Specific Absorption Rate (SAR) Test Report

for

CyraCom International

on the

2.4GHz EDCT CORDLESS PHONE

Model Number: VT-802C

Test Report: EME-071194
Date of Report: Dec. 14, 2007
Date of test: Dec. 10, 2007

Total No of Pages Contained in this Report: 102

Testing Laboratory
0597

Accredited for testing to FCC Part 15

Tested by: Jimmie Liu	Jimmie Liu
Reviewed by: Kevin Chen	Kevin Chen

Review Date: Dec. 17, 2007

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STATEMENT OF COMPLIANCE

The VT-802C handset supplied for Specific Absorption Rate (SAR) testing is a signal band GFSK 2450 device.

The 2.4GHz EDCT CORDLESS PHONE sample device, model # VT-802C was evaluated in accordance with the requirements for compliance testing defined in FCC OET Bulletin 65, Supplement C (Edition 01-01). Testing was performed at the Intertek Testing Services facility in Hsinchu, Taiwan.

For the evaluation, the dosimetric assessment system INDEXSAR SARA2 was used. The phantom employed was the head Specific Anthropomorphic Mannequin (SAM) phantom and the box phantom of 2mm thick in one wall. The total uncertainty for the evaluation of the spatial peak SAR values averaged over a cube of 1g tissue mass had been assessed for this system to be ±20.6%.

SAR testing was performed at both the left and right ear of the phantom at the two-handset positions stated in the specification. Testing was performed at the middle frequency of 2450 band and at the top and the bottom frequencies with a fully charged battery. The sequence used accorded with the block diagram of tests given in section 1.3. The VT-802C had a dipole antenna so that the requirement for testing with antenna extended and retracted was not applicable. The VT-802C was tested in operation mode, which provided by client.

Any accessories supplied with VT-802C have also been tested.

The device was tested at their maximum output power declared by the CyraCom International.

In summary, the maximum spatial peak SAR value for the sample device averaged over 1g was found to be:

Phantom	Worst Case Position	SAR_{1g}, W/kg
Head Specific Anthropomorphic Mannequin (SAM) phantom	EUT (w/o keyprees) left tilt to the phantom.	0.094 W/kg
2mm thick box phantom wall	Separating the box Phantom 0 mm in rear position from Eut (w/o keyprees).	0.030 W/kg

In conclusion, the tested Sample device was found to be in compliance with the requirements defined in OET Bulletin 65, Supplement C (Edition 01-01) for head and body configurations.

1.0 Job Description

1.1 Client Information

The 2.4GHz EDCT CORDLESS PHONE has been tested at the request of:

Company: CyraCom International
5780 N. Swan Rd., Tucson, AZ 85718 USA

1.2 Equipment under test (EUT)

Product Descriptions:

Equipment	2.4GHz EDCT CORDLESS PHONE		
Trade Name	ClearLink® Cordless	**Model No.**	VT-802C
FCC ID	VSWVT-802C	**S/N No.**	Not Labeled
Category	Portable	**RF Exposure**	Uncontrolled Environment
Frequency Band	2401.808203MHz to 2479.398926MHz	**System / Power Level**	GFSK, FHSS

EUT Antenna Description			
Type	Dipole	**Configuration**	Fixed
Dimensions	45 mm length	**Gain**	2dBi
Location	Embedded		

Use of product: **Mobile Phone Communication**

Manufacturer: LOLI PRECISION INDUSTRY CO. LTD

Production is planned: [X] Yes, [ ] No

EUT receive date: Nov. 22, 2007

EUT received condition: Good operating condition prototype

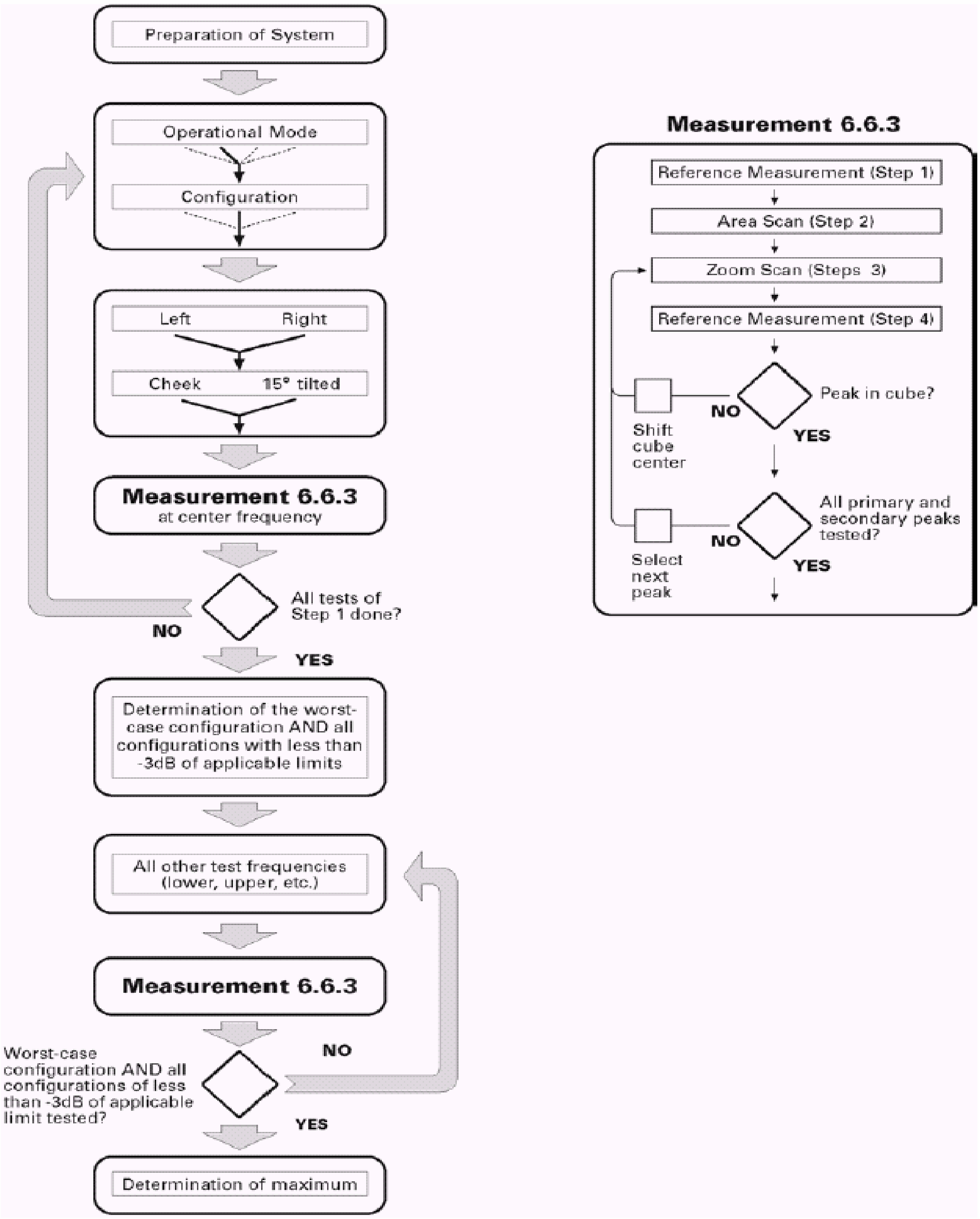
Test start date: Dec. 10, 2007

Test end date: Dec. 10, 2007

1.3 Test plan reference

FCC Rule: Part 2.1093, FCC's OET Bulletin 65, Supplement C (Edition 01-01) and IEEE 1528.

Block Diagram of the Recommended Practices and Procedures



1.4 System test configuration

1.4.1 System block diagram & Support equipment

Support Equipment			
Item #	**Equipment**	**Model No.**	**S/N**
1	N/A	N/A	N/A

(with keypress)

(without keypress)

1.4.2 Test Position

See the photographs as section 2.2

1.4.3 Test Condition

During tests the worst-case data (max RF coupling) was determined with following conditions:

Handset with keypress

Usage	Operates with a built-in test mode by client	**Distance between antenna axis at the joint and the liquid surface:**	EUT is touching and tilting the Head Phantom in right and left position, separating the Body Phantom 15 mm in front and rear position from EUT.	
Simulating human Head / Body	Head and Body	**EUT Battery**	Fully-charged with 1 batteries	
Max. conducted Output power	**Channel (DSST System)**	**Frequency MHz**	**Before SAR Test (dBm)**	**After SAR Test (dBm)**
	Low Channel	2401.808	19.12	19.13
	Mid Channel	2440.157	18.92	18.93
	High Channel	2479.399	18.95	18.96

Handset without keypress

Usage	Operates with a built-in test mode by client	**Distance between antenna axis at the joint and the liquid surface:**	EUT is touching and tilting the Head Phantom in right and left position, separating the Body Phantom 15 mm in front and rear position from EUT.	
Simulating human Head / Body	Head and Body	**EUT Battery**	Fully-charged with 1 batteries	
Max. conducted Output power	**Channel (DSST System)**	**Frequency MHz**	**Before SAR Test (dBm)**	**After SAR Test (dBm)**
	Low Channel	2401.808	19.15	19.16
	Mid Channel	2440.157	18.96	18.97
	High Channel	2479.399	18.94	18.95

The spatial peak SAR values were assessed for lowest, middle and highest operating channels, defined by the manufacturer.

The EUT was transmitted continuously during the test.

The EUT is a 2.4GHz EDCT CORDLESS PHONE which contains of main, secondary handset unit and base unit. The main and secondary handsets are identical in electrical, mechanical and physical design. The difference was in keypress only. Intertek verified the main and secondary handset, the final test was executed under worst condition than recorded the data in this report.

1.5 Modifications required for compliance

Intertek Testing Services implemented no modifications.

1.6 Additions, deviations and exclusions from standards

The phantom employed was the upright head phantom and the box phantom of 2mm thick in vertical wall.

2.0 SAR Evaluation

2.1 SAR Limits

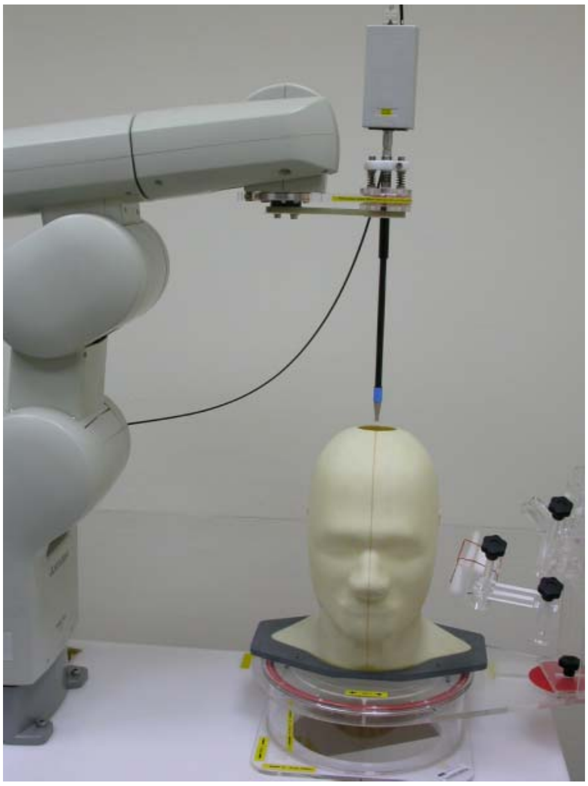
The following FCC limits for SAR apply to devices operate in General Population/Uncontrolled Exposure environment:

EXPOSURE (General Population/Uncontrolled Exposure environment)	**SAR (W/kg)**
Average over the whole body	0.08
Spatial Peak (1g)	1.60
Spatial Peak for hands, wrists, feet and ankles (10g)	4.00

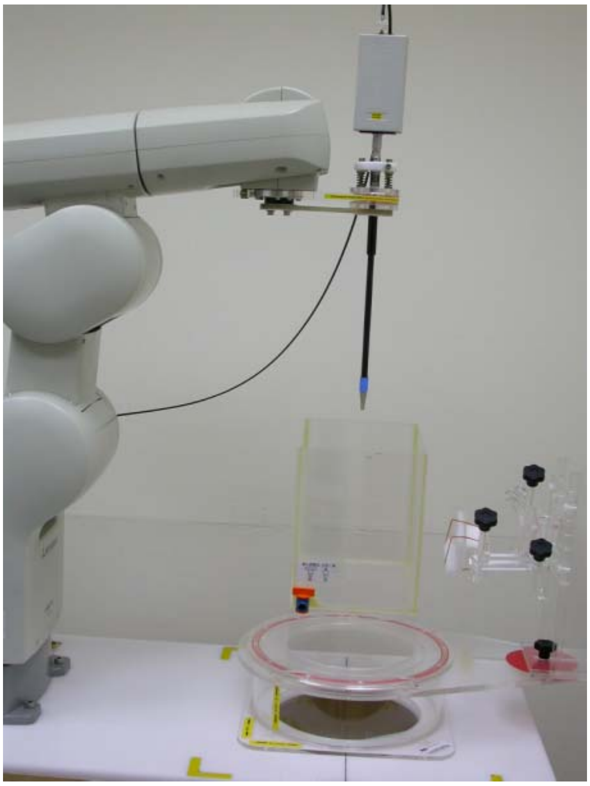
2.2 Configuration Photographs

SAR Measurement Test Setup

Test System



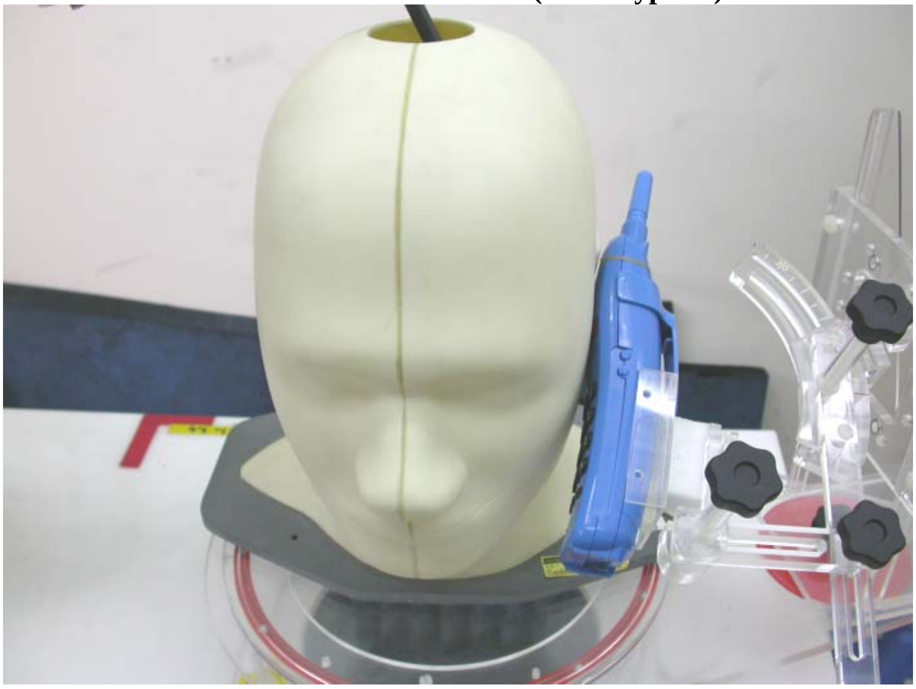
Specific Anthropomorphic Mannequin (SAM) Head Phantom



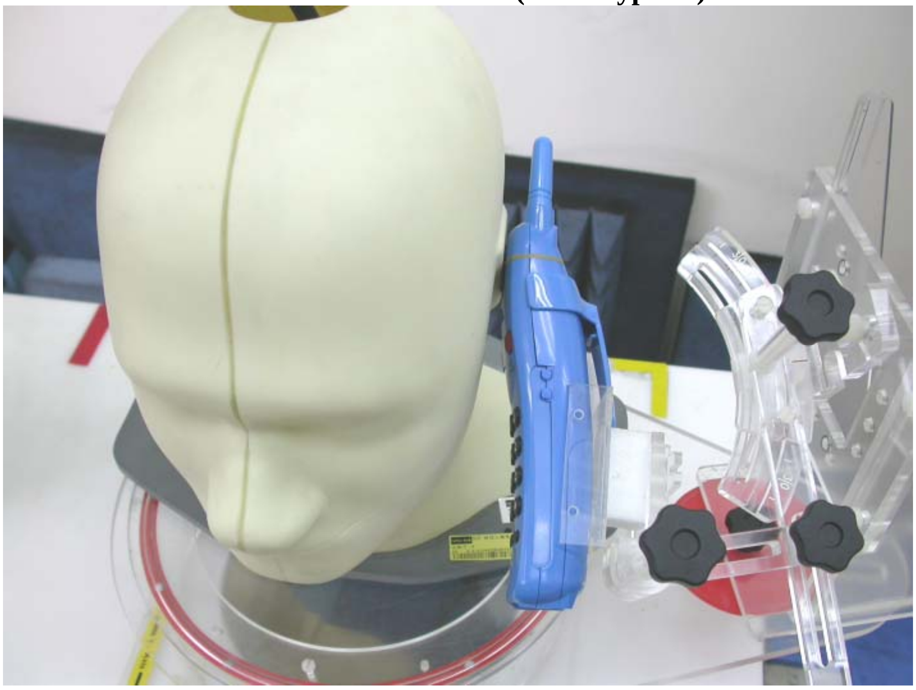
Flat Phantom

Test System: Head Simulator

SAR Measurement Test Setup
Cheek Position of Left Ear (with keypress)



Tilt Position of Left Ear (with keypress)

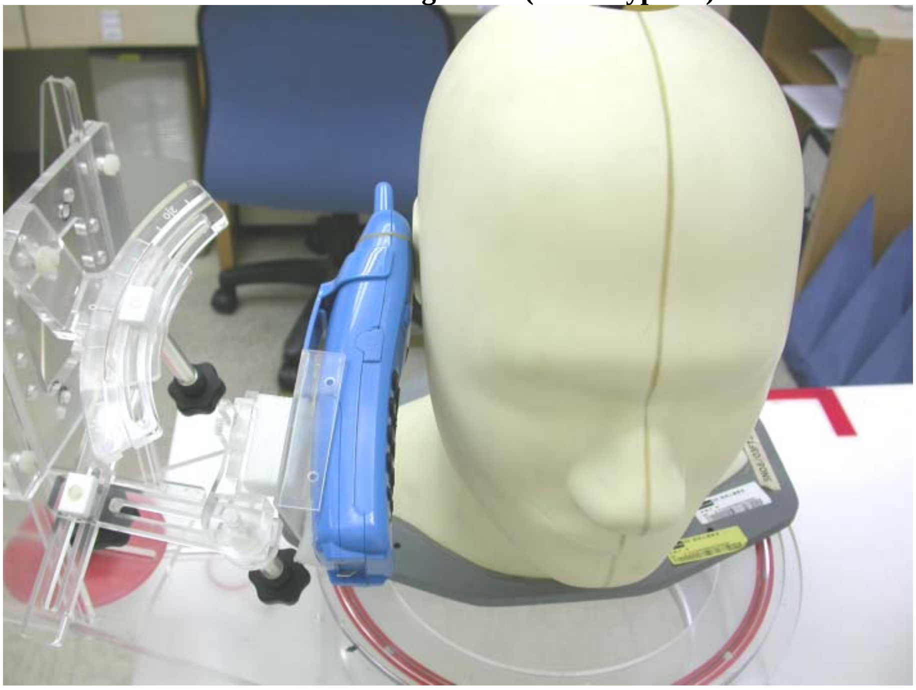


Cheek Position of Left Ear (without keypress)

Tilt Position of Left Ear (without keypress)

SAR Measurement Test Setup
Cheek Position of Right Ear (with keypress)

Tilt Position of Right Ear (with keypress)

