

Test Report

Specific Absorption Rate (SAR) Test Report
for
LXE, Inc.
on the
Radio
LXE P/N: 154597-0001

Test Report: 20013373
Date of Report: April 25, 2000



NVLAP Laboratory Code 200201-0
Accredited for testing to FCC Parts 15

Tested by: <i>Xi-Ming Yang</i>	Xi-Ming Yang
Reviewed by: <i>David Chernomordik</i>	David Chernomordik

All services undertaken are subject to the following general policy: Reports are submitted for exclusive use of the client to whom they are addressed. Their significance is subject to the adequacy and representative character of the samples and to the comprehensiveness of the tests, examinations or surveys made. This report shall not be reproduced except in full, without written consent of Intertek Testing Services, NA Inc. This report must not be used to claim product endorsement by NVLAP, NIST nor any other agency of the U.S. Government.

Table of Contents

1.0	Job description	3
1.1	Client Information	3
1.2	Equipment under test (EUT)	3
1.3	Test plan reference.....	4
1.4	System test configuration.....	4
1.4.1	System block diagram & Support equipment	4
1.4.2	Test Position	5
1.4.3	Test Condition	6
1.5	Modifications required for compliance	6
1.6	Additions, deviations and exclusions from standards	6
2.0	SAR EVALUATION.....	7
2.1	SAR Limits	7
2.2	Configuration Photographs	8
2.4	Evaluation Procedures	10
2.5	Test Results	10
3.0	TEST EQUIPMENT	12
3.1	Equipment List	12
3.2	Muscle Tissue Simulating Liquid.....	13
3.3	E-Field Probe Calibration	13
3.4	Measurement Uncertainty	14
3.5	Measurement Tractability	14
4.0	WARNING LABEL INFORMATION - USA.....	15
5.0	REFERENCES.....	16
APPENDIX A - SAR Evaluation Data		17
APPENDIX B - E-Field Probe Calibration Data.....		18

1.0 Job description**1.1 Client Information**

The EUT has been tested at the request of

Company: LXE, Inc.
125 Technology Parkway
PO Box 926000
Norcross GA 30092
USA

Name of contact: Mr. Sam Wismer
Telephone: 770.447.4224 Ext. 3654
Fax: 770.447.6928

1.2 Equipment under test (EUT)**Product Descriptions:**

Equipment	XCVR, SUB-ASSY, 900MHz, PCMCIA, V3 900MHz FHSS 250mW "902.2MHz – 927.8 MHz"		
Trade Name	LXE, Inc.	P/N.	154597-0001
FCC ID	N/A	S/N No.	N/A
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band (uplink)	902.2-927.8 MHz	System	FHSS

EUT Antenna Description			
Type	Dipole	Configuration	Fixed, 360° Rotation
Dimensions	30mm (L),	Gain	0 dBi
Location	N/A		

Use of Product : Data communications

Manufacturer: SAME as above.

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

EUT receive date: 4/14/00

EUT received condition: Good working condition prototype

Test start date: 4/14/00

Test end date: 4/16/00

1.3 Test plan reference

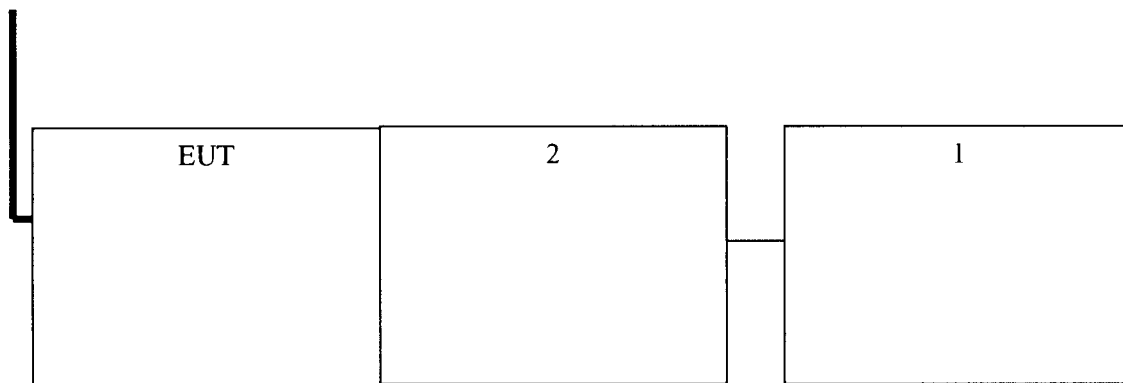
FCC rule part 2.1093, FCC Docket 96-326 & Supplement C to OET Bulletin 65

1.4 System test configuration

1.4.1 System block diagram & Support equipment

The diagram shown below details test configuration of the equipment under test.

Unit with antenna



S: Shielded	U: Unshield	F: With Ferrite Core
--------------------	--------------------	-----------------------------

Support equipment					
Equip. #	Equipment	Manufacturer	Model #	S/N #	FCC ID
1	Notebook Computer	Extender	PA1123U	0361997	N/A
2	Test Bed	LXE	N/A	N/A	N/A

1.4.2 Test Position

Three test configurations were used to show compliance with the FCC RF human exposure requirements. In all configurations, the EUT was configured for testing in a typical fashion (as a customer would normally use it). Due to the application and usage of the product, SAR measurements with the human head region are not necessary. Table 1 below describes the setup and condition:

Table 1, Equipment setup	
Configuration	Description
A	• Antenna in horizontal position, distance from antenna to Phantom = 2mm • Simulating close proximity of human body

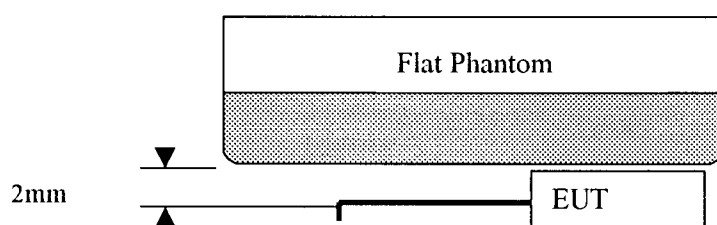


Figure 1a: Configuration A

1.4.3 Test Condition

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

EUT Antenna	Fixed length	Orientation	N/A
Usage	Operates with a portable computer	Distance between antenna axis at the joint and the liquid surface:	2mm
Simulating human Body/hand	Yes	EUT Battery	Unit powered from host computer.
Power output	24.3 dBm (Maximum power at antenna port)		

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

Antenna port power measurement was performed, with the HP 435A power meter, before and after the SAR tests to ensure that the EUT operated at the highest power level.

1.5 Modifications required for compliance

No modifications were implemented by Intertek Testing Services.

1.6 Additions, deviations and exclusions from standards

No additions, deviations or exclusions have been made from standard.

