemedicine International Ltd.
Ashdar Building, 90 Igal Alon St.
67891 Tel Aviv
Israel

Declares under our sole responsibility the our product:

Type of equipment: ECG Cardiograph (Recorder / Transmitter)
Model name: Cardio Sen`C
FCC ID: U6VCBSENC

Integrates withouth any modification and following the manufacturer instructions the following product:

Grantee name: Telit Communications S.p.A.
Model: GE863-QUAD
FCC ID: R17GE863L

Signed on behalf of SHL Telemedicine International Ltd. by

Name: Mr. Roni Kazaz

Date: July 17th 2007
Place: Tel Aviv, Israel

Signature

July 17th 2007	Page 1 of 1	Declaration letter.doc

TÜV SÜD Product Service

FCC PART 22, PART 24 & PART 15 SIGNATURE PAGE

CETECOM™

CENTRO DE TECNOLOGÍA DE LAS COMUNICACIONES, S.A.
Parque Tecnológico de Andalucía,
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Tel. 952 61 91 00 - Fax 952 61 91 13
MÁLAGA, C.I.F. A29 507 456
Registro Mercantil Tomo 1169 Libro 82
Folio 133 Hoja MA3729

FCC LISTED,
REGISTRATION
NUMBER: 905266

IC LISTED,
REGISTRATION
NUMBER: IC 4621

TEST REPORT

Report No.: 22345RET

TEST NAME: FCC PART 22, PART 24 & PART 15 (Electromagnetic emissions)

Product	:	QUAD-BAND GSM/GPRS MODULE
Trade Mark	:	TELIT
Model/type Ref.	:	GE864-QUAD GE864-PY
Manufacturer	:	TELIT COMMUNICATIONS S.p.A
Requested by	:	TELIT COMMUNICATIONS S.p.A
Other identification of the product	:	FCC ID: RI7GE864 IC: 5131A-GM864
Standard(s)	:	FCC Part 22 & 24 FCC Part 15, Subpart B y C

This test report includes 4 annexes and therefore the total number of pages is 87

Date: 2005-11-29	Test operator M.Pérez/R. López	Revised by:	Approved by: Date: 2005.11.29 Rojas Technical Director	Page: 1 of 10

CETECOM CENTRO DE TECNOLOGÍA DE LAS COMUNICACIONES, S.A.

FDT08_04

TELIT DECLARATIONS OF EQUIVALENCE

Telit Communications S.p.A.

TELIT Communications S.p.A.

Att : To whom may concern

Software and Hardware declaration for GE863-PY variant

We, TELIT Communications S.p.A. declares that software version of the GE863-PY module will be different in comparison with the software version of the GE863-QUAD module.
The improvements introduced with the GE863-PY software version will not have any impact on the essential requirement of the R&TTE directive. These software differences will not affect in anyway to the RF, EMC and SAFETY functionality of the GE863-PY module.

We also declare that the hardware difference of the GE863-PY module in comparison with the hardware of the GE863-QUAD module will not have affect in anyway to the RF, EMC and SAFETY functionality of the GE863-PY module. The schematic, PCB and layout of the GE863-PY module are the same of the GE863-QUAD and the only difference is the memory size of 8Mb instead of 4Mb (same package and same pin_out)

Company: TELIT Communications S.p.A.
Address: Via Stazione di Prosecco 5/b
34010 Sgonico TS
Italy

Date: 04 July 2005

Telit Communications SpA

Name : Sandro Spanghero
Title: Technical director

Signature

Telit Communications S.p.A. - Via Stazione di Prosecco 5/b, Sgonico (TS) 34010 – Tel: 040-4192111 Fax: 040-4192333
Internet: www.telit.com

Product Service

Telit Communications S.p.A.

DECLARATION

We, Telit Communication S.p.A. declare that the devices:

- GE863-GPS

And

- GE863-Quad

Differ only by the fact that in GPS version the GPS receiver and related circuitry are assembled on the printed circuit board, while in Quad version are not. All components, layout and schematics of GSM/GPRS section are the same. Also the software is the same with the exception of a compilation switch that enables or disables the section of AT command and controls related to GPS receiver only.

These changes do not effect on GSM/GPRS performances.

Name: Sandro Spanghero
Title: Telit Communication R&D Director

Date: 02 March 2006

Telit Communications S.p.A. 5/b, Via Stazione di Prosecco, Sgonico (TS) 34010, Italy - Ph: +39(040)4192111 Fax: +39(040)41922333 Website: www.telit.com

Telit Communications S.p.A.

TECHNICAL NOTE

Cod:. 30278NT10744A
Prj.: 0278
Rel.: 0
Date: 03/03/06

GE863-GPS HARDWARE DIFFERENCES DECLARATIONS

Introduction

We, TELIT Communications S.p.A. declares that the new quad-bands GSM 850/900/1800/1900 terminal equipment type GE863-GPS hardware revision 2, is based on the already tested quad-bands GSM 900/1800/1900 terminal equipment type GE864-QAUD hardware revision 1 that should be considered as the ' based model'.

Aim of this document is also that to describe the main hardware differences between the new product GE863-GPS and its based model GE864-QUAD.

List of differences between GE863-GPS HW Rev. 2 and GE864-QUAD Rev. 1

The following main differences between the new GE863-GPS HW Rev.2 and the already tested GE864-QUAD HW Rev. 1 are declared as follows:

Added components:

Added resistor R309 = 560k ohm 0402 5% form pin 3 Q301 to GND
Added resistor R310 = 47k ohm 0402 5% from VCXOEN (PIN 36 U301) to VINT
Added C414 = 33pF.

Related to GPS functionality all page 5 of the schematic is added (this part doesn't affect the functionality of the GSM part)

Other Changes:

U101 = uP PMB7860 V 1.1D	Has to be U101 IC uP PMB7860 V 1.1K
Resistor R407 WAS 3.3k ohm	Has to be 3.3k ohm NO MOUNT
U401 was version A1 ;	Has to be Ver 1.1
L409 =27 nH was NOT mounted,	Has to be MOUNTED.
C413 = 100pF was NOT mounted,	Has to be MOUNTED.
L416 was connected between pin 10 U402 and VBATT,	Has to be connected between pin 10 U402 and pin 9 U402

The PCB used on GE863-GPS HW Rev 2 is called CS1186A

Company: TELIT Communications S.p.A.
Address: Via Stazione di Prosecco 5/b
34010 Sgonico TS
Italy

Date: 03 March 2006

Telit Communications SpA

Name : Sandro Spanghero
Title: Technical director

Signature