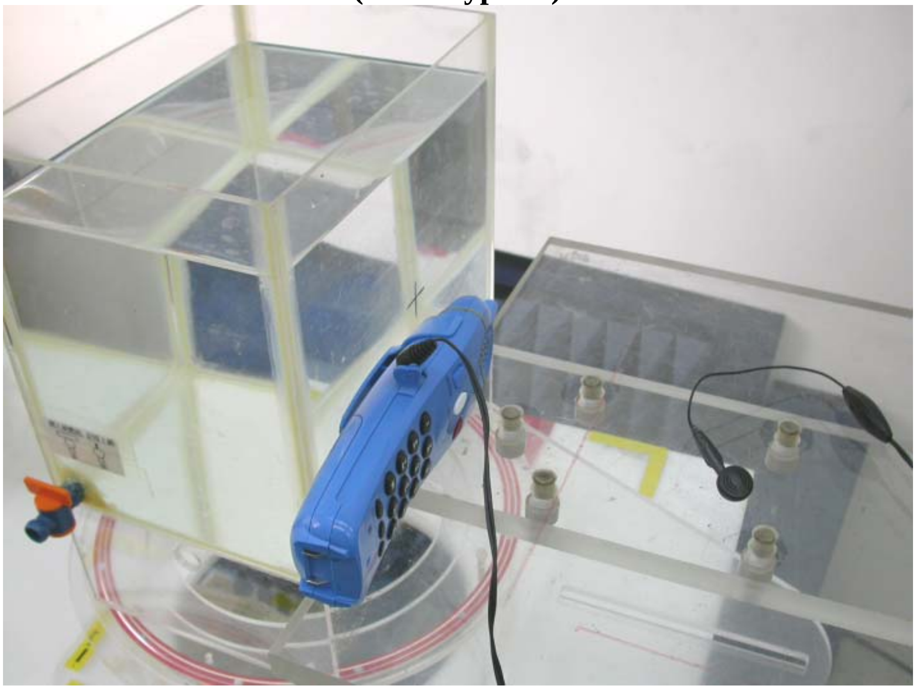


Cheek Position of Right Ear (without keypress)

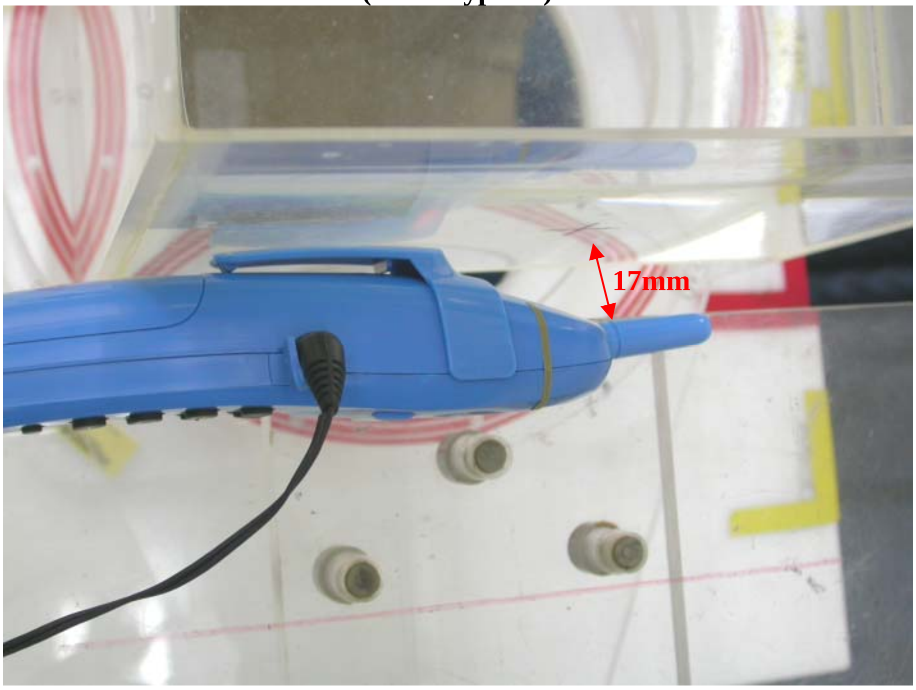
Tilt Position of Right Ear (without keypress)

Test System: Body Simulator

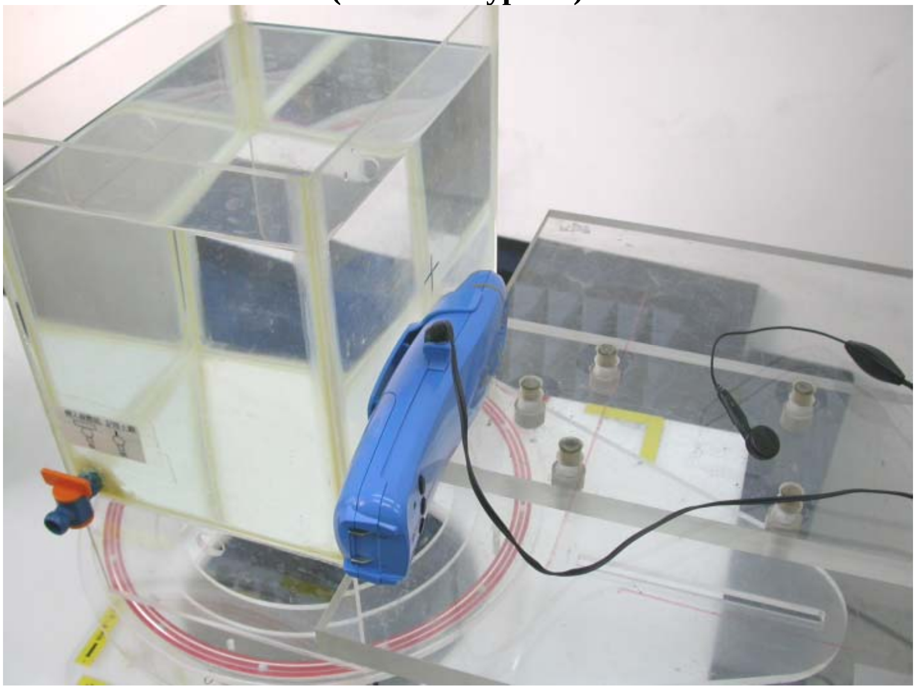
SAR Measurement Test Setup
EUT rear to phantom, 0 mm separation
(with keypress)



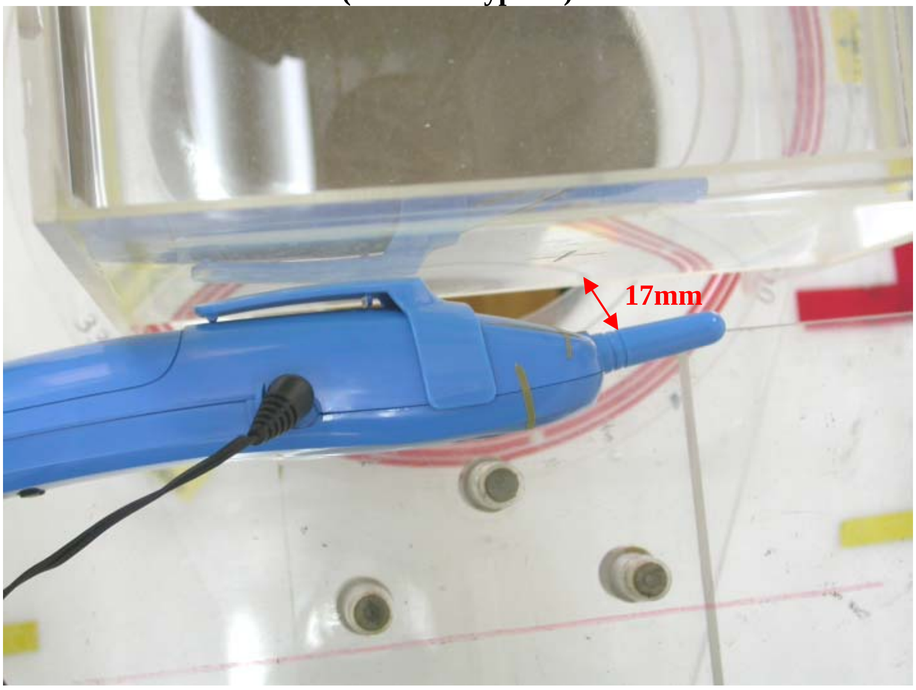
EUT rear to phantom, 0 mm separation – Zoom In
(with keypress)



SAR Measurement Test Setup
EUT rear to phantom, 0 mm separation
(without keypress)



EUT rear to phantom, 0 mm separation – Zoom In
(without keypress)



2.3 SAR measurement system

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, amplifier and the phantom with Head or Box Shape. The robot is used to articulate the probe to programmed positions inside the phantom head to obtain the SAR readings from the DUT.

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

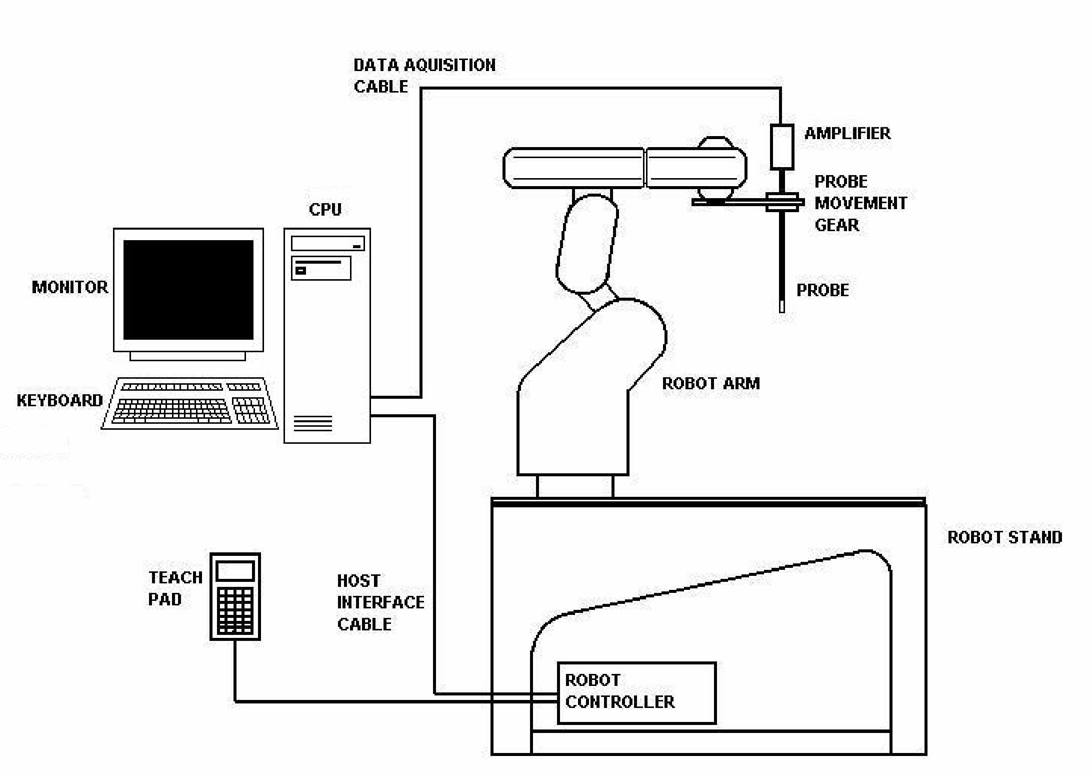


Figure 1: Schematic diagram of the SAR measurement system

The position and digitized 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 digitized using a Mitutoyo CMM machine to a precision of 0.02mm. 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. The first 2 measurements points in a direction perpendicular to the surface of the phantom during the zoom scan and closest to the phantom surface, were only 3.5mm and the probe is kept at greater than half a diameter from the surface.

2.4 SAR measurement system validation

Routine record keeping procedures should be established for tracking the calibration and performance of SAR measurement system. When SAR measurements are performed, the entire measurement system should be checked daily within the device transmitting frequency ranges to verify system accuracy. A flat phantom irradiated by a half-wavelength dipole is typically used to verify the measurement accuracy of a system. When a radiating source is not available at the operating frequency range of the test device to verify system accuracy, a source operating within 100 MHz of the mid-band channel of each operating mode may be used. The measured one-gram SAR should be within 10% of the expected target values specified for the specific phantom and RF source used in the system verification measurement.

Procedures

The SAR evaluation was performed with the following procedures:

a. The SAR distribution was measured at the exposed side of the bottom of the box phantom and was measured at a distance of 15 mm for 300 ~ 1000 MHz and 10 mm for 1000 ~ 3000 MHz from the inner surface of the shell. The feed power was 1/5W.

b. The dimension for this cube is 32 mm x 32 mm x 34 mm was assessed by measuring 5 x 5 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure:

   i) The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measurement point is 5 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in Z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

   ii) The maximum interpolated value was searched with a straightforward algorithm. Around this maximum, the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3-D spline interpolation algorithm. The 3-D spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y and z directions). The volume was integrated with the trapezoidal algorithm. 1000 points (10 x 10 x 10) were interpolated to calculate the average.

   iii) All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

c. Re-measurements of the SAR value at the same location as in step a. above. If the value changed by more than 5 %, the evaluation was repeated.

d. The test scan procedure for system validation also apply to the general scan procedure except for the set-up position. For general scan, the EUT was placed at the side of phantom. For validation scan, the dipole antenna was placed at the bottom of phantom

2.4.1 System Validation results

System validation check (2450 MHz Head and Body)				
Frequency MHz	**Operating Mode**	**Target SAR_{1g} (mW/g)**	**Measured SAR_{1g} (mW/g)**	**Deviation** (±10%)
2450 (Head)	CW	52.4	51.43	-1.85
2450 (Body)	CW	52.4	50.45	-3.72

Please see the plot below.

Date:	2007/12/09	**Position:**	Bottom of the phantom
Filename:	2450Hper. check.txt	**Phantom:**	HeadBox1-val..csv
Device Tested:	2450 validation	**Head Rotation:**	0
Antenna:	2450 Dipole	**Test Frequency:**	2450 MHz
Shape File:	none.csv	**Power Level:**	23 dBm

Probe: 0146
Cal File: SN0146_2450_CW_HEAD

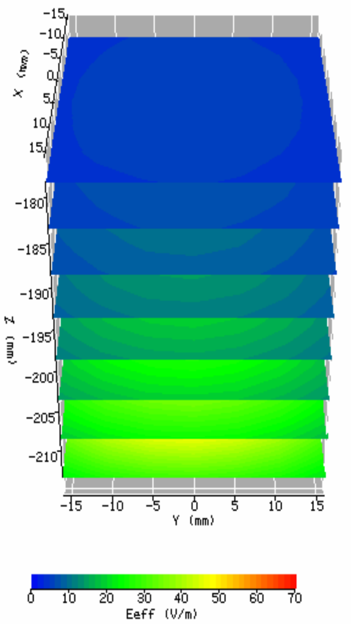
Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain: 2
Averaging: 1
Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	24
Ambient Temp (deg C):	24
Ambient RH (%):	55
Density (kg/m3):	1000
Software Version:	2.41VPM

Crest Factor=1



ZOOM SCAN RESULTS:

Spot SAR (W/kg):	**Start Scan**	**End Scan**
	0.631	0.620

Change during Scan (%) -1..68

Max E-field (V/m): 64.62

Max SAR (W/kg)	**1g**	**10g**
	10.286	4.770

Location of Max (mm):	**X**	**Y**	**Z**
	-1.3	-1.3	-221.4

Normalized to an input power of 1W
Averaged over 1 cm^3 (1g) of tissue
51.43W/kg

Date:	2007/12/09	**Position:**	Bottom of the phantom
Filename:	2450Bper. check.txt	**Phantom:**	HeadBox1-val..csv
Device Tested:	2450 validation	**Head Rotation:**	0
Antenna:	2450 Dipole	**Test Frequency:**	2450 MHz
Shape File:	none.csv	**Power Level:**	23 dBm

Probe: 0146
Cal File: SN0146_2450_CW_BODY

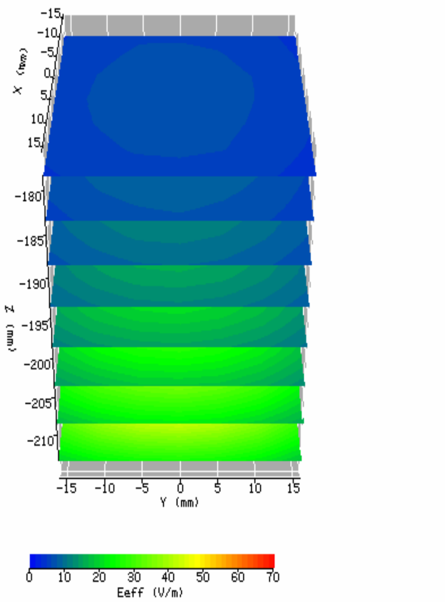
Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.538	.538	.538

Amp Gain: 2
Averaging: 1
Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Body
Conductivity:	1.9361
Relative Permittivity:	52.939
Liquid Temp (deg C):	24
Ambient Temp (deg C):	24
Ambient RH (%):	55
Density (kg/m3):	1000
Software Version:	2.41VPM

Crest Factor=1



ZOOM SCAN RESULTS:

	Start Scan	End Scan
Spot SAR (W/kg):	0.828	0.836

Change during Scan (%) 0.99

Max E-field (V/m): 63.69

	1g	10g
Max SAR (W/kg)	10.090	4.758

	X	Y	Z
Location of Max (mm):	-1.3	-1.3	-221.4

Normalized to an input power of 1W
Averaged over 1 cm^3 (1g) of tissue
50.45W/kg

2.4.2 System Performance Check results

System performance check (2450 MHz Head and Body)				
Frequency MHz	**Operating Mode**	**Target SAR_{1g} (mW/g)**	**Measured SAR_{1g} (mW/g)**	**Deviation (±10%)**
2450 (Head)	CW	52.4	51.43	-1.85
2450 (Body)	CW	52.4	50.45	-3.72

Please see the plot below:

Date:	2007/12/09	**Position:**	Bottom of the phantom
Filename:	2450Hper. check.txt	**Phantom:**	HeadBox1-val..csv
Device Tested:	2450 validation	**Head Rotation:**	0
Antenna:	2450 Dipole	**Test Frequency:**	2450 MHz
Shape File:	none.csv	**Power Level:**	23 dBm

Probe: 0146

Cal File: SN0146_2450_CW_HEAD

Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

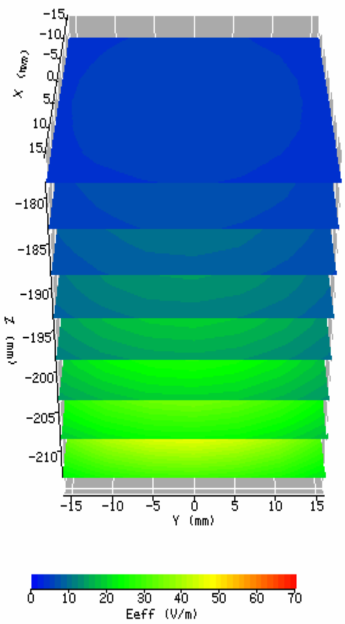
Amp Gain: 2

Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	24
Ambient Temp (deg C):	24
Ambient RH (%):	55
Density (kg/m3):	1000
Software Version:	2.41VPM

Crest Factor=1



ZOOM SCAN RESULTS:

Spot SAR (W/kg):	**Start Scan**	**End Scan**
	0.631	0.620

Change during Scan (%) -1..68

Max E-field (V/m): 64.62

Max SAR (W/kg)	**1g**	**10g**
	10.286	4.770

Location of Max (mm):	**X**	**Y**	**Z**
	-1.3	-1.3	-221.4

Normalized to an input power of 1W
Averaged over 1 cm^3 (1g) of tissue
51.43W/kg

Date:	2007/12/09	**Position:**	Bottom of the phantom
Filename:	2450Bper. check.txt	**Phantom:**	HeadBox1-val..csv
Device Tested:	2450 validation	**Head Rotation:**	0
Antenna:	2450 Dipole	**Test Frequency:**	2450 MHz
Shape File:	none.csv	**Power Level:**	23 dBm

Probe: 0146
Cal File: SN0146_2450_CW_BODY

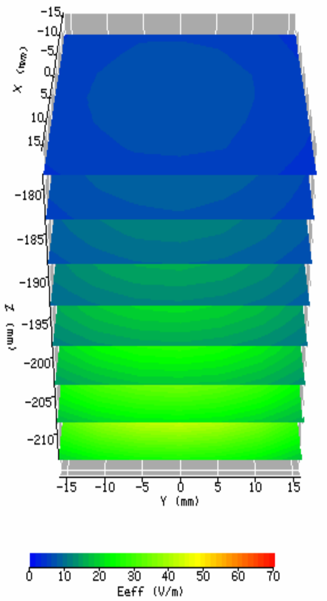
Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.538	.538	.538

Amp Gain: 2
Averaging: 1
Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Body
Conductivity:	1.9361
Relative Permittivity:	52.939
Liquid Temp (deg C):	24
Ambient Temp (deg C):	24
Ambient RH (%):	55
Density (kg/m3):	1000
Software Version:	2.41VPM

Crest Factor=1



ZOOM SCAN RESULTS:

	Start Scan	End Scan
Spot SAR (W/kg):	0.828	0.836
Change during Scan (%)	0.99	
Max E-field (V/m):	63.69	

	1g	10g
Max SAR (W/kg)	10.090	4.758

	X	Y	Z
Location of Max (mm):	-1.3	-1.3	-221.4

Normalized to an input power of 1W
Averaged over 1 cm^3 (1g) of tissue
50.45W/kg

2.5 Test Results

The results on the following page(s) were obtained when the device was tested in the condition described in this report. Detailed measurement data and plots, which reveal information about the location of the maximum SAR with respect to the device, are reported in Appendix A.