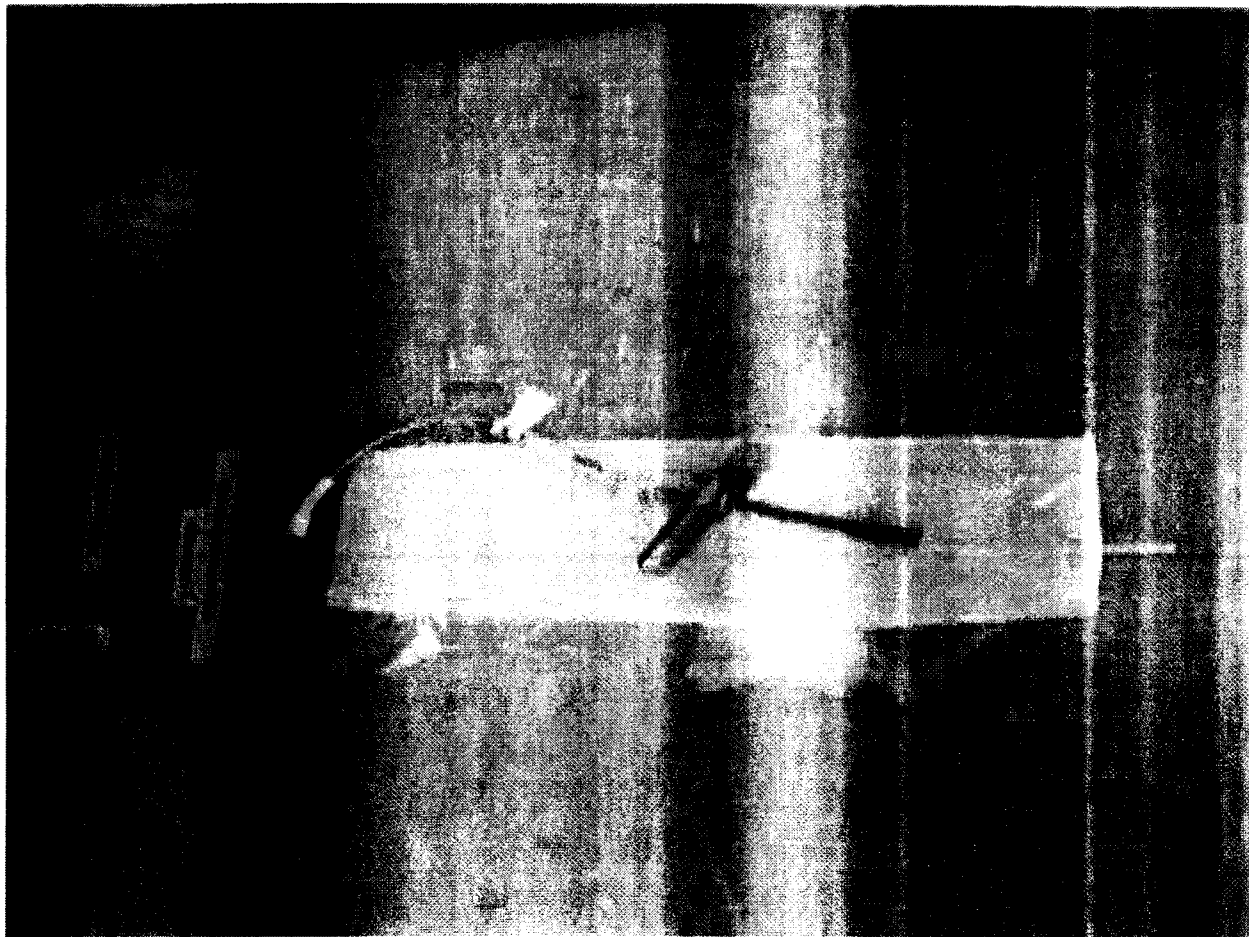
2.0 SAR EVALUATION**2.1 SAR Limits**

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

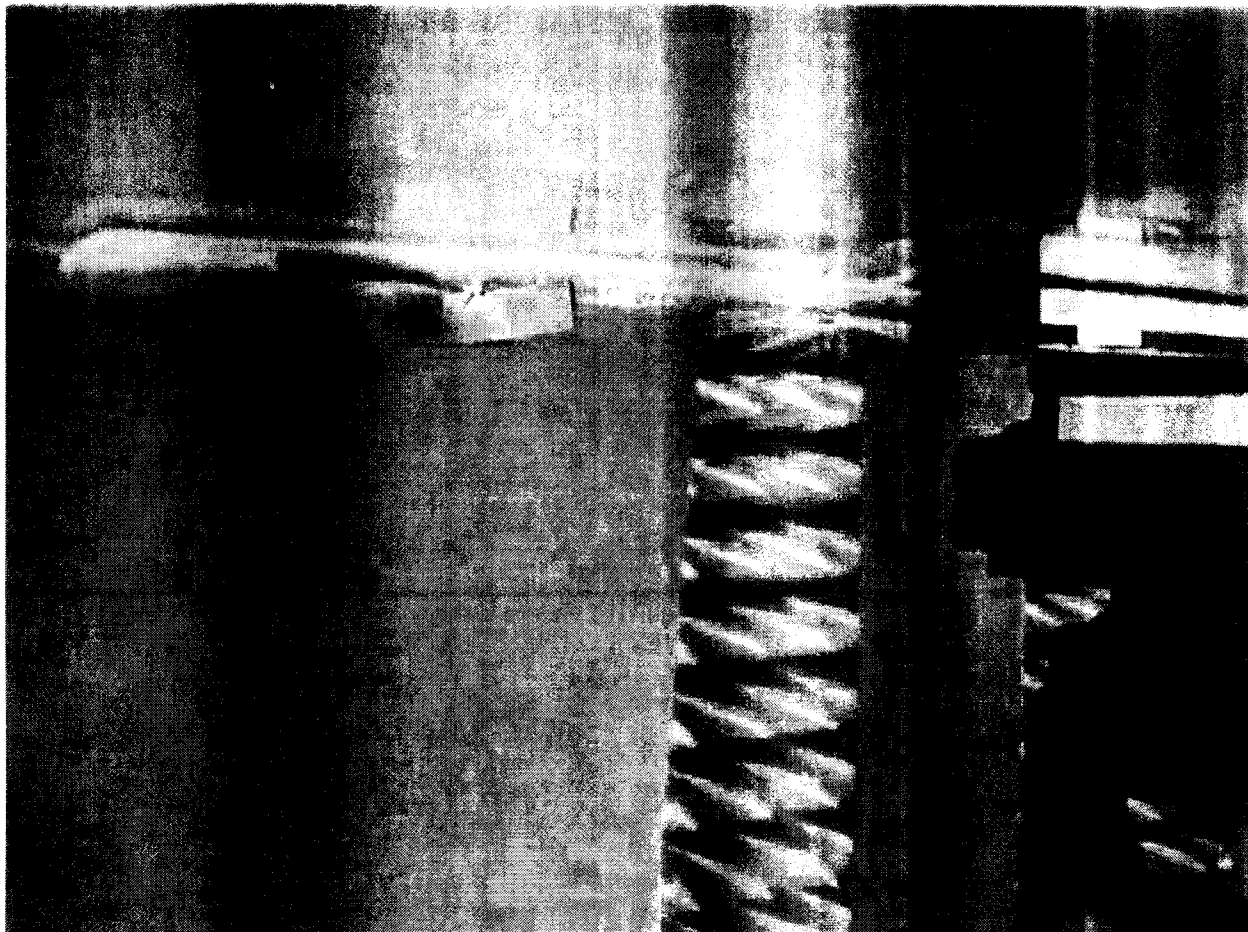
EXPOSURE (General Population/Uncontrolled Exposure environment)	SAR (W/kg)
Average over the whole body	0.08
Spatial Peak (1g)	1.60
Spatial Peak for hands, wrists, feet and ankles (10g)	4.00