Measurement Results

Trade Name:	ClearLink® Cordless	**Model No.:**	VT-802C
Serial No.:	Not Labled	**Test Engineer:**	Jimmie Chen
TEST CONDITIONS			
Ambient Temperature	23 °C	**Relative Humidity**	55~56 %
Test Signal Source	Test Mode	**Signal Modulation**	GFSK
Output power Before SAR Test	See page 7	**Output power After SAR Test**	See page 7
Test Duration	23 min. each scan	**Number of Battery Change**	Fully Charged battery for every Scan

Head Evaluation
Handset with keypress

EUT Position						
Channel (MHz)	**Operating Mode**	**Crest Factor**	**Description**	**Degree / Distance**	**Measured SAR_{1g} (W/kg)**	**Plot Number**
2440.157	GFSK	1	Left cheek	0°	0.064	1
2440.157	GFSK	1	Left tilt	15°	0.082	2
2440.157	GFSK	1	Right cheek	0°	0.044	3
2440.157	GFSK	1	Right tilt	15°	0.051	4
2401.808	GFSK	1	Left tilt	15°	0.081	5
2479.399	GFSK	1	Left tilt	15°	0.076	6

Handset without keypress

EUT Position						
Channel (MHz)	**Operating Mode**	**Crest Factor**	**Description**	**Degree / Distance**	**Measured SAR_{1g} (W/kg)**	**Plot Number**
2440.157	GFSK	1	Left cheek	0°	0.068	7
2440.157	GFSK	1	Left tilt	15°	0.089	8
2440.157	GFSK	1	Right cheek	0°	0.042	9
2440.157	GFSK	1	Right tilt	15°	0.051	10
2401.808	GFSK	1	Left tilt	15°	0.094	11
2479.399	GFSK	1	Left tilt	15°	0.081	12

Note: Configuration middle channel with more than -3 of applicable limit.

Body Evaluation
Handset with keypress

EUT Position						
Channel (MHz)	**Operating Mode**	**Crest Factor**	**Description**	**Degree / Distance**	**Measured SAR_{1g} (W/kg)**	**Plot Number**
2401.808	GFSK	1	Rear side 0 mm to phantom	0 mm	0.027	13
2440.157	GFSK	1	Rear side 0 mm to phantom	0 mm	0.028	14
2479.399	GFSK	1	Rear side 0 mm to phantom	0 mm	0.022	15

Handset without keypress

EUT Position						
Channel (MHz)	**Operating Mode**	**Crest Factor**	**Description**	**Degree / Distance**	**Measured SAR_{1g} (W/kg)**	**Plot Number**
2401.808	GFSK	1	Rear side 0 mm to phantom	0 mm	0.030	16
2440.157	GFSK	1	Rear side 0 mm to phantom	0 mm	0.025	17
2479.399	GFSK	1	Rear side 0 mm to phantom	0 mm	0.026	18

Note: Configuration at middle channel with more than –3dB of applicable limit.

3.0 Test Equipment

3.1 Equipment List

The Specific Absorption Rate (SAR) tests were performed with the INDEXSAR SARA2 SYSTEM.

The following major equipment/components were used for the SAR evaluations:

SAR Measurement System			
EQUIPMENT	**SPECIFICATIONS**	Intertek ID No.	LAST CAL. DATE
Balanced Validation Dipole Antenna	**2450MHz**	EC381-4	10/15/2007
Controller	**Mitsubishi CR-E116**	EP320-1	N/A
Robot	**Mitsubishi RV-E2**	EP320-2	N/A
	Repeatability: ± 0.04mm; Number of Axes: 6		
E-Field Probe	**IXP-050**	EC356-3	04/17/2007
	Frequency Range: Probe outer diameter: 5.2 mm; Length: 350 mm; Distance between the probe tip and the dipole center: 2.7 mm		
Data Acquisition	**SARA2**	N/A	N/A
	Processor: Pentium 4; Clock speed: 1.5GHz; OS: Windows XP; I/O: two RS232; Software: SARA2 ver. 2.41 VPM		
Phantom	**Upright Head Specific Anthropomorphic Mannequin (SAM) phantom, 2mm wall thickness box phantom**	N/A	N/A
	The head and body phantom shell should be made of low-loss dielectric material with dielectric constant and loss tangent less than 5.0 and 0.05 respectively. The shell thickness for all regions coupled to the test device and its antenna should be within 2.0 ± 0.2 mm. The phantom should be filled with the required head or body equivalent tissue medium to a depth of 15.0 ± 0.5 cm. Body capacity: 152.5 x 225.5 x 200 (W x L x D) mm^3.		
Device holder	**Material: clear Perspex**	N/A	N/A
	Dielectric constant: less than 2.85 above 500MHz		
Simulated Tissue	**Mixture**	N/A	12/07/2007
	Please see section 3.2 for details		
RF Power Meter	**Boonton 4231A with 51011-EMC power sensor**	EC359	03/22/2007
	Frequency Range: 0.03 to 8 GHz, <24dBm		
Vector Network Analyzer	**HP 8753B** **HP 85046A**	EC375	08/19/2007
	300k to 3GHz		
Signal Generator	**R&S SMR27**	EC354	08/19/2007
	10M to 27GHz, <120dBuV		
Wideband Peak Power Meter/ Sensor	**Anritsu ML2497A with MA2491A Power sensor**	EC396	10/18/2007
	Frequency Range: 100MHz~18GHz		

3.2 Tissue Simulating Liquid

The head and body tissue parameters should be used to test operating frequency band of transmitters. When a transmission band overlaps with one of the target frequencies, the tissue dielectric parameters of the tissue medium at the middle of a device transmission band should be within ±5% of the parameters specified at that target frequency.

3.2.1 Head Tissue Simulating Liquid for System performance Check test

Head Ingredients Frequency (2.45 GHz)	
DGBE (Dilethylene Glycol Butyl Ether)	53.3%
Water	46.7%

The dielectric parameters were verified prior to assessment using the HP 85046A dielectric probe kit and the HP 8753B network Analyzer. The dielectric parameters were:

Frequency (MHz)	Temp. (℃)	ε_r / Relative Permittivity			σ / Conductivity (mho/m)			ρ *(kg/m^3)
		measured	target	Δ (±5%)	measured	target	Δ (±5%)	
2450	24.5	38.622	39.2	-1.47	1.819	1.80	-1.056	1000

* *Worst-case assumption*

3.2.2 Body Tissue Simulating Liquid for evaluation test

Body Ingredients Frequency (2.45 GHz)	
DGBE (Dilethylene Glycol Butyl Ether)	26.7%
Salt	0.04%
Water	73.2%

The dielectric parameters were verified prior to assessment using the HP 85046A dielectric probe kit and the HP 8753B network Analyzer. The dielectric parameters were:

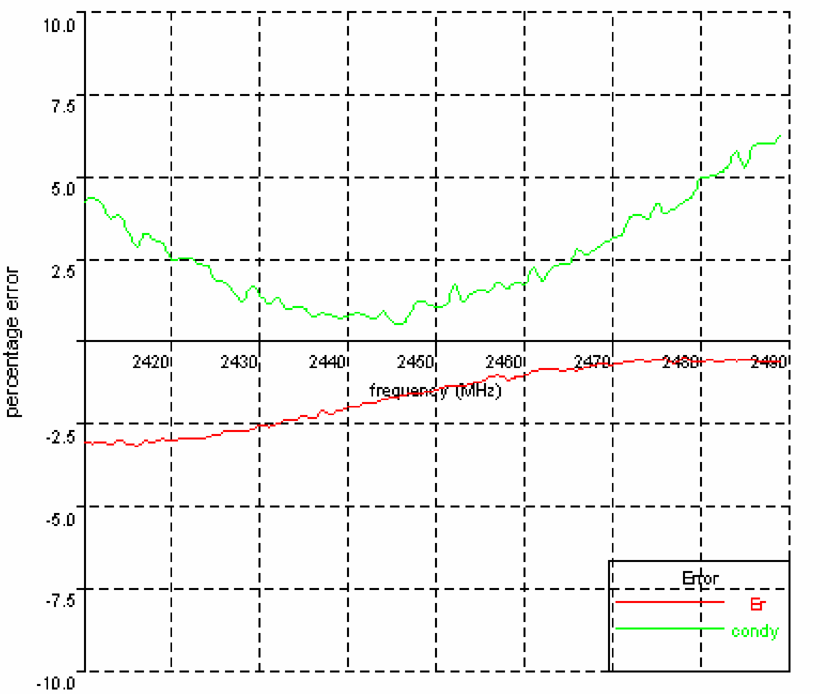
Frequency (MHz)	Temp. (℃)	ε_r / Relative Permittivity			σ / Conductivity (mho/m)			ρ *(kg/m^3)
2450	23.5	measured	target	Δ(±5%)	measured	target	Δ(±5%)	1000
		52.939	52.7	0.45%	1.936	1.95	0.72%	

* *Worst-case assumption*

Please see the plot showed as section 3.2.3

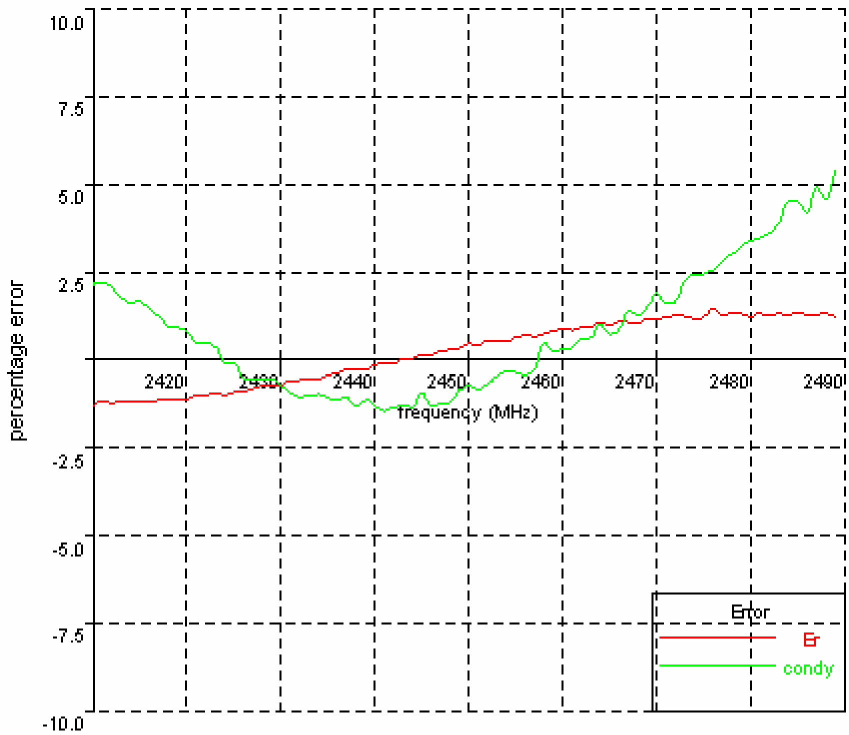
3.2.3 Head Liquid results

<table>
<tr><td>Date: 09 Dec. 2007</td><td>Temperature: 24.0 °C</td><td>Type: 2450 MHz/ head (FCC)</td><td>Tested by: Jimmie</td></tr>
<tr><td colspan="2">2410, 38.0791334078, -1.8392919047
2411, 38.0534888055, -1.8424921577
2412, 38.0689004685, -1.8402460157
2413, 38.0478882339, -1.8335134633
2414, 38.0860437645, -1.8360926967
2415, 38.0346276054, -1.8282097477
2416, 38.0238429169, -1.8211861244
2417, 38.0705489711, -1.8291085049
2418, 38.0655071485, -1.8261343221
2419, 38.0887889564, -1.8252286649
2420, 38.0756293775, -1.817499045
2421, 38.0886431753, -1.818851645
2422, 38.1021245644, -1.8199837593
2423, 38.0857214068, -1.8177152532
2424, 38.1136997794, -1.8180580104
2425, 38.1305256348, -1.8107113785
2426, 38.1675119376, -1.810790424
2427, 38.1787480292, -1.8063313487
2428, 38.1755007576, -1.8020362168
2429, 38.1909618354, -1.8115582863
2430, 38.2334876209, -1.8076939548
2431, 38.2240397613, -1.8037452666
2432, 38.2464425827, -1.8080086893
2433, 38.3013323619, -1.802313324
2434, 38.2922864587, -1.8046232332
2435, 38.3412786462, -1.8047409072
2436, 38.3078639465, -1.8011563109
2437, 38.3983791354, -1.803731172
2438, 38.3616521836, -1.8036068113
2439, 38.4021283816, -1.8026207949
2440, 38.4337271312, -1.8051288605
2441, 38.4393775695, -1.8073743691
2442, 38.4875760099, -1.8070552782
2443, 38.4861731378, -1.8061517449
2444, 38.5253764193, -1.8112522105
2445, 38.5428054764, -1.8061406436
2446, 38.5588369489, -1.8056614619
2447, 38.5809681619, -1.8124779343
2448, 38.5870621967, -1.8205740915
2449, 38.6096777828, -1.8194209887</td><td colspan="2">2450, 38.6224517801, -1.8192255791
2451, 38.6603379982, -1.8205702559
2452, 38.6788616992, -1.8330569922
2453, 38.6712951037, -1.825034814
2454, 38.6978237448, -1.8309328611
2455, 38.7218465975, -1.833461691
2456, 38.7675729617, -1.8338242972
2457, 38.7884101431, -1.8405421964
2458, 38.7360457894, -1.8380809375
2459, 38.7683432264, -1.8426257258
2460, 38.7822066389, -1.8423374634
2461, 38.8368743102, -1.8527605829
2462, 38.8544442904, -1.8466707066
2463, 38.8677242779, -1.8545239088
2464, 38.8413847505, -1.8578988488
2465, 38.8451128049, -1.8595434205
2466, 38.841808856, -1.8682073732
2467, 38.8766508867, -1.8664418567
2468, 38.9060108556, -1.8708985001
2469, 38.908326801, -1.8750539523
2470, 38.899562897, -1.879245729
2471, 38.9256806159, -1.8819215937
2472, 38.9390324788, -1.8931920733
2473, 38.9486500484, -1.8952295579
2474, 38.936612681, -1.893973028
2475, 38.9585347104, -1.9039663228
2476, 38.964120299, -1.8995138679
2477, 38.9110932392, -1.9034551594
2478, 38.9736730307, -1.9083876506
2479, 38.937247375, -1.9118768239
2480, 38.9247878891, -1.9239421454
2481, 38.945709572, -1.9259161934
2482, 38.9170216263, -1.9287464446
2483, 38.951490912, -1.9333353053
2484, 38.9289981585, -1.9431455715
2485, 38.9423036276, -1.9352506983
2486, 38.9348132212, -1.9484911069
2487, 38.9110055485, -1.9515981187
2488, 38.9081214508, -1.9520009014
2489, 38.9195755696, -1.957850782
2490, 38.8898138181, -1.9567640027</td></tr>
</table>



3.2.4 Body Liquid results

<table>
<tr><td>Date: 09 Dec. 2007</td><td>Temperature: 23.5 ℃</td><td>Type: 2450 MHz/ Body (FCC)</td><td>Tested by: Jimmie</td></tr>
<tr><td colspan="2">2410, 52.0717885146, -1.9530838124
2411, 52.138220639, -1.9545620384
2412, 52.0991103093, -1.9536163958
2413, 52.1359906793, -1.9481136311
2414, 52.1298271678, -1.9468785055
2415, 52.1361609418, -1.9485235273
2416, 52.1279262661, -1.9450908244
2417, 52.1446025696, -1.9427179398
2418, 52.1653788743, -1.9376662857
2419, 52.1532296869, -1.9380735867
2420, 52.1545603558, -1.9374392415
2421, 52.2182810722, -1.9314463975
2422, 52.2086556367, -1.9325000855
2423, 52.2446423415, -1.9315551432
2424, 52.2040579046, -1.9233014462
2425, 52.2514575617, -1.9247104267
2426, 52.2623935125, -1.9164355329
2427, 52.3059689815, -1.9178877619
2428, 52.3406696606, -1.9181003926
2429, 52.3434932675, -1.9199154705
2430, 52.3542767321, -1.9166643114
2431, 52.4172478926, -1.9140192119
2432, 52.421132516, -1.9122424714
2433, 52.4377305969, -1.9143257498
2434, 52.4435283049, -1.9158881874
2435, 52.4943981051, -1.9147932201
2436, 52.5266409743, -1.9149247384
2437, 52.5704367681, -1.9172452218
2438, 52.5671791991, -1.9130990889
2439, 52.5671791991, -1.9176164307
2440, 52.6427942263, -1.9155039397
2441, 52.66469044, -1.9134904012
2442, 52.666610068, -1.9163848935
2443, 52.7214110136, -1.9184848389
2444, 52.7334523886, -1.9179066389
2445, 52.7865718466, -1.9273044156
2446, 52.773527781, -1.9205741957
2447, 52.8435970409, -1.9230828908
2448, 52.8515971595, -1.9248670624
2449, 52.8842062859, -1.9325813874</td><td colspan="2">2450, 52.9392336459, -1.9361240432
2451, 52.9113637444, -1.9352474252
2452, 52.9873000374, -1.9396007437
2453, 52.9861218658, -1.9447773953
2454, 52.9810358075, -1.9493456633
2455, 53.0215382893, -1.9497869431
2456, 53.0657467198, -1.9494832074
2457, 53.025940627, -1.9545844638
2458, 53.0838242636, -1.9702509051
2459, 53.110788184, -1.9667871906
2460, 53.1483847094, -1.9689798553
2461, 53.125872008, -1.9716686469
2462, 53.1623165384, -1.9777976546
2463, 53.1773854392, -1.9794984991
2464, 53.2256688473, -1.9885770268
2465, 53.1999944204, -1.9844977326
2466, 53.238648947, -1.9878073537
2467, 53.233538649, -2.0002078715
2468, 53.2133367483, -1.9994884805
2469, 53.2871169975, -2.0041949072
2470, 53.2694832049, -2.0144207258
2471, 53.3014812834, -2.0098825318
2472, 53.3185330202, -2.0118279789
2473, 53.3120548184, -2.0258216261
2474, 53.2591219964, -2.0300481854
2475, 53.2886999587, -2.0320410411
2476, 53.4134442371, -2.0355619128
2477, 53.3107282714, -2.041981269
2478, 53.3541859864, -2.0476458944
2479, 53.3365299993, -2.0526497372
2480, 53.29156194, -2.057521927
2481, 53.3314582614, -2.060849871
2482, 53.3043144727, -2.0644502476
2483, 53.3233758935, -2.0717222461
2484, 53.3101991784, -2.0852845636
2485, 53.3455368367, -2.0868446653
2486, 53.2964559408, -2.0816095639
2487, 53.31350607, -2.0981592493
2488, 53.3129230868, -2.0921469428
2489, 53.2634451104, -2.1093521886
2490, 53.2760180936, -2.1131023414</td></tr>
</table>



3.3 E-Field Probe and 2450 Balanced Dipole Antenna Calibration

Probe calibration factors and dipole antenna calibration are included in Appendix C.

4.0 Measurement Uncertainty

The uncertainty budget has been determined for the INDEXSAR SARA2 measurement system according to IEEE P1528 documents [3] and is given in the following table. The extended uncertainty (95% confidence level) was assessed to be 20.6 % for SAR measurement, and the extended uncertainty (95% confidence level) was assessed to be 20.2 % for system performance check.

Table 1 Exposure Assessment Uncertainty
Example of measurement uncertainty assessment SAR measurement

(blue entries are site-specific)

a	b			c	d	e		f	g	h	I
Uncertainty Component	Sec.	Tol. (+/-)			Prob. Dist.	Divisor (descrip)	Divisor (value)	c1 (1g)	c1 (10g)	Standard Uncertainty (%) 1g	Standard Uncertainty (%) 10g
		(dB)		(%)							
Measurement System											
Probe Calibration	E2.1			2.5	N	1 or k	1	1	1	2.50	2.50
Axial Isotropy	E2.2	0.25	5.93	5.93	R	√3	1.73	0	0	0.00	0.00
Hemispherical Isotropy	E2.2	0.45	10.92	10.92	R	√3	1.73	1	1	6.30	6.30
Boundary effect	E2.3		4	4.00	R	√3	1.73	1	1	2.31	2.31
Linearity	E2.4	0.04	0.93	0.93	R	√3	1.73	1	1	0.53	0.53
System Detection Limits	E2.5		1	1.00	R	√3	1.73	1	1	0.58	0.58
Readout Electronics	E2.6		1	1.00	N	1 or k	1.00	1	1	1.00	1.00
Response time	E2.7		0	0.00	R	√3	1.73	1	1	0.00	0.00
Integration time	E2.8		1.4	1.40	R	√3	1.73	1	1	0.81	0.81
RF Ambient Conditions	E6.1		3	3.00	R	√3	1.73	1	1	1.73	1.73
Probe Positioner Mechanical Tolerance	E6.2		0.6	0.60	R	√3	1.73	1	1	0.35	0.35
Probe Position wrt. Phantom Shell	E6.3		3	3.00	R	√3	1.73	1	1	1.73	1.73
SAR Evaluation Algorithms	E5		8	8.00	R	√3	1.73	1	1	4.62	4.62
Test Sample Related											
Test Sample Positioning	E4.2		2	2.00	N	1	1.00	1	1	2.00	2.00
Device Holder Uncertainty	E4.1		2	2.00	N	1	1.00	1	1	2.00	2.00
Output Power Variation	6.6.2		5	5.00	R	√3	1.73	1	1	2.89	2.89
Phantom and Tissue Parameters											
Phantom Uncertainty (shape and thickness)	E3.1		4	4.00	R	√3	1.73	1	1	2.31	2.31
Liquid conductivity (Deviation from target)	E3.2		5	5.00	R	√3	1.73	0.64	0.43	1.85	1.24
Liquid conductivity (measurement uncert.)	E3.3		1.1	1.10	N	1	1.00	0.64	0.43	0.70	0.47
Liquid permittivity (Deviation from target)	E3.2		5	5.00	R	√3	1.73	0.6	0.49	1.73	1.41
Liquid permittivity (measurement uncert.)	E3.3		1.1	1.10	N	1	1.00	0.6	0.49	0.66	0.54
Combined standard uncertainty					**RSS**					10.5	10.3
Expanded uncertainty	(95% Confidence Level)				k=2					**20.6**	**20.3**

Table 2 System Check (Verification)

Example of measurement uncertainty assessment for system performance check

(blue entries are site-specific)

a	b			c	d	e		f	g	h	I
Uncertainty Component	Sec.	Tol. (+/-)			Prob. Dist.	Divisor (descrip)	Divisor (value)	c1 (1g)	c1 (10g)	Standard Uncertainty (%) 1g	Standard Uncertainty (%) 10g
		(dB)		(%)							
Measurement System											
Probe Calibration	E2.1			2.5	N	1 or k	1	1	1	2.50	2.50
Axial Isotropy	E2.2	0.25	5.93	5.93	R	√3	1.73	0	0	0.00	0.00
Hemispherical Isotropy	E2.2	0.45	10.92	10.92	R	√3	1.73	1	1	6.30	6.30
Boundary effect	E2.3		4	4.00	R	√3	1.73	1	1	2.31	2.31
Linearity	E2.4	0.04	0.93	0.93	R	√3	1.73	1	1	0.53	0.53
System Detection Limits	E2.5		1	1.00	R	√3	1.73	1	1	0.58	0.58
Readout Electronics	E2.6		1	1.00	N	1 or k	1.00	1	1	1.00	1.00
Response time	E2.7		0	0.00	R	√3	1.73	1	1	0.00	0.00
Integration time	E2.8		1.4	1.40	R	√3	1.73	1	1	0.81	0.81
RF Ambient Conditions	E6.1		3	3.00	R	√3	1.73	1	1	1.73	1.73
Probe Positioner Mechanical Tolerance	E6.2		0.6	0.60	R	√3	1.73	1	1	0.35	0.35
Probe Position wrt. Phantom Shell	E6.3		3	3.00	R	√3	1.73	1	1	1.73	1.73
SAR Evaluation Algorithms	E5		8	8.00	R	√3	1.73	1	1	4.62	4.62
Dipole											
Dipole axis to liquid distance	8, E4.2		2	2.00	N	1	1.00	1	1	2.00	2.00
Input power and SAR drift measurement	8, 6.6.2		5	5.00	R	√3	1.73	1	1	2.89	2.89
Phantom and Tissue Parameters											
Phantom Uncertainty (thickness)	E3.1		4	4.00	R	√3	1.73	1	1	2.31	2.31
Liquid conductivity (Deviation from target)	E3.2		5	5.00	R	√3	1.73	0.64	0.43	1.85	1.24
Liquid conductivity (measurement uncert.)	E3.3		1.1	1.10	N	1	1.00	0.64	0.43	0.70	0.47
Liquid permittivity (Deviation from target)	E3.2		5	5.00	R	√3	1.73	0.6	0.49	1.73	1.41
Liquid permittivity (measurement uncert.)	E3.3		1.1	1.10	N	1	1.00	0.6	0.49	0.66	0.54
Combined standard uncertainty					**RSS**					10.3	10.1
Expanded uncertainty	(95% Confidence Level)				k=2					**20.2**	**19.9**

5.0 Measurement Traceability

All measurements described in this report are traceable to Chinese National Laboratory Accreditation (CNLA) standards or appropriate national standards.

6.0 WARNING LABEL INFORMATION - USA

See user manual.

7.0 REFERENCES

[1] ANSI, *ANSI/IEEE C95.1-1999: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 GHz*, The Institute of electrical and Electronics Engineers, Inc., New York, NY 10017, 1999

[2] Federal Communications Commission, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Supplement C to OET Bulletin 65, Washington, D.C. 20554, 1997

[3] IEEE Standards Coordinating Committee 34, "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", IEEE Std 1528™-2003

8.0 DOCUMENT HISTORY

Revision/ Job Number	Writer Initials	Date	Change
N/A	S.L.	Dec. 17, 2007	Original document

APPENDIX A - SAR Evaluation Data

Power drift is the measurement of power drift of the device over one complete SAR scan. To assess the drift of the power of the device under test, a SAR measurement was made in the middle of the zoom scan volume at the start of the scan and a measurement at this point was then also made after the measurement scan. The difference between the two measurements should be greater or less than 5%.

Plot #1 (1/2)

Date:	2007/12/10	**Position:**	Left cheek
Filename:	01VT-802C_LC_ch mid.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_F_w keypress.csv	**Power Level:**	18.92 dBm

Probe: 0146

Cal File: SN0146_2450_CW_HEAD

Cal Factors:

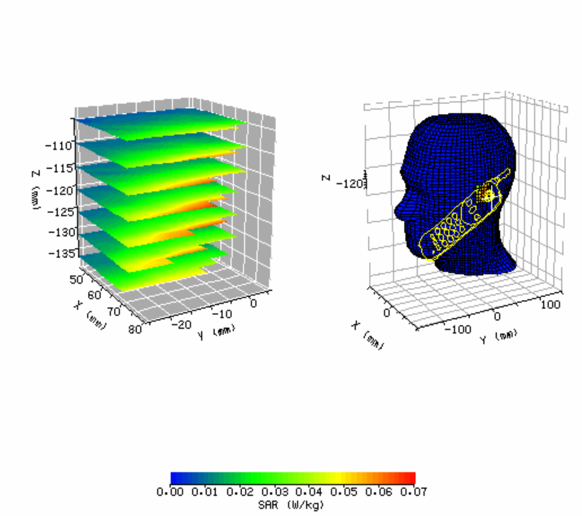
	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain: 2

Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.025	0.026

Change during Scan (%) 0.70

Max E-field (V/m): 6.05

Max SAR (W/kg)

1g	10g
0.064	0.040

Location of Max (mm):

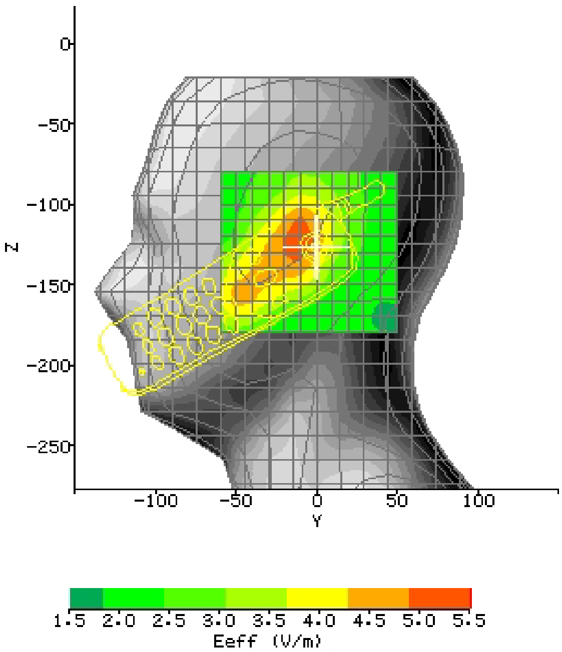
X	Y	Z
78.3	-26.0	-124.6

Plot #1 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	50.0	11.0
Z	-180.0	-80.0	10.0



Plot #2 (1/2)

Date:	2007/12/10	**Position:**	Left tilt
Filename:	02VT-802C_LT_ch mid.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_F_w keypress.csv	**Power Level:**	18.92 dBm

Probe: 0146

Cal File: SN0146_2450_CW_HEAD

Cal Factors:

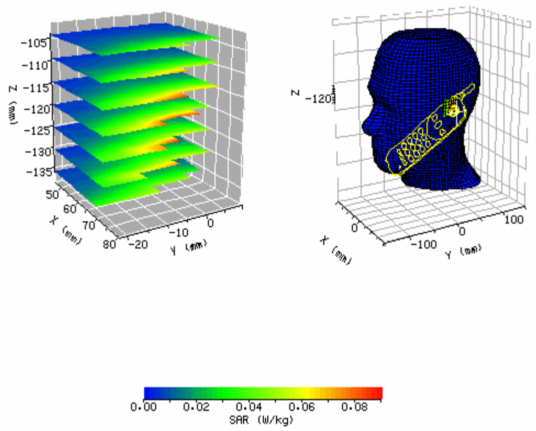
	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain: 2

Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.028	0.028

Change during Scan (%) 0

Max E-field (V/m): 6.92

Max SAR (W/kg)

1g	10g
0.082	0.045

Location of Max (mm):

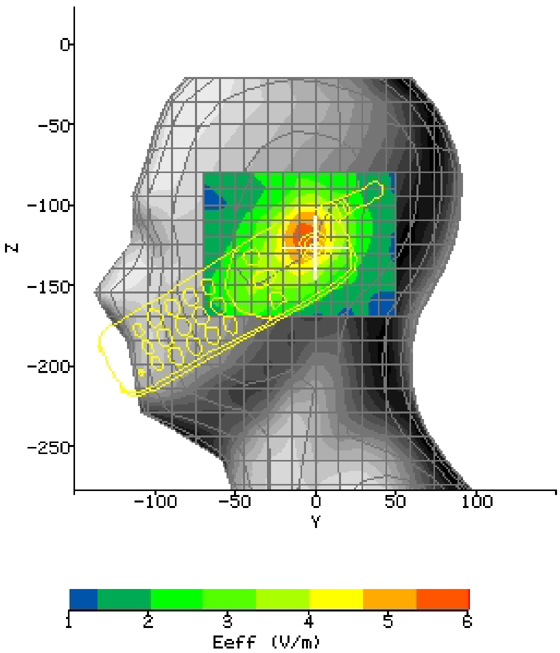
X	Y	Z
78.3	-22.0	-120.9

Plot #2 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-70.0	50.0	12.0
Z	-170.0	-80.0	9.0



Plot #3 (1/2)

Date:	2007/12/10	**Position:**	Right cheek
Filename:	03VT-802C_RC_ch mid.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	180
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_F_w keypress.csv	**Power Level:**	18.92 dBm

Probe: 0146

Cal File: SN0146_2450_CW_HEAD

Cal Factors:

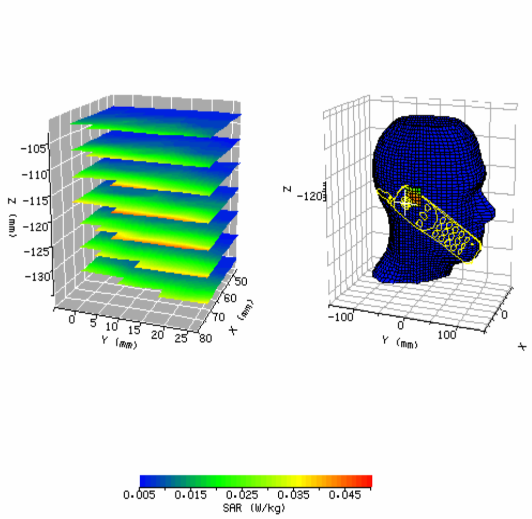
	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain: 2

Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.017	0.017

Change during Scan (%) 0

Max E-field (V/m): 5.01

Max SAR (W/kg)

1g	10g
0.044	0.027

Location of Max (mm):

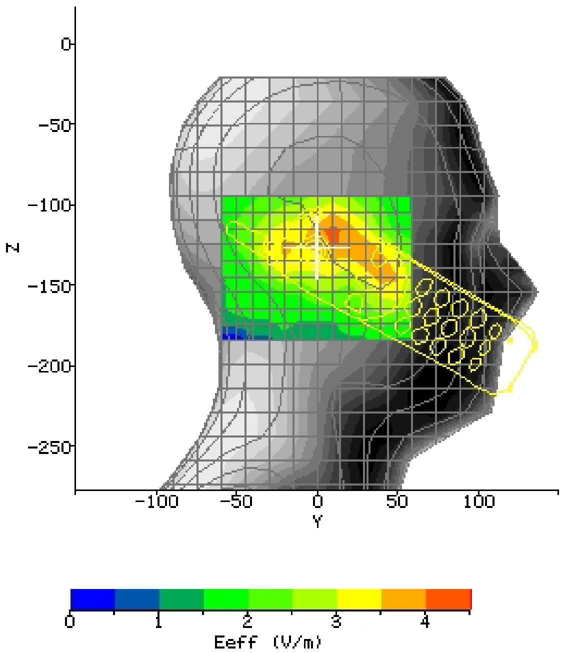
X	Y	Z
74.1	-5.0	-118.1

Plot #3 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-185.0	-95.0	9.0



Plot #4 (1/2)

Date:	2007/12/10	**Position:**	Right tilt
Filename:	04VT-802C_RT_ch mid.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	180
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_F_w keypress.csv	**Power Level:**	18.92 dBm

Probe: 0146

Cal File: SN0146_2450_CW_HEAD

Cal Factors:

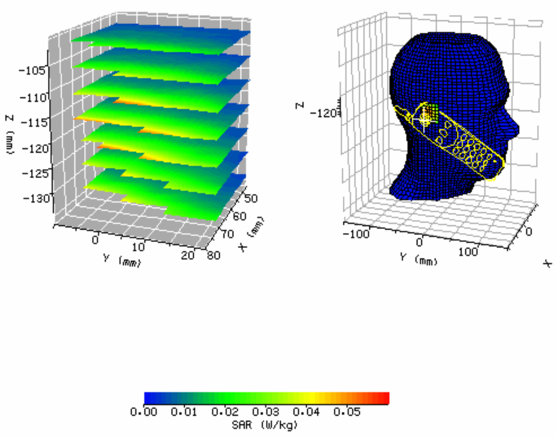
	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain: 2

Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan

Change during Scan (%)

Max E-field (V/m): 5.49

Max SAR (W/kg)

1g	10g
0.051	0.030

Location of Max (mm):

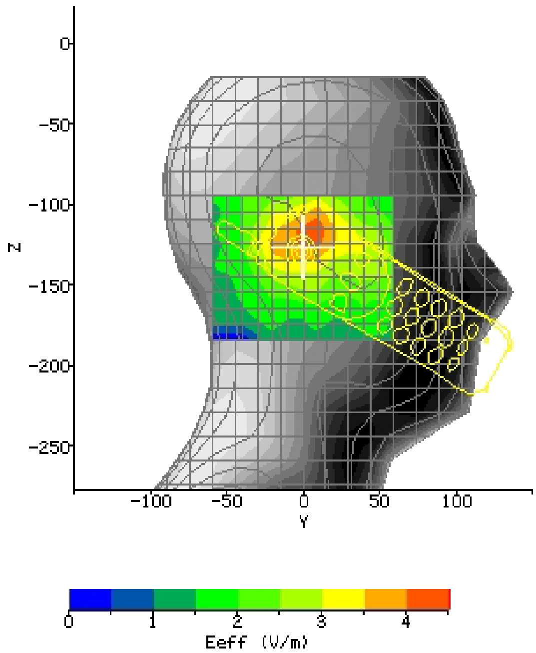
X	Y	Z
73.2	-10.0	-118.0

Plot #4 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-185.0	-95.0	9.0



Plot #5 (1/2)

Date:	2007/12/10	**Position:**	Left tilt
Filename:	05VT-802C_LT_ch low.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2401.808 MHz
Shape File:	VT-802C_F_w keypress.csv	**Power Level:**	19.12 dBm

Probe: 0146

Cal File: SN0146_2450_CW_HEAD

Cal Factors:

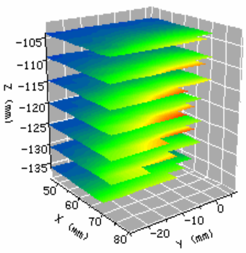
	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

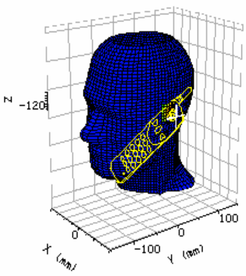
Amp Gain: 2

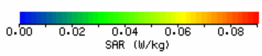
Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM







ZOOM SCAN RESULTS:

	Start Scan	End Scan
Spot SAR (W/kg):	0.031	0.031

Change during Scan (%) 0

Max E-field (V/m): 6.88

	1g	10g
Max SAR (W/kg)	0.081	0.048

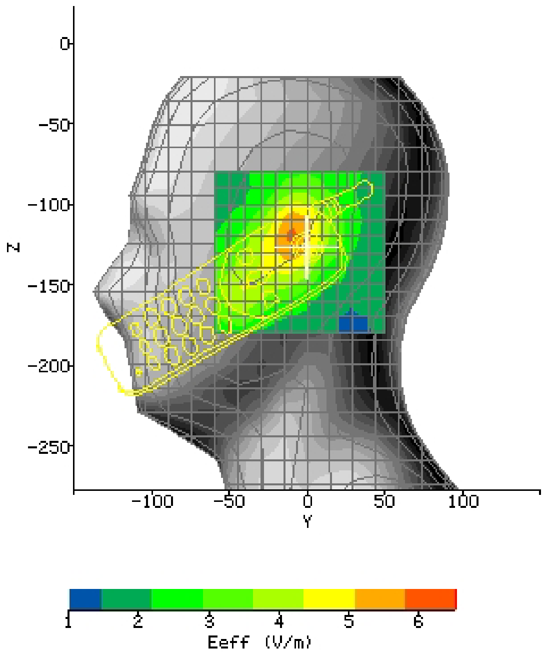
	X	Y	Z
Location of Max (mm):	78.3	-25.0	-123.6