2.2 Configuration Photographs

**Worst-Case SAR measurement
(Configuration A)**



**Worst-Case SAR measurement (cont.)
(Configuration A)**



2.3 System Verification

Prior to the assessment, the system was verified to the $\pm 5\%$ of the specifications by using the system validation kit. The validation was performed at 1800 MHz.

Validation kit	Targeted SAR _{1g} (mW/g)	Measured SAR _{1g} (mW/g)
D900V2, S/N #: 0013	4.03	3.97

2.4 Evaluation Procedures

The SAR evaluation was performed with the following procedures:

- a. SAR was measured at a fixed location above the reference point and used as a reference value for the assessing the power drop.
- b. The SAR distribution at the exposed side of the flat Phantom was measured at a distance of 30 mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 20 mm x 20 mm. Based on this data, the area of the maximum absorption was determined by spline interpolation.
- c. Around this point, a volume of 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 1.6 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 straight-forward 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.
- d. Re-measurement 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.

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. Detail 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:	LXE, Inc.	Model No.:	65XX-11 MBPS
Serial No.:	Not Labeled	Test Engineer:	Xi-Ming Yang

TEST CONDITIONS

Ambient Temperature	23.5 °C	Relative Humidity	55 %
Test Signal Source	Test Mode	Signal Modulation	CW
Output Power Before SAR Test	24.3 dBm	Output Power After SAR Test	24.3 dBm
Test Duration	20 Min. each test	Number of Battery Change	N/A. Powered from host PC

Configuration A (Human Body/Hand)

Channel	Operating Mode	Duty Cycle ratio	Antenna Position *	Measured SAR _{1g} (mW/g)	Measured SAR _{10g} (mW/g)
902	CW	1	Horizontal Front	1.08	0.580
915	CW	1	Horizontal Front	1.18	0.628
927	CW	1	Horizontal Front	1.36	0.713

Configuration B (Human Body/Hand)

Channel	Operating Mode	Duty Cycle ratio	Antenna Position *	Measured SAR _{1g} (mW/g)	Measured SAR _{10g} (mW/g)
902	CW	1	Horizontal Back	0.949	0.524
915	CW	1	Horizontal Back	1.11	0.585
927	CW	1	Horizontal Back	1.33	0.676

- Note:
- a) Worst case data were reported
 - b) Duty cycle factor included in the measured SAR data
 - c) Uncertainty of the system is not included
 - d) *. w.r.t. Notebook computer base

3.0 TEST EQUIPMENT**3.1 Equipment List**

The Specific Absorption Rate (SAR) tests were performed with the SPEAG model DASY 3 automated near-field scanning system which is package optimized for dosimetric evaluation of mobile radios [3].

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

SAR Measurement System			
EQUIPMENT	SPECIFICATIONS	S/N #	CAL. DATE
Robot	Stäubli RX60L Repeatability: $\pm 0.025\text{mm}$ Accuracy: 0.806×10^{-3} degree Number of Axes: 6	597412-01	N/A
E-Field Probe	ET3DV5 Frequency Range: 10 MHz to 6 GHz Linearity: ± 0.2 dB Directivity: ± 0.1 dB in brain tissue	1334	12/29/99
Data Acquisition	DAE3 Measurement Range: $1\mu\text{V}$ to $>200\text{mV}$ Input offset Voltage: $< 1\mu\text{V}$ (with auto zero) Input Resistance: 200 M	317	N/A
Phantom	Generic Twin V3.0 Type: Generic Twin, Homogenous Shell Material: Fiberglass Thickness: 2 ± 0.1 mm Capacity: 20 liter Ear spacer: 4 mm (between EUT ear piece and tissue simulating liquid)	N/A	N/A
Simulated Tissue	Mixture Please see section 6.2 for details	N/A	08/06/99
Power Meter	HP 435A w/ 8481H sensor Frequency Range: 100kHz to 18 GHz Power Range: $300\mu\text{W}$ to 3W	1312A01255	2/16/00

3.2 Muscle Tissue Simulating Liquid

Ingredient	Frequency (1800-1900 MHz)
Water	54.05%
Sugar	45.05%
Salt	0.1%
Bactericide	0.8 %

The dielectric parameters were verified prior to assessment using the HP 85070A dielectric probe kit and the HP 8753C network Analyzer. The dielectric parameters were:

Frequency (MHz)	ϵ_r^*	σ^* (mho/m)	ρ^{**} (kg/m ³)
815	56.5 $\pm$ 5%	0.94 $\pm$ 10%	1000

* Worst case uncertainty of the HP 85070A dielectric probe kit

** Worst case assumption

3.3 E-Field Probe Calibration

Probes were calibrated by the manufacturer in the TEM cell ifi 110. To ensure consistency, a strict protocol was followed. The conversion factor (ConF) between this calibration and the measurement in the tissue simulation solution was performed by comparison with temperature measurement and computer simulations. Probe calibration factors are included in Appendix C.

3.4 Measurement Uncertainty

The uncertainty budget has been determined for the DASY3 measurement system according to the NIS81 [5] and the NIST 1297 [6] documents and is given in the following table. The extended uncertainty (K=2) was assessed to be 23.5 %

UNCERTAINTY BUDGET				
Uncertainty Description	Error	Distrib.	Weight	Std.Dev.
Probe Uncertainty				
Axial isotropy	±0.2 dB	U-shape	0.5	±2.4 %
Spherical isotropy	±0.4 dB	U-shape	0.5	±4.8 %
Isotropy from gradient	±0.5 dB	U-shape	0	
Spatial resolution	±0.5 %	Normal	1	±0.5 %
Linearity error	±0.2 dB	Rectang.	1	±2.7 %
Calibration error	±3.3 %	Normal	1	±3.3 %
SAR Evaluation Uncertainty				
Data acquisition error	±1 %	Rectang.	1	±0.6 %
ELF and RF disturbances	±0.25 %	Normal	1	±0.25 %
Conductivity assessment	±10 %	Rectang.	1	±5.8 %
Spatial Peak SAR Evaluation Uncertainty				
Extrapol boundary effect	±3 %	Normal	1	±3 %
Probe positioning error	±0.1 mm	Normal	1	±1 %
Integrat. and cube orient	±3 %	Normal	1	±3 %
Cube shape inaccuracies	±2 %	Rectang.	1	±1.2 %
Device positioning	±6 %	Normal	1	±6 %
Combined Uncertainties				±11.7 %

3.5 Measurement Tractability

All measurements described in this report are traceable to National Institute of Standards and Technology (NIST) standards or appropriate national standards.

4.0 WARNING LABEL INFORMATION - USA

See attached page.

5.0 REFERENCES

- [1] ANSI, *ANSI/IEEE C95.1-1991: 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, 1992
- [2] Federal Communications Commission, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", OET Bulletin 65, FCC, Washington, D.C. 20554, 1997
- [3] Thomas Schmid, Oliver Egger, and Niels Kuster, "Automated E-field scanning system for dosimetric assessments", *IEEE Transaction on Microwave Theory and Techniques*, vol. 44, pp. 105-113, Jan. 1996.
- [4] Niels Kuster, Ralph Kastle, and Thomas Schmid, "Dosimetric evaluation of mobile communications equipment with known precision", *IEICE Transactions on Communications*, vol. E80-B, no. 5, pp. 645-652, May 1997.
- [5] NIS81, NAMAS, "The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddington, Middlesex, England, 1994.
- [6] Barry N. Taylor and Chris E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994.

APPENDIX A - SAR Evaluation Data

Please note that the graphical visualization of the phone position onto the SAR distribution gives only limited information on the current distribution of the device, since the curvature of the head results in graphical distortion. Full information can only be obtained either by H-field scans in free space or SAR evaluation with a flat phantom.

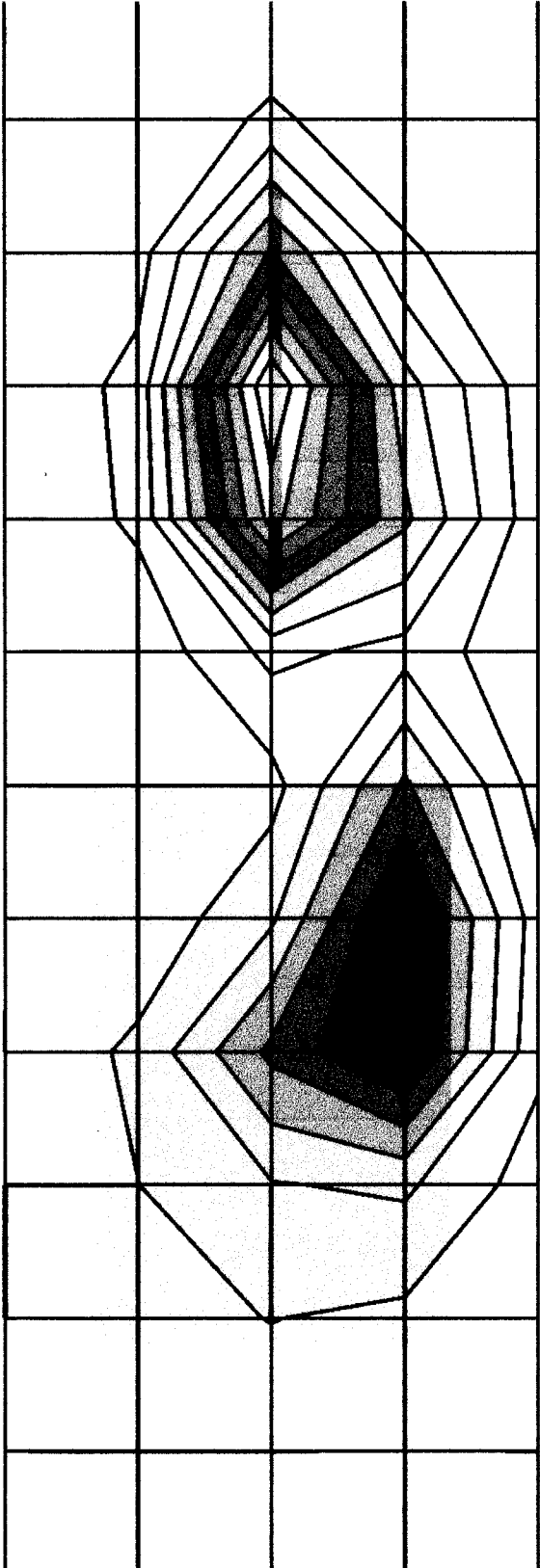
Powerdrift is the measurement of power drift of the device over one complete SAR scan.

Graph #	Configuration	Antenna Position	Channel (MHz)
1	A	Horizontal Front	902
2	A	Horizontal Front	915
3	A	Horizontal Front	927
4	B	Horizontal Back	902
5	B	Horizontal Back	915
6	B	Horizontal Back	927

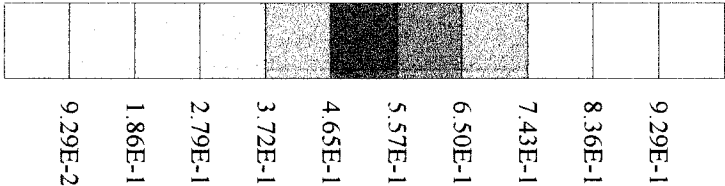
LXE 900MHz FH P/N:154597-0001

Plot # 1

Generic Twin Phantom; Flat Section; Position: (270°,90°), Frequency: 902 MHz
Probe: ET3DVS - SN1334; ConvF(5.50,5.50,5.50); Crest factor: 1.0; Muscle 900 MHz: $\sigma = 0.99$ mho/m $\epsilon_r = 55.7$ $\rho = 1.00$ g/cm³
Cube 5x5x7; SAR (1g): 1.08 mW/g, SAR (10g): 0.580 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.08 dB