Plot #5 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	50.0	11.0
Z	-180.0	-80.0	10.0



Plot #6 (1/2)

Date:	2007/12/10	**Position:**	Left tilt
Filename:	06VT-802C_LT_ch high.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2479.399 MHz
Shape File:	VT-802C_F_w keypress.csv	**Power Level:**	18.95 dBm

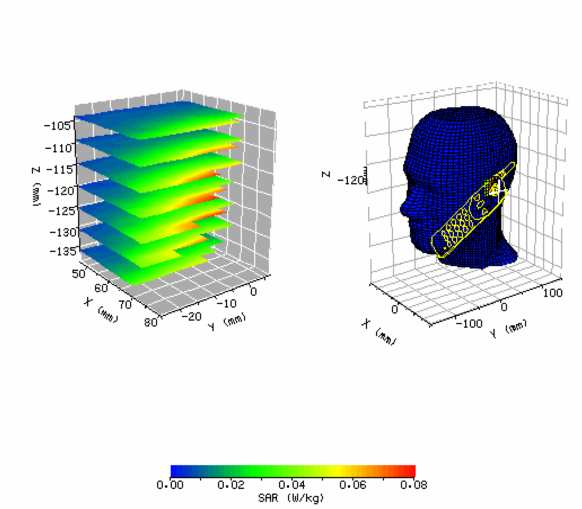
Probe:	0146
Cal File:	SN0146_2450_CW_HEAD

Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain:	2
Averaging:	1
Batteries Replaced:	-

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.027	0.027

Change during Scan (%) 0

Max E-field (V/m): 6.58

Max SAR (W/kg)

1g	10g
0.076	0.044

Location of Max (mm):

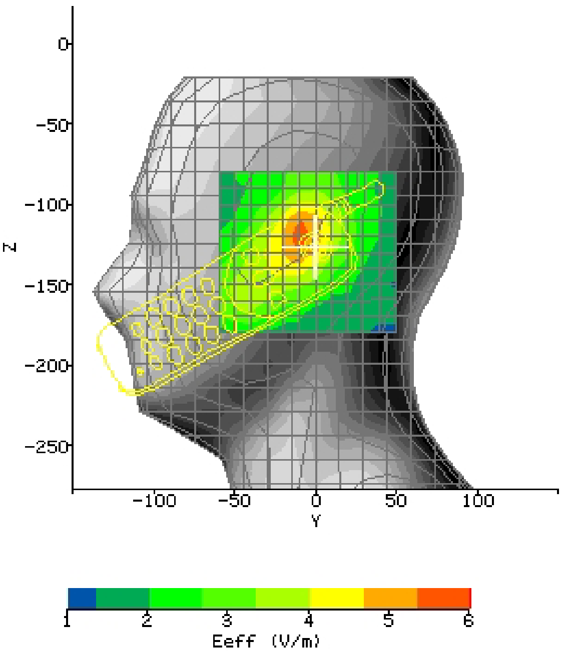
X	Y	Z
78.3	-25.0	-123.6

Plot #6 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	50.0	11.0
Z	-180.0	-80.0	10.0



Plot #7 (1/2)

Date:	2007/12/10	**Position:**	Left cheek
Filename:	07VT-802C_LC(wo)_ch mid.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_F_wo keypress.csv	**Power Level:**	18.96 dBm

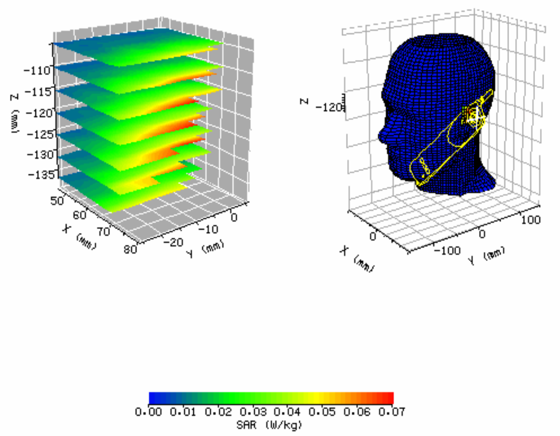
Probe:	0146
Cal File:	SN0146_2450_CW_HEAD

Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain:	2
Averaging:	1
Batteries Replaced:	-

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.028	0.026

Change during Scan (%) -2.26

Max E-field (V/m): 6.20

Max SAR (W/kg)

1g	10g
0.068	0.042

Location of Max (mm):

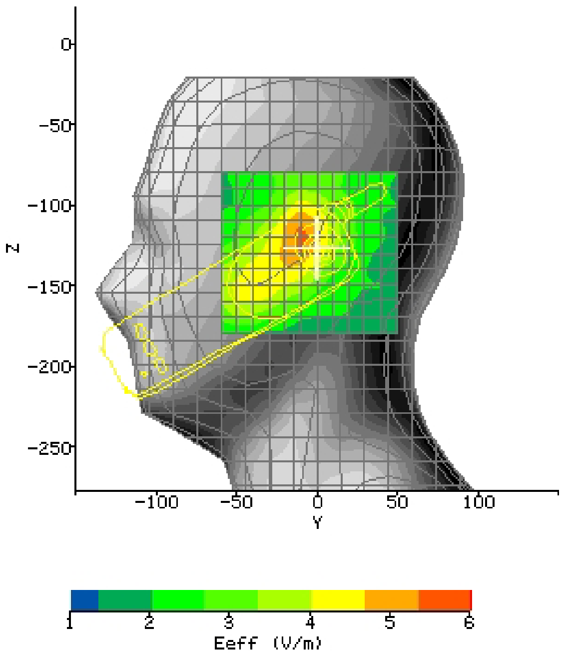
X	Y	Z
78.3	-26.0	-124.6

Plot #7 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	50.0	11.0
Z	-180.0	-80.0	10.0



Plot #8 (1/2)

Date:	2007/12/10	**Position:**	Left tilt
Filename:	08VT-802C_LT(wo)_ch mid.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_F_wo keypress.csv	**Power Level:**	18.96 dBm

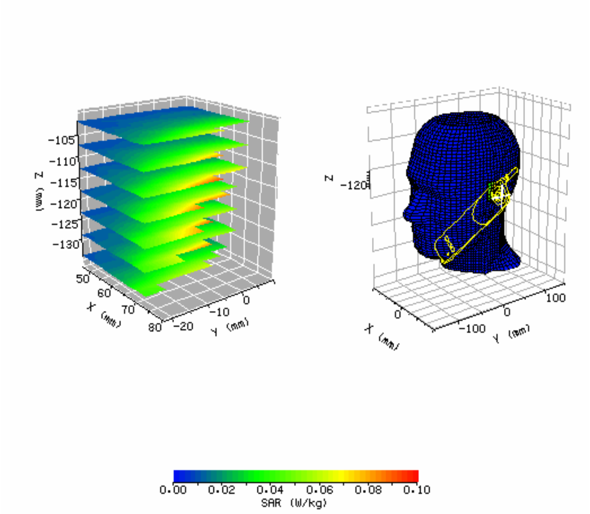
Probe:	0146
Cal File:	SN0146_2450_CW_HEAD

Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain:	2
Averaging:	1
Batteries Replaced:	-

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.033	0.032

Change during Scan (%) -2.08

Max E-field (V/m): 7.13

Max SAR (W/kg)

1g	10g
0.089	0.052

Location of Max (mm):

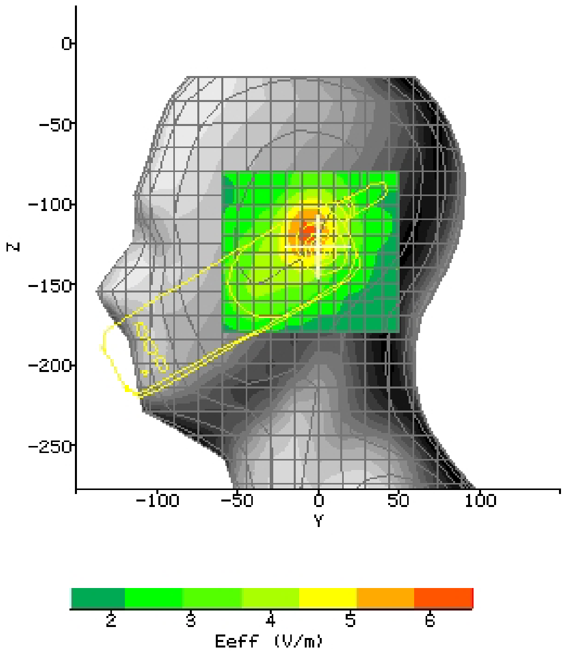
X	Y	Z
78.4	-22.0	-119.8

Plot #8 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	50.0	11.0
Z	-180.0	-80.0	10.0



Plot #9 (1/2)

Date:	2007/12/10	**Position:**	Right cheek
Filename:	09VT-802C_RC(wo)_ch mid.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	180
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_F_wo keypress.csv	**Power Level:**	18.96 dBm

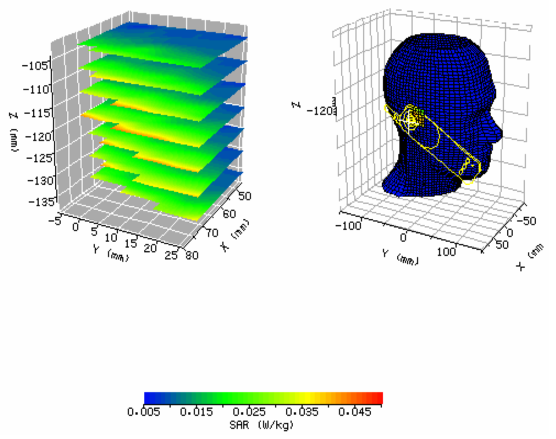
Probe:	0146
Cal File:	SN0146_2450_CW_HEAD

Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain:	2
Averaging:	1
Batteries Replaced:	-

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.020	0.020

Change during Scan (%) 0

Max E-field (V/m): 4.99

Max SAR (W/kg)

1g	10g
0.042	0.028

Location of Max (mm):

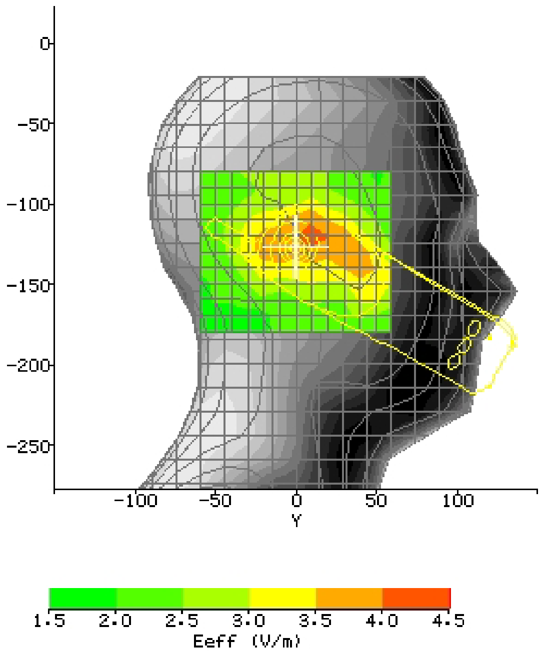
X	Y	Z
73.5	-6.0	-119.1

Plot #9 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-180.0	-80.0	10.0



Plot #10 (1/2)

Date:	2007/12/10	**Position:**	Right tilt
Filename:	10VT-802C_RT(wo)_ch mid.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	180
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_F_wo keypress.csv	**Power Level:**	18.96 dBm

Probe: 0146

Cal File: SN0146_2450_CW_HEAD

Cal Factors:

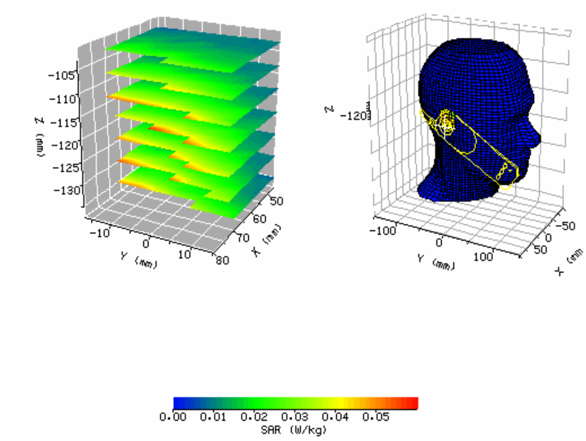
	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain: 2

Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.023	0.023

Change during Scan (%) 0

Max E-field (V/m): 5.69

Max SAR (W/kg)

1g	10g
0.051	0.033

Location of Max (mm):

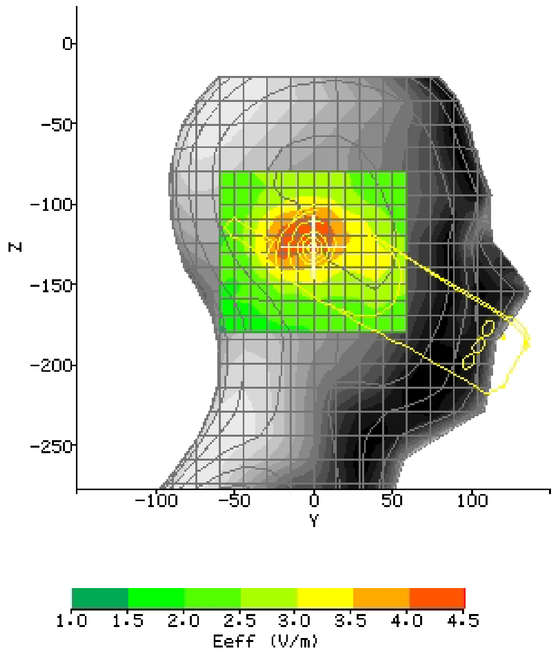
X	Y	Z
71.5	-17.0	-125.2

Plot #10 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-180.0	-80.0	10.0



Plot #11 (1/2)

Date:	2007/12/10	**Position:**	Left tilt
Filename:	11VT-802C_LT(wo)_ch low.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2401.808 MHz
Shape File:	VT-802C_F_wo keypress.csv	**Power Level:**	19.15 dBm

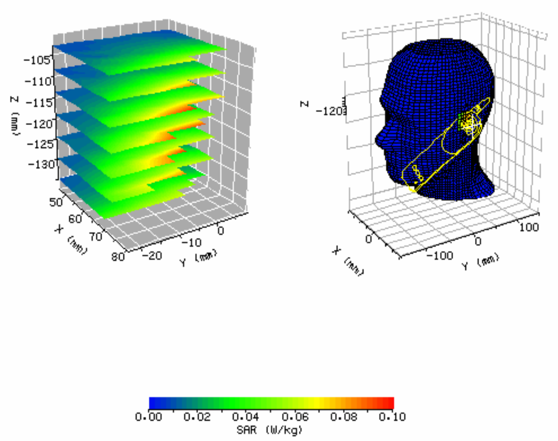
Probe:	0146
Cal File:	SN0146_2450_CW_HEAD

Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain:	2
Averaging:	1
Batteries Replaced:	-

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.037	0.036

Change during Scan (%) -3.66

Max E-field (V/m): 7.31

Max SAR (W/kg)

1g	10g
0.094	0.054

Location of Max (mm):

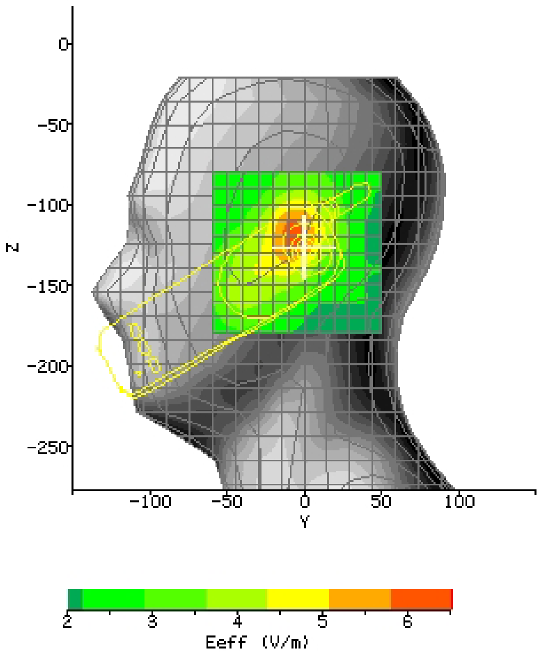
X	Y	Z
78.4	-23.0	-119.9

Plot #11 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	50.0	11.0
Z	-180.0	-80.0	10.0



Plot #12 (1/2)

Date:	2007/12/10	**Position:**	Left tilt
Filename:	12VT-802C_LT(wo)_ch high.txt	**Phantom:**	HeadFT34.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2479.399 MHz
Shape File:	VT-802C_F_wo keypress.csv	**Power Level:**	18.94 dBm

Probe: 0146

Cal File: SN0146_2450_CW_HEAD

Cal Factors:

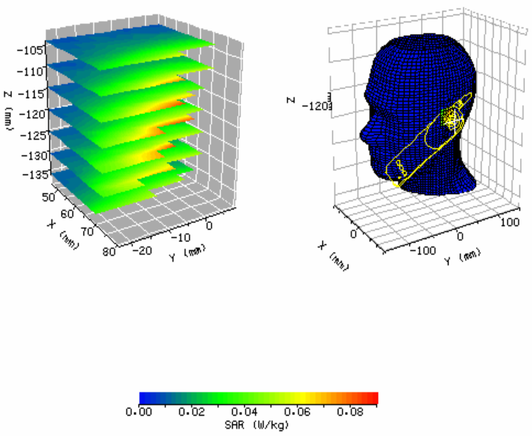
	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.467	.467	.467

Amp Gain: 2

Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Head
Conductivity:	1.8192
Relative Permittivity:	38.622
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.032	0.031

Change during Scan (%) -3.88

Max E-field (V/m): 6.80

Max SAR (W/kg)

1g	10g
0.081	0.047

Location of Max (mm):

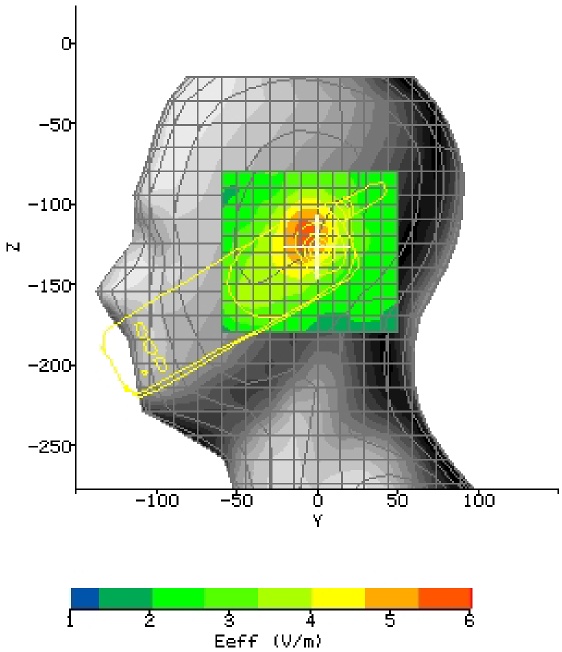
X	Y	Z
78.4	-23.0	-120.9

Plot #12 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	50.0	11.0
Z	-180.0	-80.0	10.0