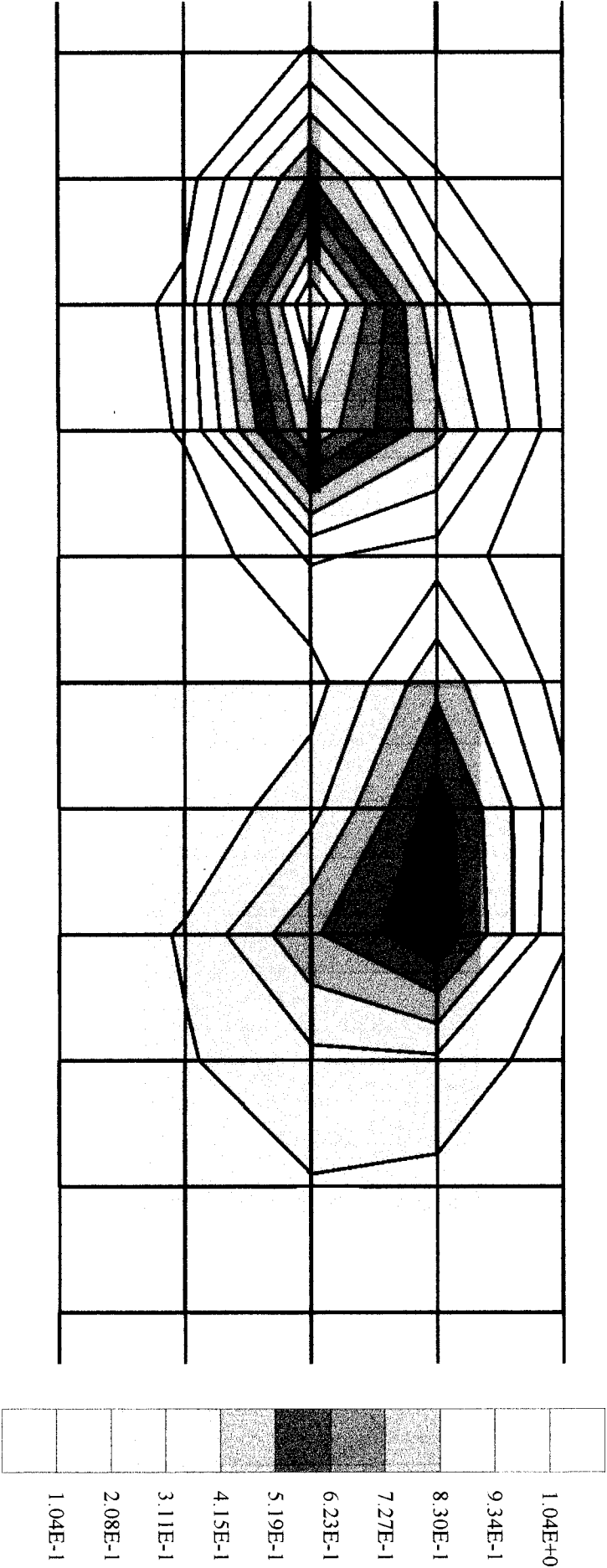
SAR_{tot} [mW/g]



LXE 900MHz FH P/N:154597-0001

Plot # 2

Generic Twin Phantom; Flat Section; Position: (270°,90°); Frequency: 915 MHz
Probe: ET3DV5 - SN1334; ConvF(5.50,5.50,5.50); Crest factor: 1.0; Muscle 900 MHz: $\sigma = 0.99 \text{ mho/m}$, $\epsilon_r = 55.7$, $\rho = 1.00 \text{ g/cm}^3$
Cubes (2): SAR (1g): 1.18 mW/g $\pm 0.03 \text{ dB}$, SAR (10g): 0.628 mW/g $\pm 0.06 \text{ dB}$, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.02 dB



LXE 900MHz FH P/N:154597-0001

Plot #3

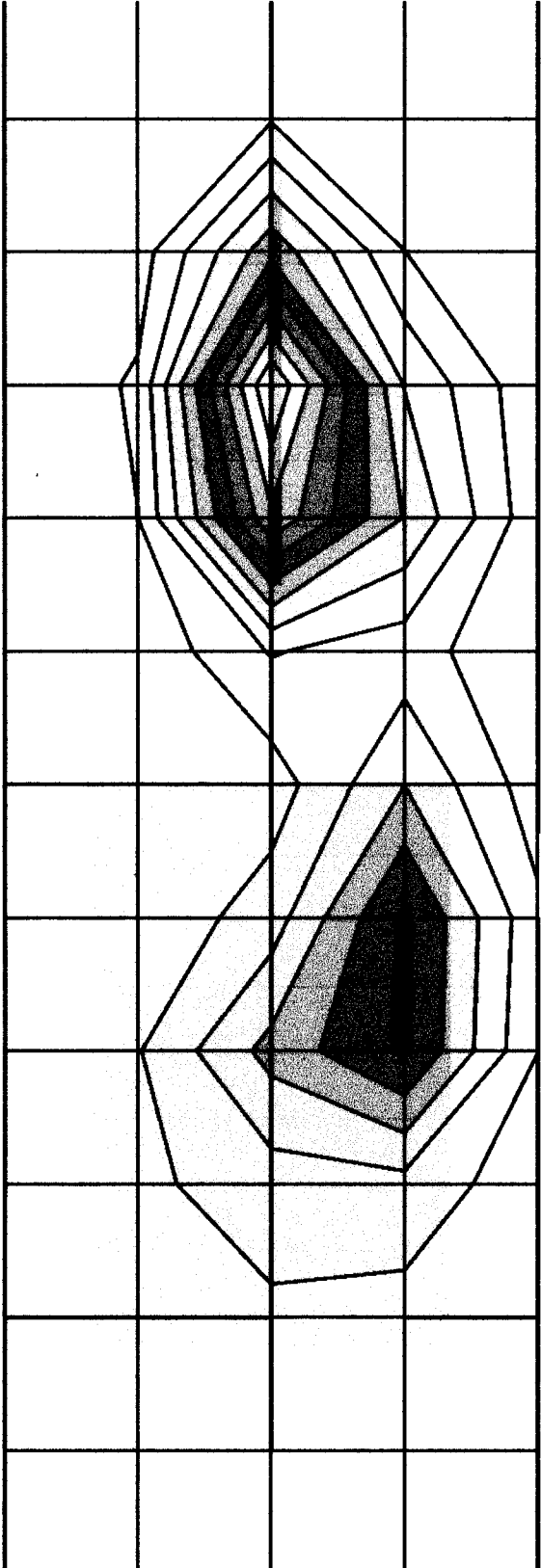
Generic Twin Phantom; Flat Section; Position: (270°,90°); Frequency: 927 MHz

Probe: ET3DVS - SN1334; ConvF(5.50,5.50,5.50); Crest factor: 1.0; Muscle 900 MHz: $\sigma = 0.99$ mho/m $\epsilon_r = 55.7$ $\rho = 1.00$ g/cm³

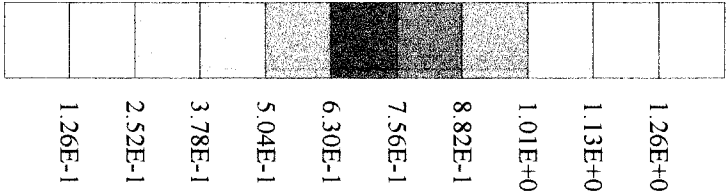
Cube 5x5x7; SAR (1g): 1.36 mW/g, SAR (10g): 0.713 mW/g, (Worst-case extrapolation)

Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0

Powerdrift: -0.02 dB



SAR_{Tot} [mW/g]



LXE 900MHz FH P/N:154597-0001

Plot # 4

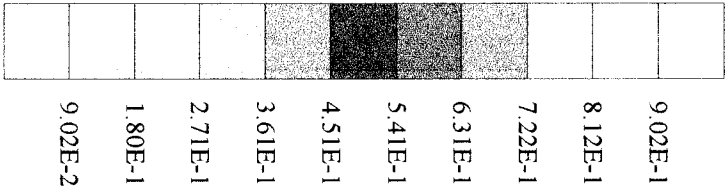
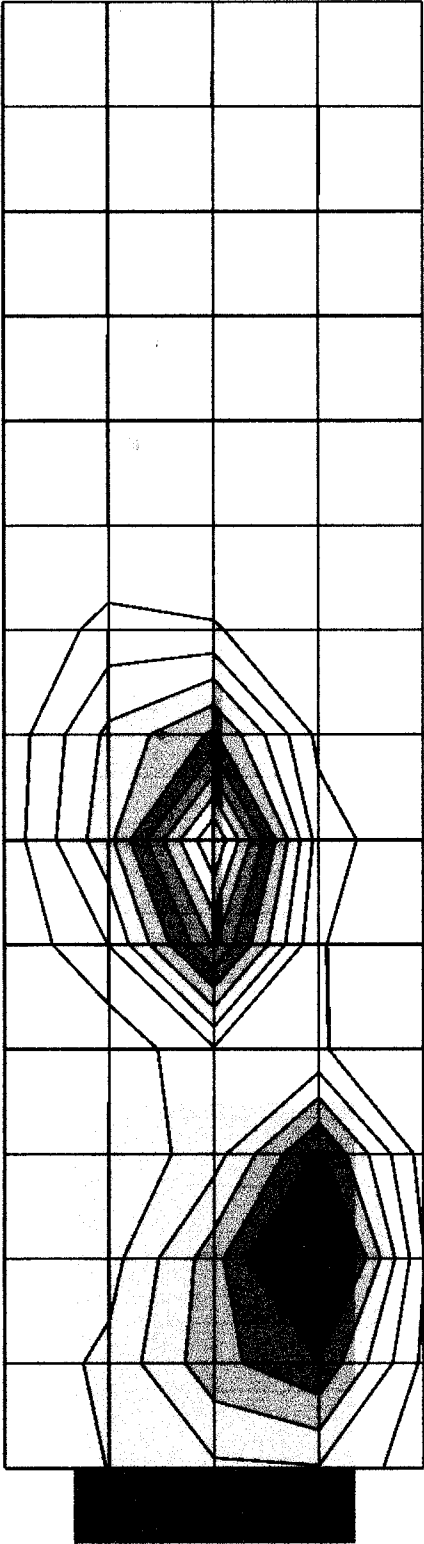
Generic: Twin Phantom; Flat Section; Position: (270°,90°), Frequency: 902 MHz

Probe: ET3DV5 - SN1334; ConvF(5.50,5.50,5.50); Crest factor: 1.0; Muscle 900 MHz: $\sigma = 0.99 \text{ mho/m } \epsilon_r = 55.7 \text{ } \rho = 1.00 \text{ g/cm}^3$

Cube 5x5x7; SAR (1g): 0.949 mW/g; SAR (10g): 0.524 mW/g; (Worst-case extrapolation)

Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0

Powerdrift: -0.06 dB



SAR_{tot} [mW/g]

LXE 900MHz FH P/N:154597-0001

Plot # 5

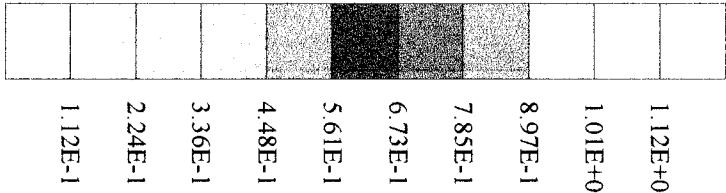
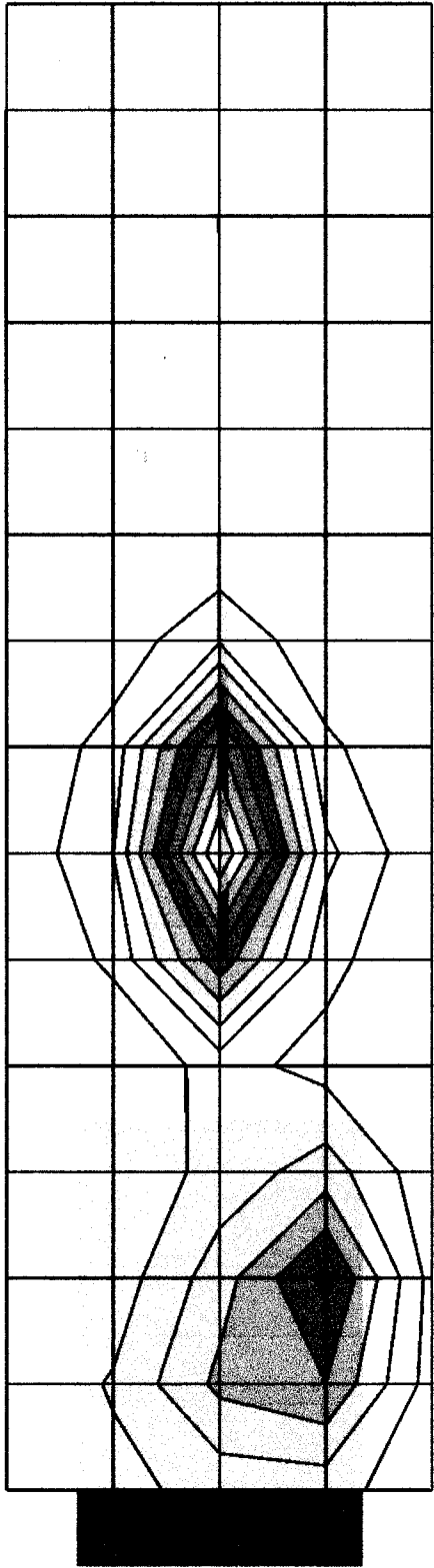
Generic Twin Phantom; Flat Section; Position: (270°,90°); Frequency: 915 MHz

Probe: ET3DVS - SN1334; Conv(5.50,5.50,5.50); Crest factor: 1.0; Muscle 900 MHz: $\sigma = 0.99$ mho/m $\epsilon_r = 55.7$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 1.11 mW/g, SAR (10g): 0.585 mW/g, (Worst-case extrapolation)

Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0

Powerdrift: -0.01 dB



LXE 900MHz FH P/N:154597-0001

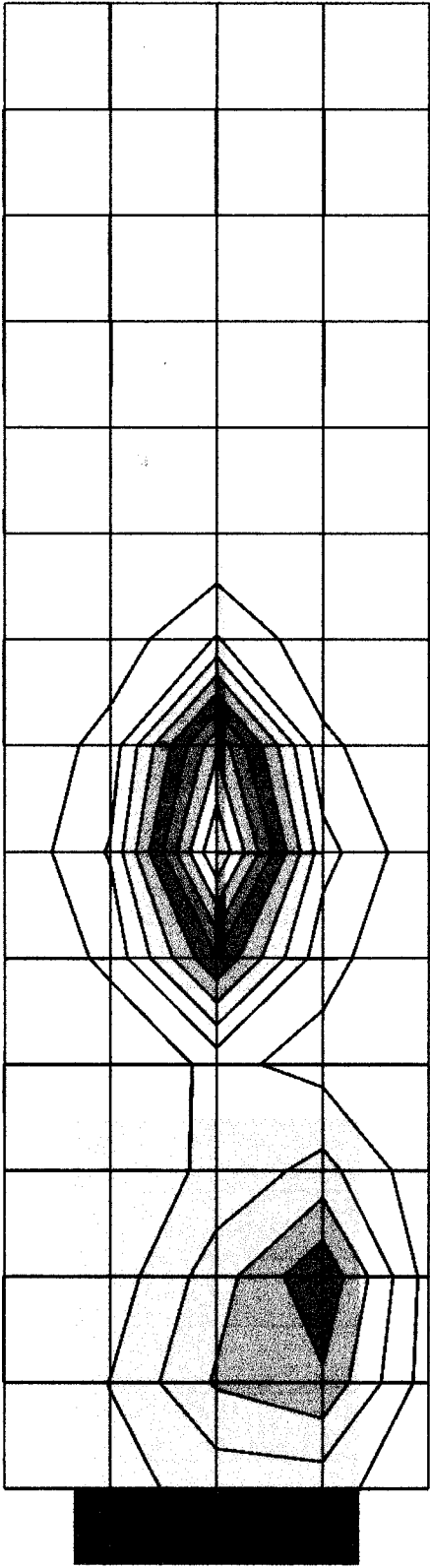
Plot # 6

Generic Twin Phantom; Flat Section; Position: (270°,90°); Frequency: 927 MHz

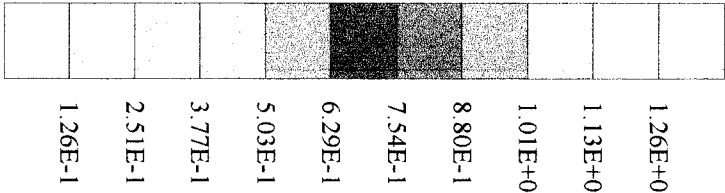
Probe: ET3DV5 - SN1334; ConvF(5.50,5.50,5.50); Crest factor: 1.0; Muscle 900 MHz: $\sigma = 0.99$ mho/m $\epsilon_r = 55.7$ $\rho = 1.00$ g/cm³
Cube 5x5x7; SAR (1g): 1.33 mW/g, SAR (10g): 0.676 mW/g. (Worst-case extrapolation)

Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0

Powerdrift: -0.04 dB



SAR_{tot} [mW/g]



APPENDIX B - E-Field Probe Calibration Data

See attached.

Probe ET3DV5

SN:1334

Manufactured:	January 10, 1998
Last calibration:	January 14, 1998
Recalibrated:	November 29, 1999

Calibrated for System DASY3

DASY3 - Parameters of Probe: ET3DV5 SN:1334

Sensitivity in Free Space

NormX	2.07 $\mu\text{V}/(\text{V}/\text{m})^2$
NormY	2.28 $\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	2.01 $\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression

DCP X	100 mV
DCP Y	100 mV
DCP Z	100 mV

Sensitivity in Tissue Simulating Liquid

Brain **450 MHz** $\epsilon_r = 48 \pm 5\%$ $\sigma = 0.50 \pm 10\%$ mho/m

ConvF X	5.82 extrapolated
ConvF Y	5.82 extrapolated
ConvF Z	5.82 extrapolated

Boundary effect:	
Alpha	-0.23
Depth	5.22

Brain **900 MHz** $\epsilon_r = 42.5 \pm 5\%$ $\sigma = 0.86 \pm 10\%$ mho/m

ConvF X	5.50 $\pm 7\%$ (k=2)
ConvF Y	5.50 $\pm 7\%$ (k=2)
ConvF Z	5.50 $\pm 7\%$ (k=2)

Boundary effect:	
Alpha	0.18
Depth	4.08

Brain **1500 MHz** $\epsilon_r = 41 \pm 5\%$ $\sigma = 1.32 \pm 10\%$ mho/m

ConvF X	5.07 interpolated
ConvF Y	5.07 interpolated
ConvF Z	5.07 interpolated

Boundary effect:	
Alpha	0.73
Depth	2.56

Brain **1800 MHz** $\epsilon_r = 41 \pm 5\%$ $\sigma = 1.69 \pm 10\%$ mho/m

ConvF X	4.85 $\pm 7\%$ (k=2)
ConvF Y	4.85 $\pm 7\%$ (k=2)
ConvF Z	4.85 $\pm 7\%$ (k=2)

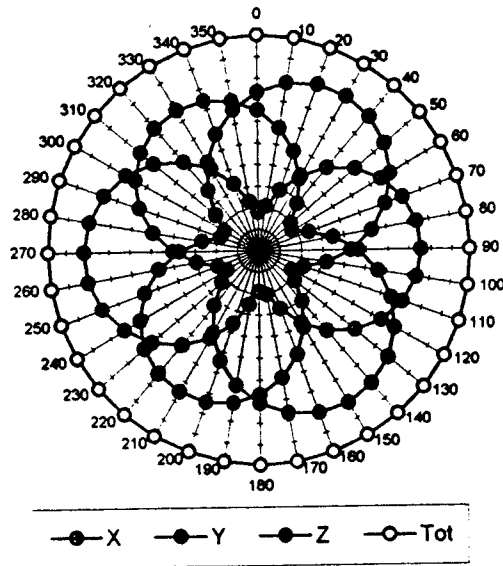
Boundary effect:	
Alpha	1.00
Depth	1.80

Sensor Offset

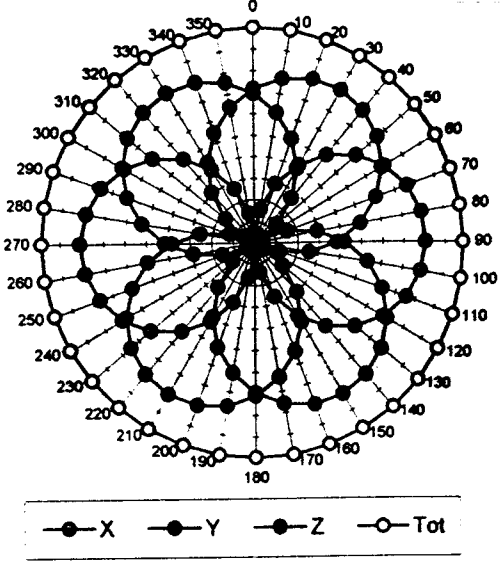
Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.9 $\pm$ 0.2	mm