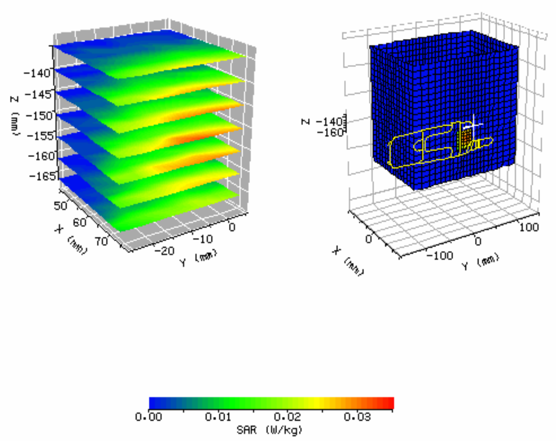


Plot #13 (1/2)

Date:	2007/12/10	**Position:**	Rear side 0 mm to phantom
Filename:	13VT-802C_rear0_ch low.txt	**Phantom:**	HeadBox2-test.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2401.808 MHz
Shape File:	VT-802C_R_w keypress.csv	**Power Level:**	19.12 dBm

Probe:	0146			
Cal File:	SN0146_2450_CW_BODY			
Cal Factors:		**X**	**Y**	**Z**
	Air	433	372	395
	DCP	20	20	20
	Lin	.538	.538	.538
Amp Gain:	2			
Averaging:	1			
Batteries Replaced:	-			

Liquid:	15.5cm
Type:	2450 MHz Body
Conductivity:	1.936
Relative Permittivity:	52.939
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):	**Start Scan**	**End Scan**
	0.009	0.009

Change during Scan (%) 0

Max E-field (V/m): 4.18

Max SAR (W/kg)	**1g**	**10g**
	0.027	0.017

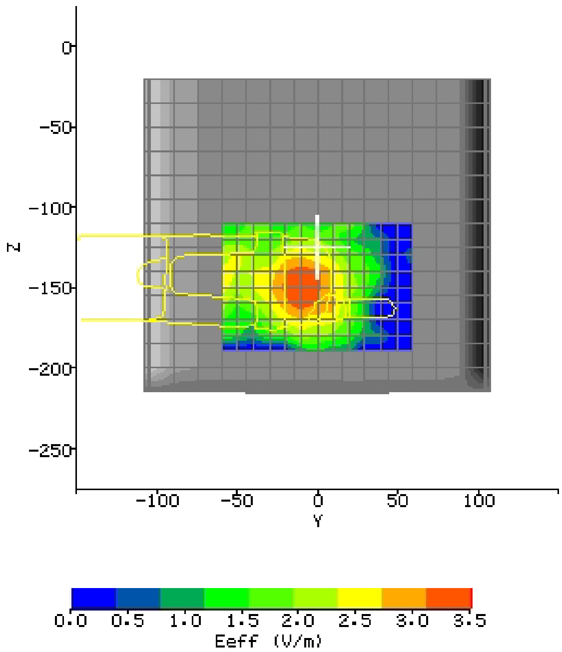
Location of Max (mm):	**X**	**Y**	**Z**
	78.1	-26.0	-151.0

Plot #13 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-190.0	-110.0	8.0



Plot #14 (1/2)

Date:	2007/12/10	**Position:**	Rear side 0 mm to phantom
Filename:	14VT-802C_rear0_ch mid.txt	**Phantom:**	HeadBox2-test.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_R_w keypress.csv	**Power Level:**	18.92 dBm

Probe: 0146

Cal File: SN0146_2450_CW_BODY

Cal Factors:

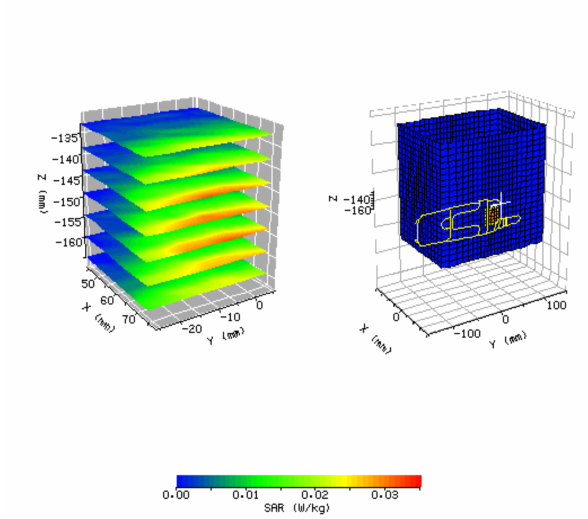
	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.538	.538	.538

Amp Gain: 2

Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Body
Conductivity:	1.936
Relative Permittivity:	52.939
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):	**Start Scan**	**End Scan**
	0.010	0.009

Change during Scan (%) -2.03

Max E-field (V/m): 4.18

Max SAR (W/kg)	**1g**	**10g**
	0.028	0.017

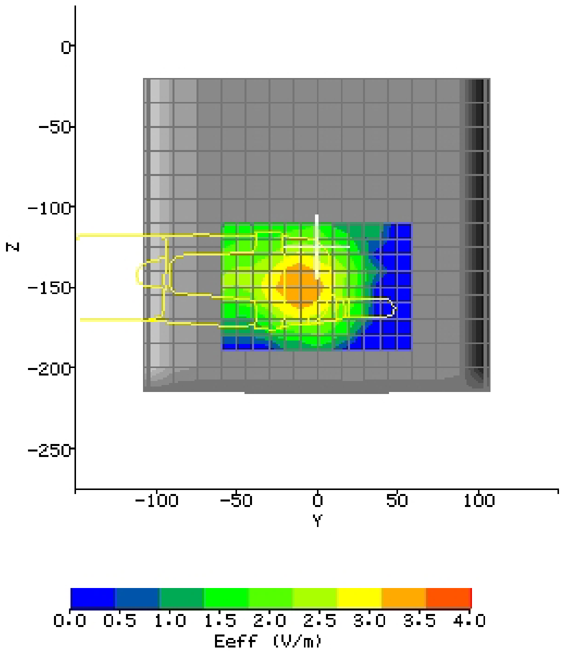
Location of Max (mm):	**X**	**Y**	**Z**
	78.1	-26.0	-149.0

Plot #14 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-190.0	-110.0	8.0



Plot #15 (1/2)

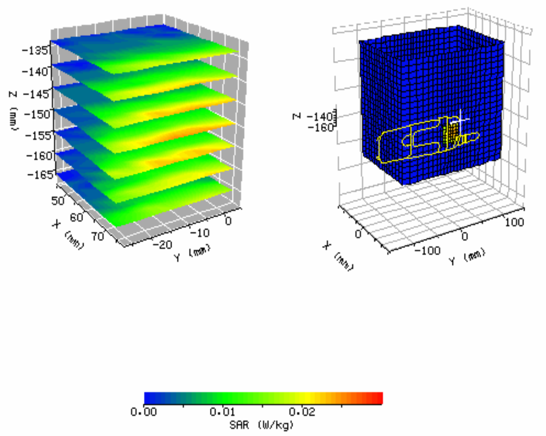
Date:	2007/12/10	**Position:**	Rear side 0 mm to phantom
Filename:	15VT-802C_rear0_ch high.txt	**Phantom:**	HeadBox2-test.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2479.399 MHz
Shape File:	VT-802C_R_w keypress.csv	**Power Level:**	18.95 dBm

Probe:	0146
Cal File:	SN0146_2450_CW_BODY
Amp Gain:	2
Averaging:	1
Batteries Replaced:	-

Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.538	.538	.538

Liquid:	15.5cm
Type:	2450 MHz Body
Conductivity:	1.936
Relative Permittivity:	52.939
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.004	0.004

Change during Scan (%) -1.14

Max E-field (V/m): 3.68

Max SAR (W/kg)

1g	10g
0.022	0.014

Location of Max (mm):

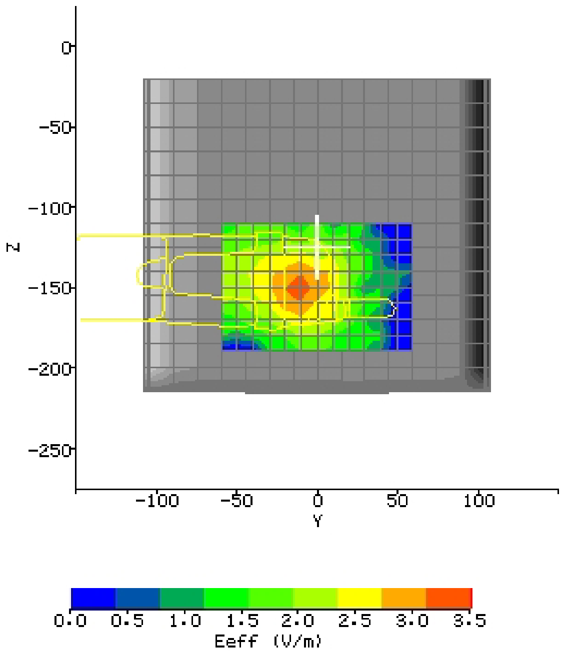
X	Y	Z
78.1	-27.0	-148.2

Plot #15 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-190.0	-110.0	8.0



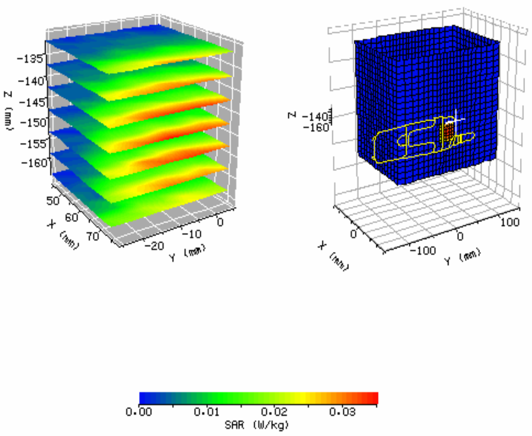
Plot #16 (1/2)

Date:	2007/12/10	**Position:**	Rear side 0 mm to phantom
Filename:	16VT-802C_rear0(wo)_ch low.txt	**Phantom:**	HeadBox2-test.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2401.808 MHz
Shape File:	VT-802C_R_wo keypress.csv	**Power Level:**	19.15 dBm

Probe:	0146
Cal File:	SN0146_2450_CW_BODY
Cal Factors:	see table below
Amp Gain:	2
Averaging:	1
Batteries Replaced:	-

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.538	.538	.538

Liquid:	15.5cm
Type:	2450 MHz Body
Conductivity:	1.936
Relative Permittivity:	52.939
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.010	0.010

Change during Scan (%) 0

Max E-field (V/m): 4.37

Max SAR (W/kg)

1g	10g
0.030	0.019

Location of Max (mm):

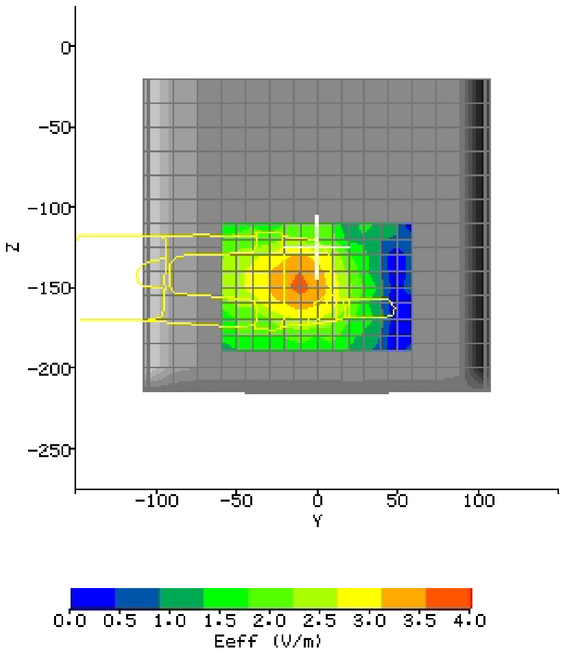
X	Y	Z
78.1	-26.0	-147.1

Plot #16 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-190.0	-110.0	8.0



Plot #17 (1/2)

Date:	2007/12/10	**Position:**	Rear side 0 mm to phantom
Filename:	17VT-802C_rear0(wo)_ch mid.txt	**Phantom:**	HeadBox2-test.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2440.157 MHz
Shape File:	VT-802C_R_wo keypress.csv	**Power Level:**	18.96 dBm

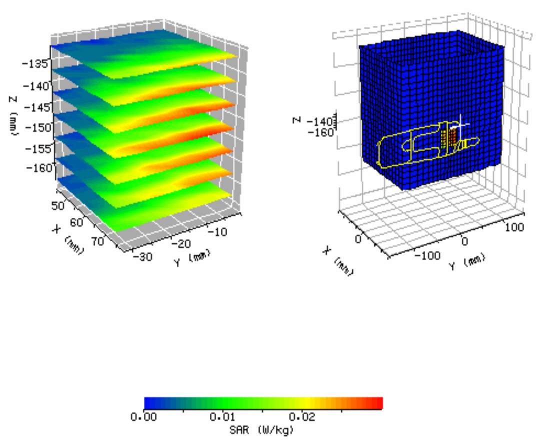
Probe:	0146
Cal File:	SN0146_2450_CW_BODY

Cal Factors:

	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.538	.538	.538

Amp Gain:	2
Averaging:	1
Batteries Replaced:	-

Liquid:	15.5cm
Type:	2450 MHz Body
Conductivity:	1.936
Relative Permittivity:	52.939
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.009	0.009

Change during Scan (%) 0

Max E-field (V/m): 3.99

Max SAR (W/kg)

1g	10g
0.025	0.017

Location of Max (mm):

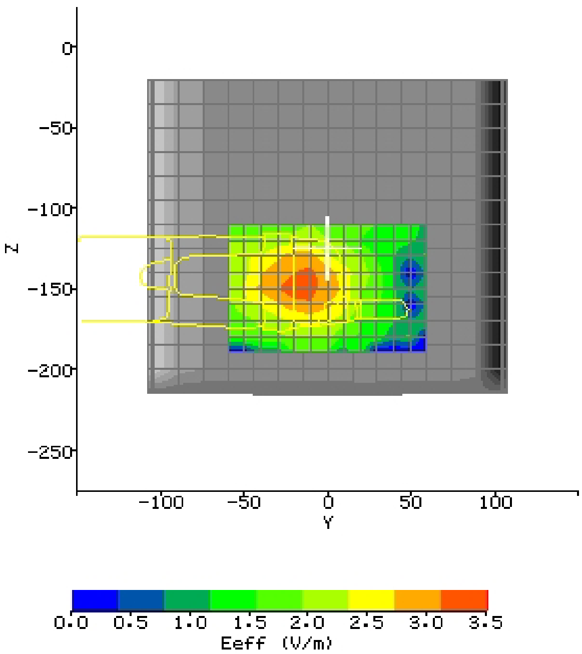
X	Y	Z
78.1	-32.0	-146.2

Plot #17 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-190.0	-110.0	8.0



Plot #18 (1/2)

Date:	2007/12/10	**Position:**	Rear side 0 mm to phantom
Filename:	18VT-802C_rear0(wo)_ch high.txt	**Phantom:**	HeadBox2-test.csv
Device Tested:	VT-802C	**Head Rotation:**	0
Antenna:	Dipole	**Test Frequency:**	2479.399 MHz
Shape File:	VT-802C_R_wo keypress.csv	**Power Level:**	18.94 dBm

Probe: 0146

Cal File: SN0146_2450_CW_BODY

Cal Factors:

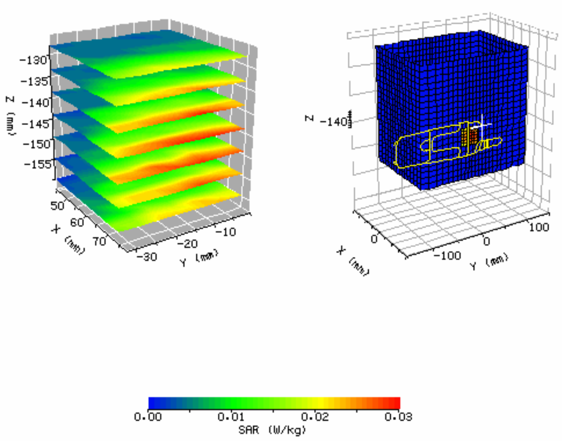
	X	Y	Z
Air	433	372	395
DCP	20	20	20
Lin	.538	.538	.538

Amp Gain: 2

Averaging: 1

Batteries Replaced: -

Liquid:	15.5cm
Type:	2450 MHz Body
Conductivity:	1.936
Relative Permittivity:	52.939
Liquid Temp (deg C):	23
Ambient Temp (deg C):	23
Ambient RH (%):	56
Density (kg/m3):	1000
Software Version:	2.41VPM



ZOOM SCAN RESULTS:

Spot SAR (W/kg):

Start Scan	End Scan
0.009	0.009

Change during Scan (%) 0

Max E-field (V/m): 4.08

Max SAR (W/kg)

1g	10g
0.026	0.017

Location of Max (mm):

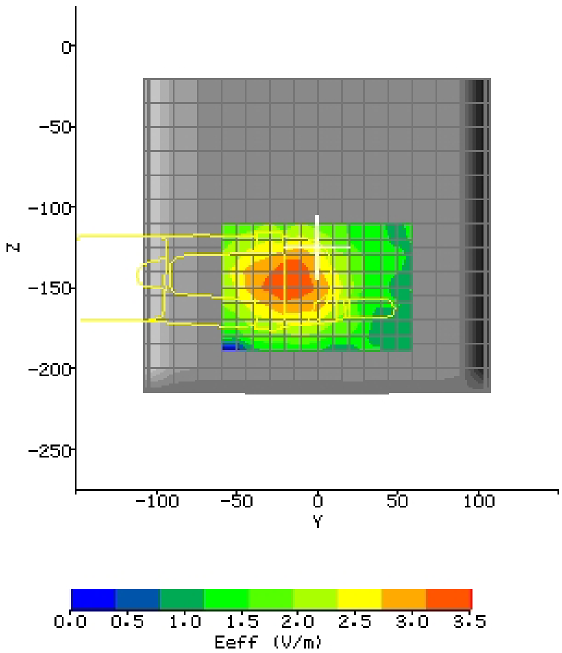
X	Y	Z
78.1	-32.0	-144.9

Plot #18 (2/2)

AREA SCAN:

Scan Extent:

	Min	Max	Steps
Y	-60.0	60.0	12.0
Z	-190.0	-110.0	8.0



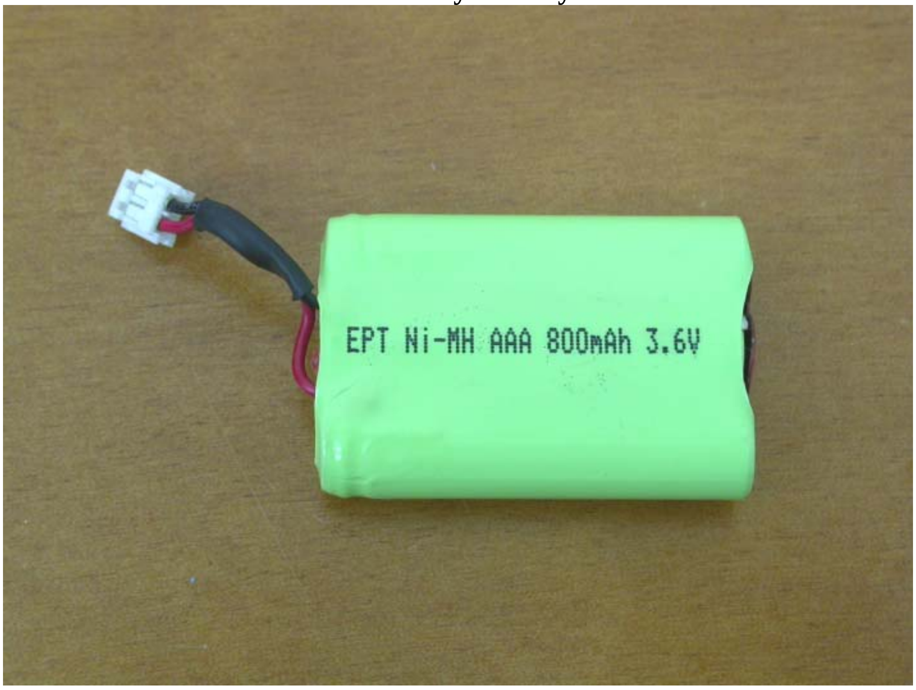
APPENDIX B - Photographs

Exterior photo 1
Headset with keypress

Exterior 2
Headset without keypress

Accessory- plastic belt-clip

Accessory-Battery



Accessory-Battery

APPENDIX C- E-Field Probe and 2450MHz Balanced Dipole Antenna Calibration Data

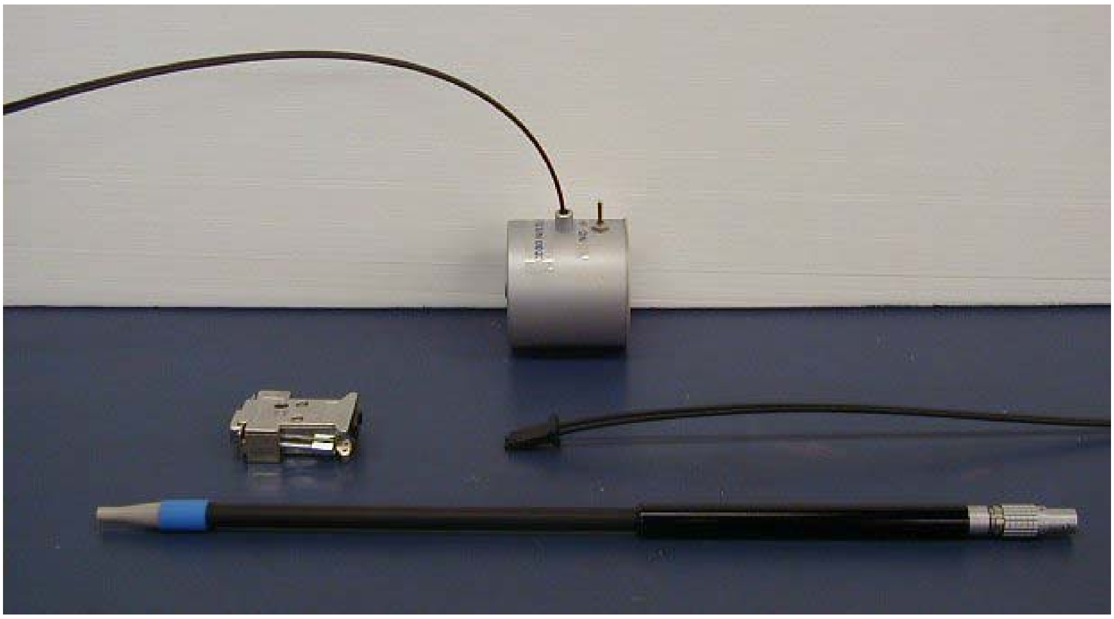
IMMERSIBLE SAR PROBE

CALIBRATION REPORT

Part Number: IXP – 050

S/N 0146

April 2007



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Fax: +44 (0) 1306 631 834
e-mail: enquiries@indexsar.com

Calibration Certificate 0704/0146
Dosimetric E-field Probe

Type:	**IXP-050**

Manufacturer:	**IndexSAR, UK**

Serial Number:	**0146**

Place of Calibration:	**IndexSAR, UK**

IndexSAR Limited hereby declares that the IXP-050 Probe named above has been calibrated for conformity to the IEEE 1528 and CENELEC EN 50361 standards on the date shown below.

Date of Initial Calibration:	17th **April 2007**

The probe named above will require a calibration check on the date shown below.

Next Calibration Date:	**April 2008**

The calibration was carried out using the methods described in the calibration document.
Where applicable, the standards used in the calibration process are traceable to the UK's National Physical Laboratory.

Calibrated By:	A. Brinklow

Approved By:	M.J. Manning

Please keep this certificate with the calibration document. When the probe is sent for a calibration check, please include the calibration document.

INTRODUCTION

This Report presents measured calibration data for a particular Indexsar SAR probe (S/N 0146) 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 four stages

1) Determination of the channel sensitivity factors which optimise the probe's overall rotational isotropy in 1800MHz brain fluid
2) Determination of the channel sensitivity factors and angular offset of the X channel which together optimise the probe's spherical isotropy in 1800MHz brain fluid
3) Numerical combination of the two sets of channel sensitivity factors to give both acceptable rotational isotropy and acceptable spherical isotropy values
4) 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

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):

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

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

3. Selecting channel sensitivity factors to optimise isotropic response

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

To do this, a 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.

4. Measurement of Spherical Isotropy

The setup for measuring the probe's spherical isotropy is shown in Figure 2.

A box phantom containing 1800MHz 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.

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.

5. 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:

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

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

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

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

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

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

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

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

During calibration, the probe is lowered carefully until it is just touching the cross-sectional centre of the dielectric window. 200 samples are then taken and written to an Excel template file before moving the probe vertically upwards. This cycle is repeated 150 times. The vertical separation between readings is determined from practical considerations of the expected SAR decay rate, and range from 0.2mm steps at low frequency, through 0.1mm at 2450MHz, down to 0.05mm 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.

For 450 MHz calibrations, a slightly different technique must be used — the equatorial response of the probe-under-test is compared with the equivalent response of a probe whose 450MHz characteristics have already been determined by NPL. The conversion factor of the probe-under-test can then be deduced.

VPM (Virtual Probe Miniaturisation)

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

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

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

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

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

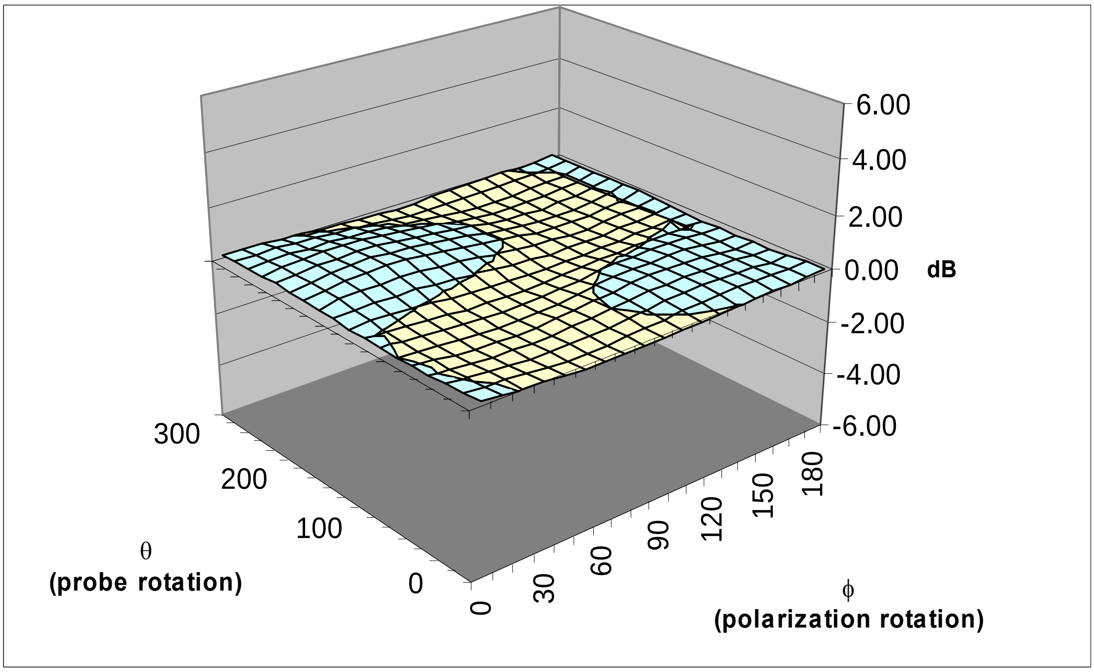
CALIBRATION FACTORS MEASURED FOR PROBE S/N 0146

The probe was calibrated at 900, 1800, and 2450 MHz in liquid samples representing brain and body liquid 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 0146 at 900MHz after VPM
(rotational isotropy axial +/-0.17dB, spherical isotropy +/-0.37dB)

Probe tip radius	1.25
X Ch. Angle to red dot	9.2

	Head		Body	
Frequency	**Bdy. Corrn. – f(0)**	**Bdy. Corrn. – d(mm)**	**Bdy. Corrn. – f(0)**	**Bdy. Corrn. – d(mm)**
900	0.94	1.4	1.05	1.4
1800	0.88	1.4	0.71	1.7
2450	0.96	1.3	0.58	2.0

SUMMARY OF CALIBRATION FACTORS FOR PROBE IXP-050 S/N 0146

Spherical isotropy measured at 900MHz	0.37	(+/-) dB

	X	Y	Z	
Air Factors	433	372	395	(V*200)
CW DCPs	20	20	20	(V*200)

Freq (MHz)	Axial Isotropy (+/- dB)		SAR ConvF (liq/air)		Notes
	Head	Body	Head	Body	
900	0.17	-	0.348	0.346	1,2
1800	-	-	0.412	0.451	1,2
2450	-	-	0.467	0.538	1,2

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

PROBE SPECIFICATIONS

Indexsar probe 0146, 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 0146	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 0146	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 0146	CENELEC [1]	IEEE [2]
Axial rotation with probe normal to source (+/- dB)	0.17 (See table above)	0.5	0.25
Spherical isotropy covering all orientations to source (+/- dB)	0.37	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.

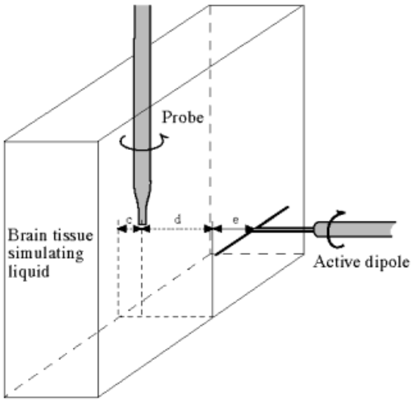


Figure 1. Spherical isotropy jig showing probe, dipole and box filled with simulated brain liquid (see Ref [2], Section A.5.2.1)

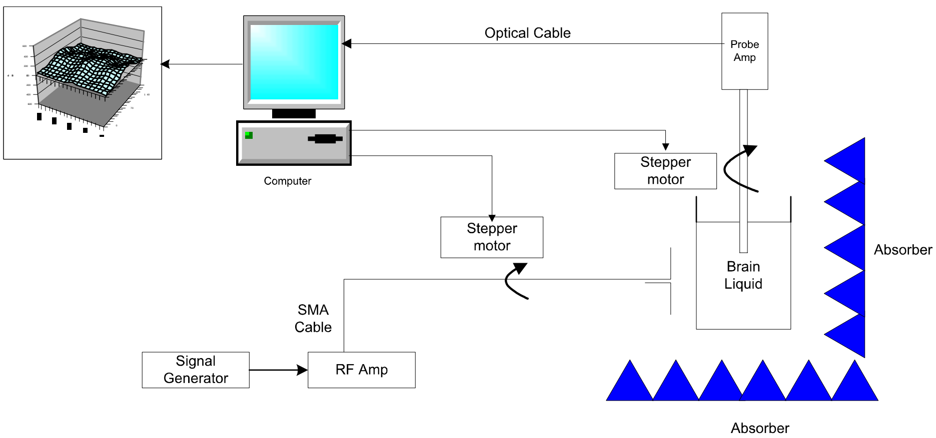


Figure 2. Schematic diagram of the test geometry used for isotropy determination

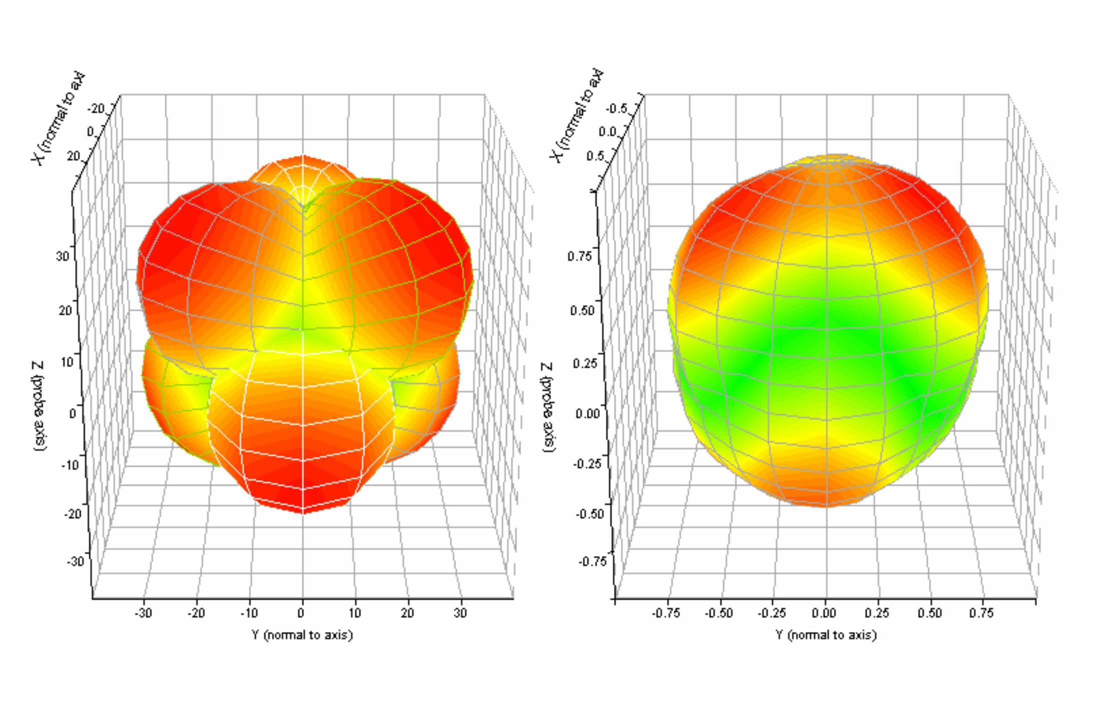


Figure 3. Graphical representation of a probe's response to fields applied from each direction. The diagram on the left shows the individual response characteristics of each of the three channels and the diagram on the right shows the resulting probe sensitivity in each direction. The colour range in the figure images the lowest values as blue and the maximum values as red. For probe S/N 0146, this range is (+/-) 0.37dB.

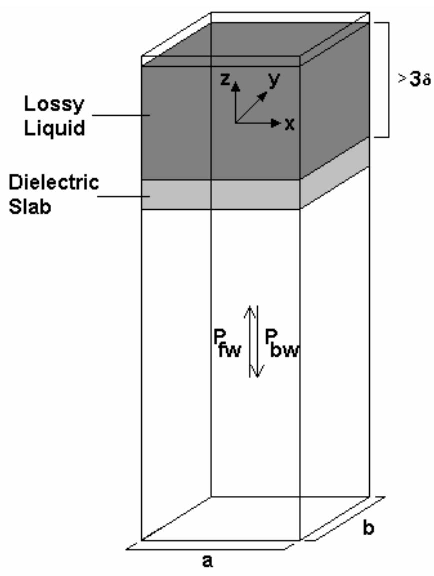


Figure 4. Geometry used for waveguide calibration (after Ref [2]. Section A.3.2.2)

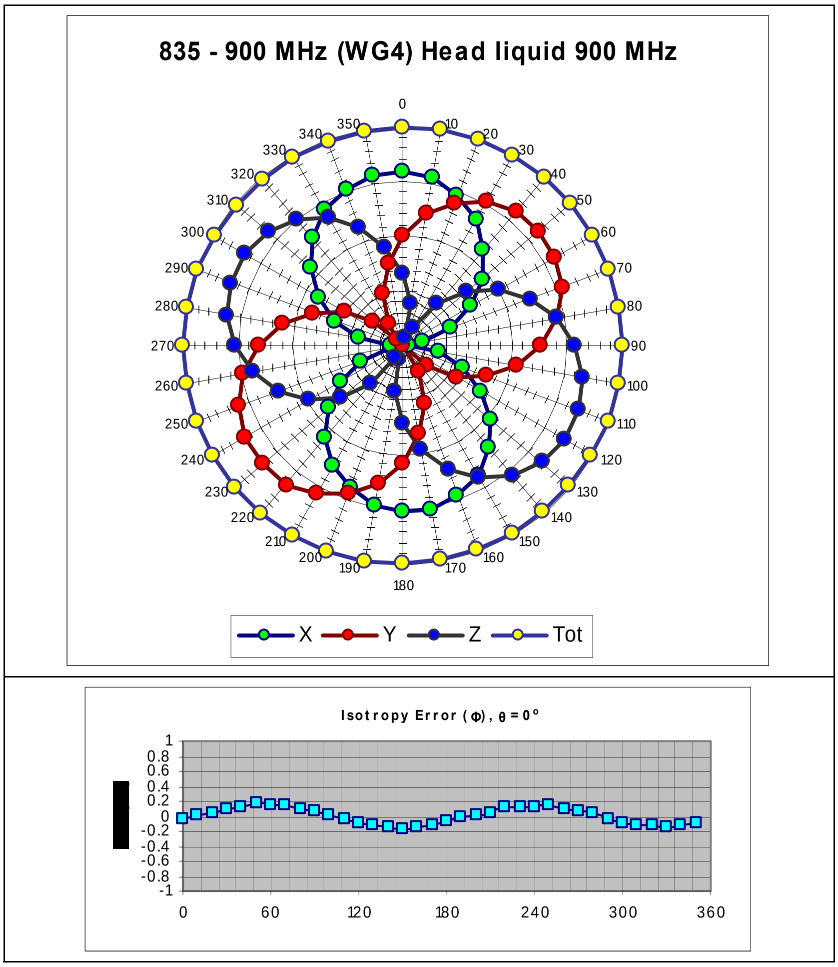


Figure 5. The rotational isotropy of probe S/N 0146 obtained by rotating the probe in a liquid-filled waveguide at 900 MHz.

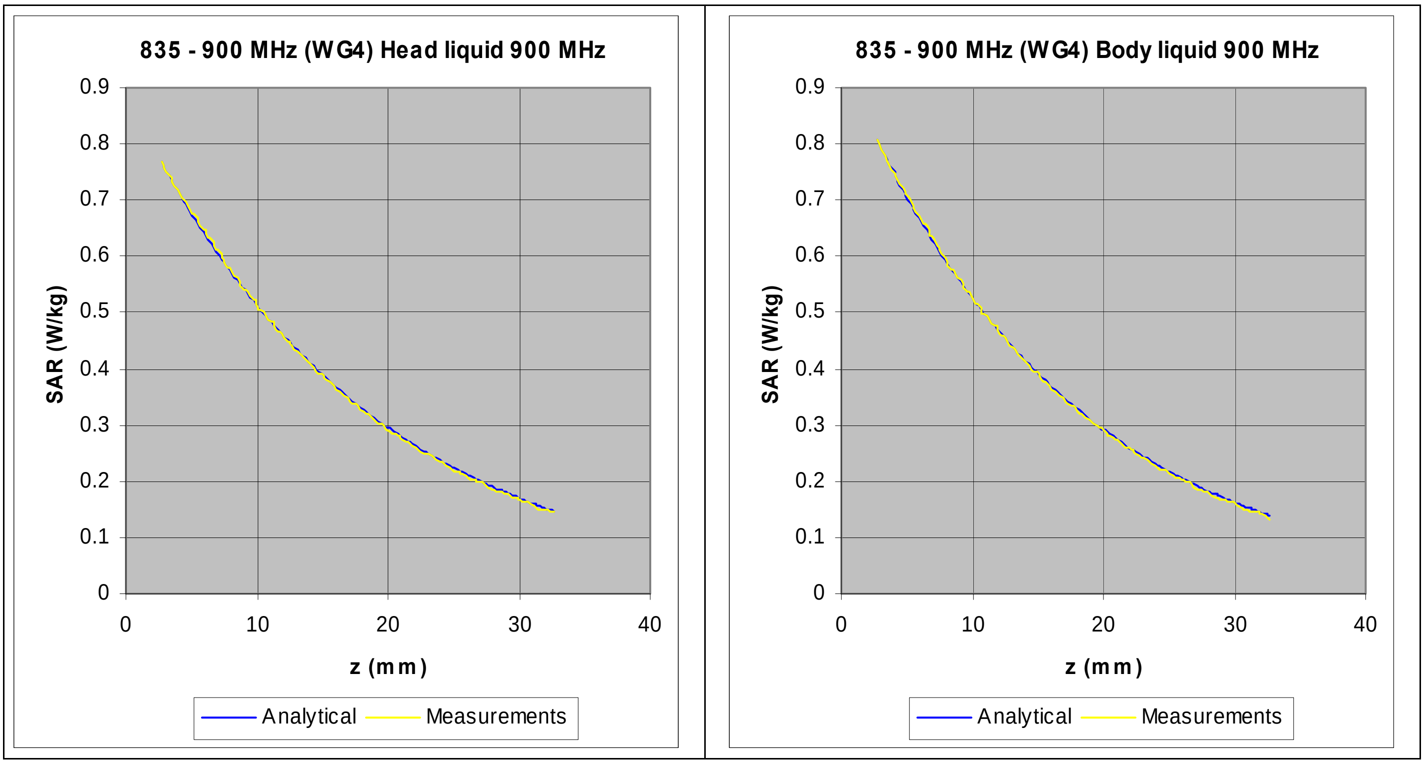


Figure 6. The measured SAR decay function along the centreline of the WG4 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

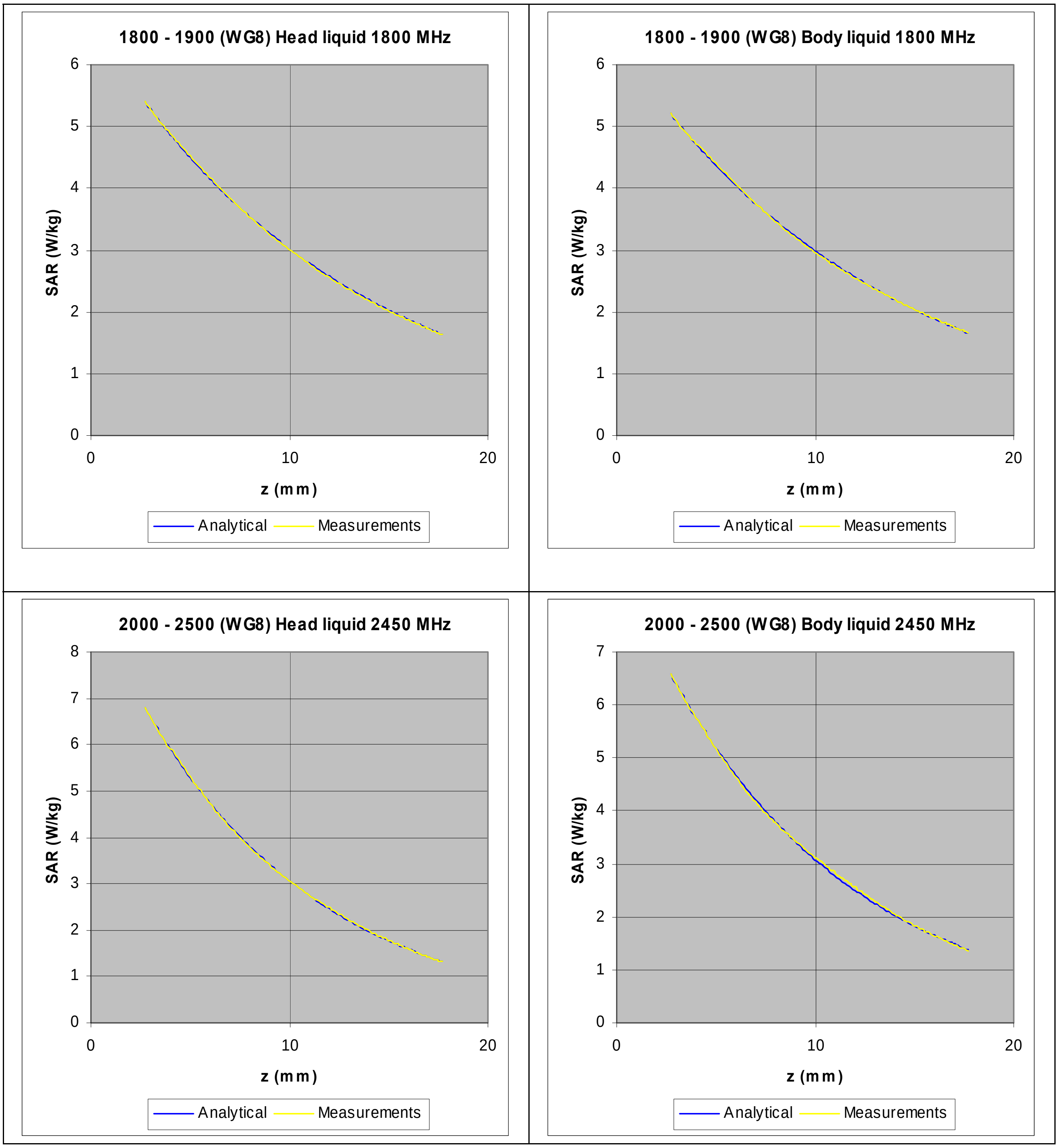


Figure 7. The measured SAR decay function along the centreline of the R22 waveguide with conversion factors adjusted to fit to the theoretical function for the particular dimension, frequency, power and liquid properties employed.

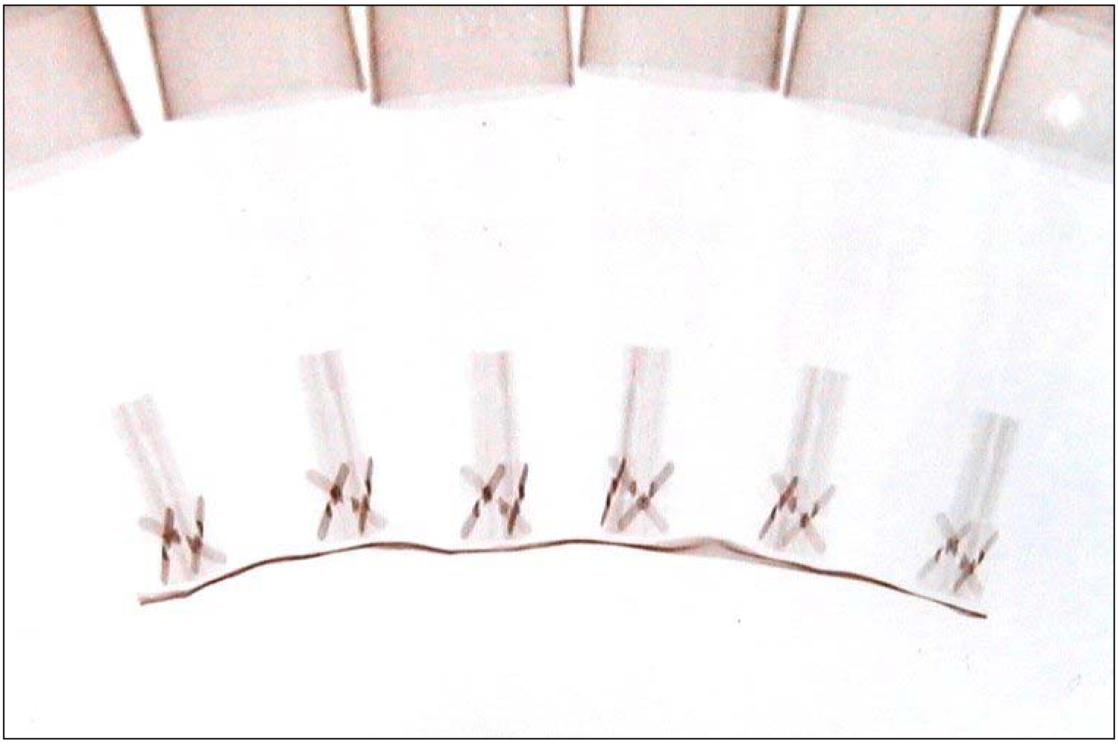


Figure 8: X-ray positive image of 5mm probes

Table indicating the dielectric parameters of the liquids used for calibrations at each frequency

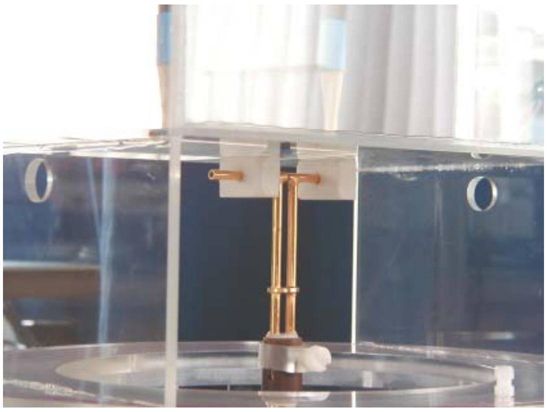
Liquid used	*Relative permittivity (measured)*	*Conductivity (S/m) (measured)*
900 MHz BRAIN	41.98	0.98
900 MHz BODY	48.40	1.12
1800 MHz BRAIN	38.95	1.35
1800 MHz BODY	53.98	1.51
2450 MHz BRAIN	39.04	1.85
2450 MHz BODY	53.58	2.05

Report No. SN0048_2450
15th October 2007

INDEXSAR
2450 MHz Validation Dipole
Type IXD-090 **S/N 0048**

Performance measurements

- ***Dr Tony Brinklow***



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1. Measurement Conditions

Measurements were performed using a box-shaped phantom made of PMMA with dimensions designed to meet the accuracy criteria for reasonably-sized phantoms that do not have liquid capacities substantially in excess of the volume of liquid required to fill the Indexsar upright SAM phantoms used for SAR testing of handsets against the ear. The wall thickness was 2mm.

An Anritsu MS4623B vector network analyser was used for the return loss measurements. The dipole was placed in a special holder made of low-permittivity, low-loss materials. This holder enables the dipole to be positioned accurately in the centre of the wall of the Indexsar box-phantom used for flat-surface testing and validation checks.

The validation dipoles are supplied with special spacers made from a low-permittivity, low-loss foam material. These spacers are fitted to the dipole arms to ensure that, when the dipole is offered up to the phantom surface, the spacing between the dipole and the liquid surface is accurately aligned according to the guidance in the relevant standards documentation [1]. The spacers are rectangular with a central hole equal to the dipole arm diameter and dimensioned so that the longer side can be used to ensure a spacing of 15mm from the liquid in the phantom (for tests at 1000MHz and below) and the shorter side can be used for tests at 1000MHz and above to ensure a spacing of 10mm from the liquid in the phantom. The spacers are made on a CNC milling machine with an accuracy of $1/40^{th}$ mm but they may suffer wear and tear and need to be replaced periodically. The material used is Rohacell, which has a relative permittivity of approx. 1.05 and a negligible loss tangent.

The apparatus supplied by Indexsar for dipole validation tests thus includes:

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. The constructed dipoles are easily deformed, if mis-handled, and periodic checks need to be made of their symmetry.

Rohacell foam spacers designed for presenting the dipoles to 2mm thick PMMA box phantoms. These components also suffer wear and tear and should be replaced when the central hole is a loose-fit on the dipole arms or if the edges are too worn to ensure accurate alignment. The standard spacers are dimensioned for use with 2mm wall thickness (additional spacers are available for 4mm wall thickness).

2. SAR Measurement

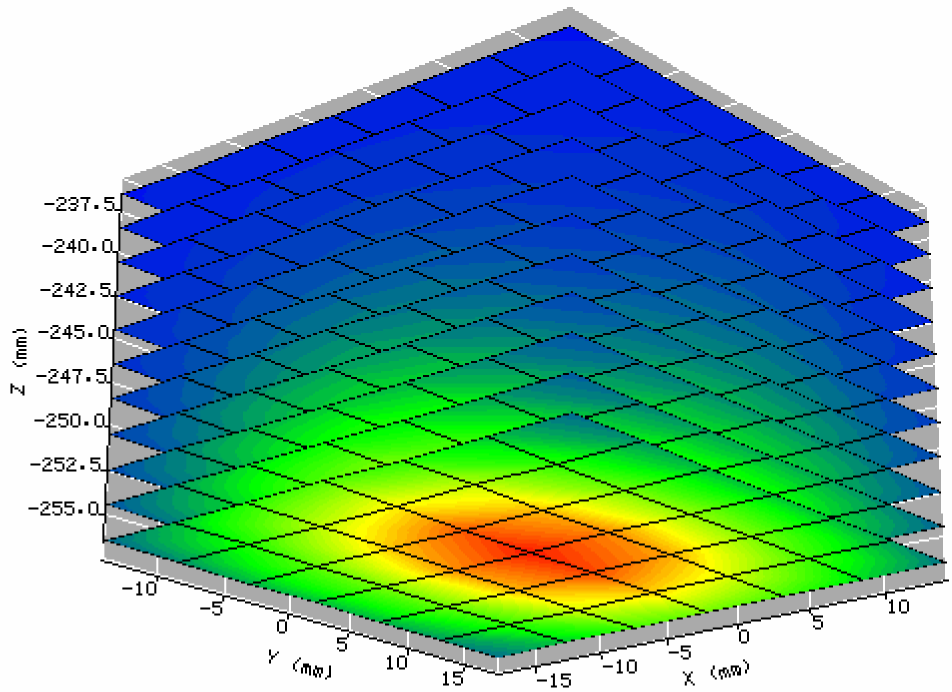
SAR validation checks have been performed using representative 2450MHz dipoles with the box-phantom located on the SARA2 phantom support base on the SARA2 robot system. Tests were then conducted at a feed power level of approx. 0.25W. The actual power level was recorded and used to normalise the results obtained to the standard input power conditions of 1W (forward power). The ambient temperature was 22°C +/- 1°C and the relative humidity was around 32% during the measurements.

The phantom was filled with a 2450MHz brain liquid using a recipe from [1], which has the following electrical parameters (measured using an Indexsar DiLine kit) at 2450MHz:

Relative Permittivity	**38.92**
Conductivity	**1.83 S/m**

The SARA2 software version 2.54 VPM was used with Indexsar IXP_050 probe Serial Number 0127 previously calibrated 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:

Averaged over 1 cm3 (1g) of tissue **48.52 W/kg**
(Standard 52.4 difference of -7.4%)
Averaged over 10cm3 (10g) of tissue **22.77 W/kg**
(Standard 24.0 difference of -5.1%)
These results can be compared with reference values from Table 8.1 in [1]. The agreement is within 10%.

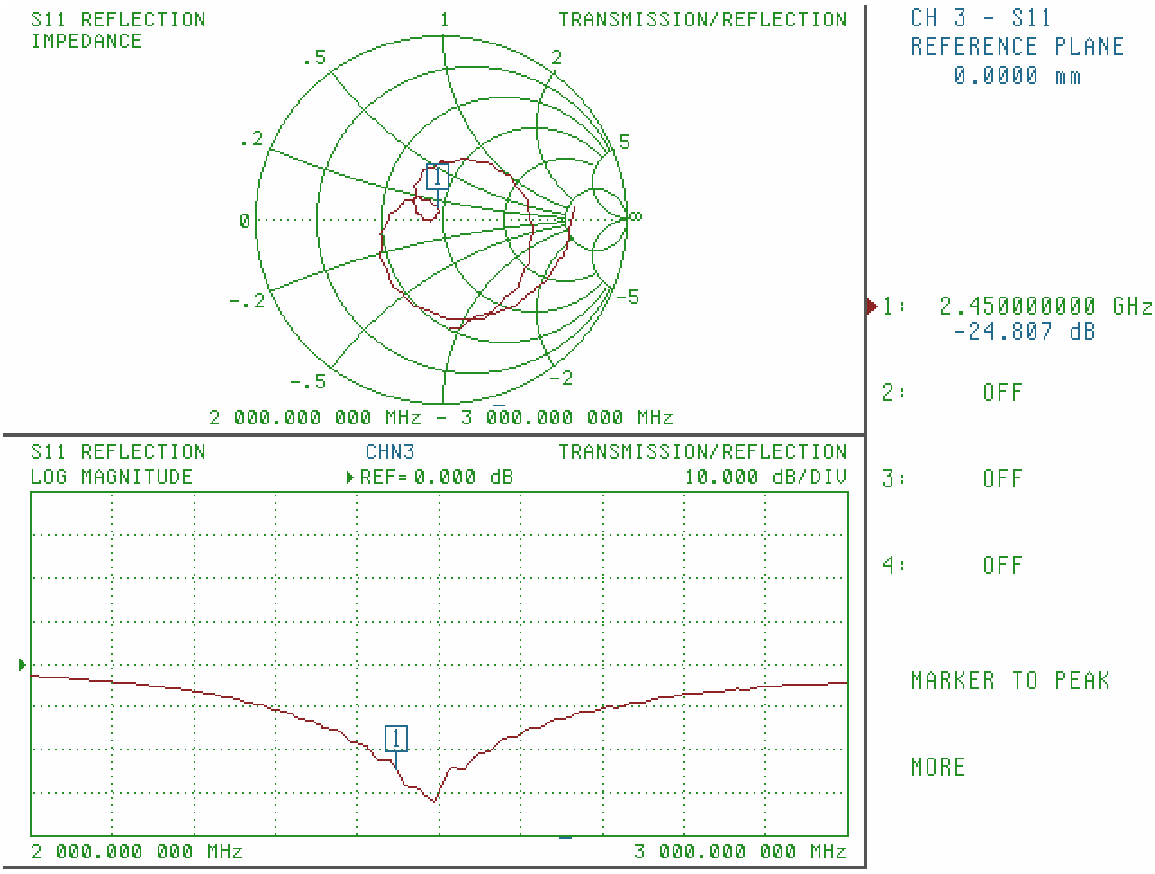
3. Dipole impedance and return loss

The dipoles are designed to have low return loss ONLY when presented against a lossy-phantom at the specified distance. A Vector Network Analyser (VNA) was used to perform a return loss measurement on the specific dipole when in the measurement-location against the box phantom. The distance was as specified in the standard i.e. 15mm from the liquid (for 2450MHz). The Indexsar foam spacers (described above) were used to ensure this condition during measurement.

The impedance was measured at the SMA-connector with the network analyser.
The following parameters were measured:

Dipole impedance at 2450 MHz Re{Z} = **47.8 Ω**
Im{Z} = **5.2 Ω**

Return loss at 2450MHz **-24.8 dB**



4. Dipole handling

The dipoles are made from standard, copper-sheathed coaxial cable. In assembly, the sections are joined using ordinary soft-soldering. This is necessary to avoid excessive heat input in manufacture, which would destroy the polythene dielectric used for the cable. The consequence of the construction material and the assembly technique is that the dipoles are fragile and can be deformed by rough handling. Conversely, they can be straightened quite easily as described in this report.

If a dipole is suspected of being deformed, a normal workshop lathe can be used as an alignment jig to restore the symmetry. To do this, the dipole is first placed in the headstock of the lathe (centred on the plastic or brass spacers) and the headstock is rotated by hand (do NOT use the motor). A marker (lathe tool or similar) is brought up close to the end of one dipole arm and then the headstock is rotated by 0.5 rev. to check the opposing arm. If they are not balanced, judicious deformation of the arms can be used to restore the symmetry.

If a dipole has a failed solder joint, the dipole can be fixed down in such a way that the arms are co-linear and the joint re-soldered with a reasonably-powerful electrical soldering iron. Do not use gas soldering irons. After such a repair, electrical tests must be performed as described below.

Please note that, because of their construction, the dipoles are short-circuited for DC signals.

5. Tuning the dipole

The dipole dimensions are based on calculations that assumed specific liquid dielectric properties. If the liquid dielectric properties are somewhat different, the dipole tuning will also vary. A pragmatic way of accounting for variations in liquid properties is to 'tune' the dipole (by applying minor variations to its effective length). For this purpose, Indexsar can supply short brass tube lengths to extend the length of the dipole and thus 'tune' the dipole. It cannot be made shorter without removing a bit from the arm. An alternative way to tune the dipole is to use copper shielding tape to extend the effective length of the dipole. Do both arms equally.

It should be possible to tune a dipole as described, whilst in place in the measurement position as long as the user has access to a VNA for determining the return loss.

6. 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.