Receiving Pattern (ϕ), $\theta = 0^\circ$

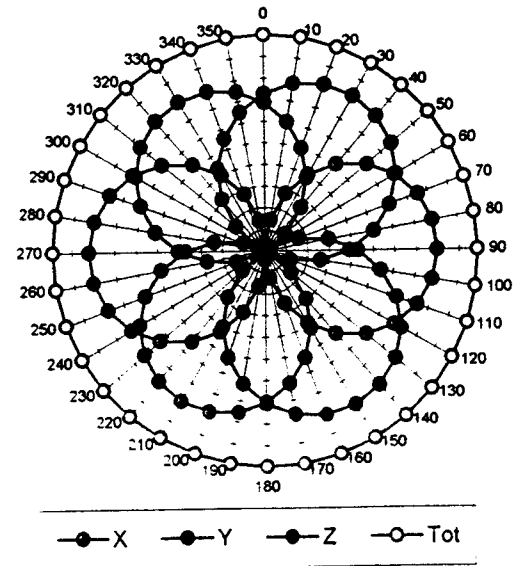
$f = 30 \text{ MHz}$, TEM cell ifi110



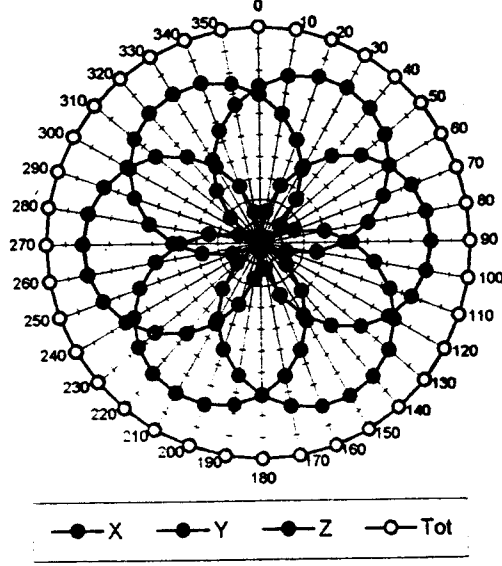
$f = 100 \text{ MHz}$, TEM cell ifi110



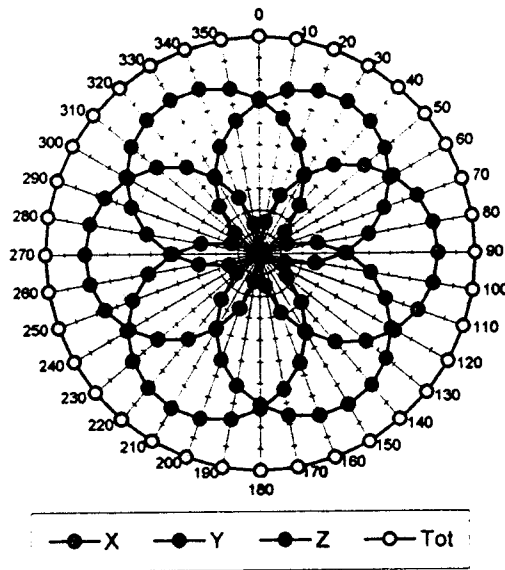
$f = 300 \text{ MHz}$, TEM cell ifi110



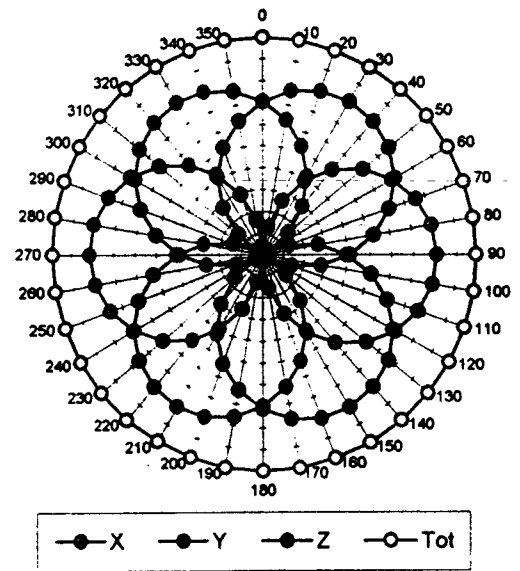
$f = 900 \text{ MHz}$, TEM cell ifi110



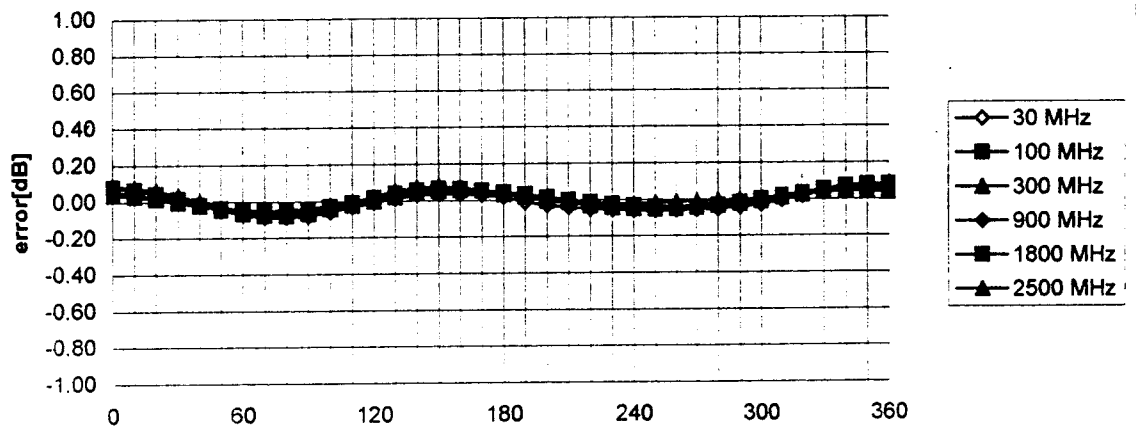
$f = 1800 \text{ MHz, WG R22}$



$f = 2500 \text{ MHz, WG R26}$

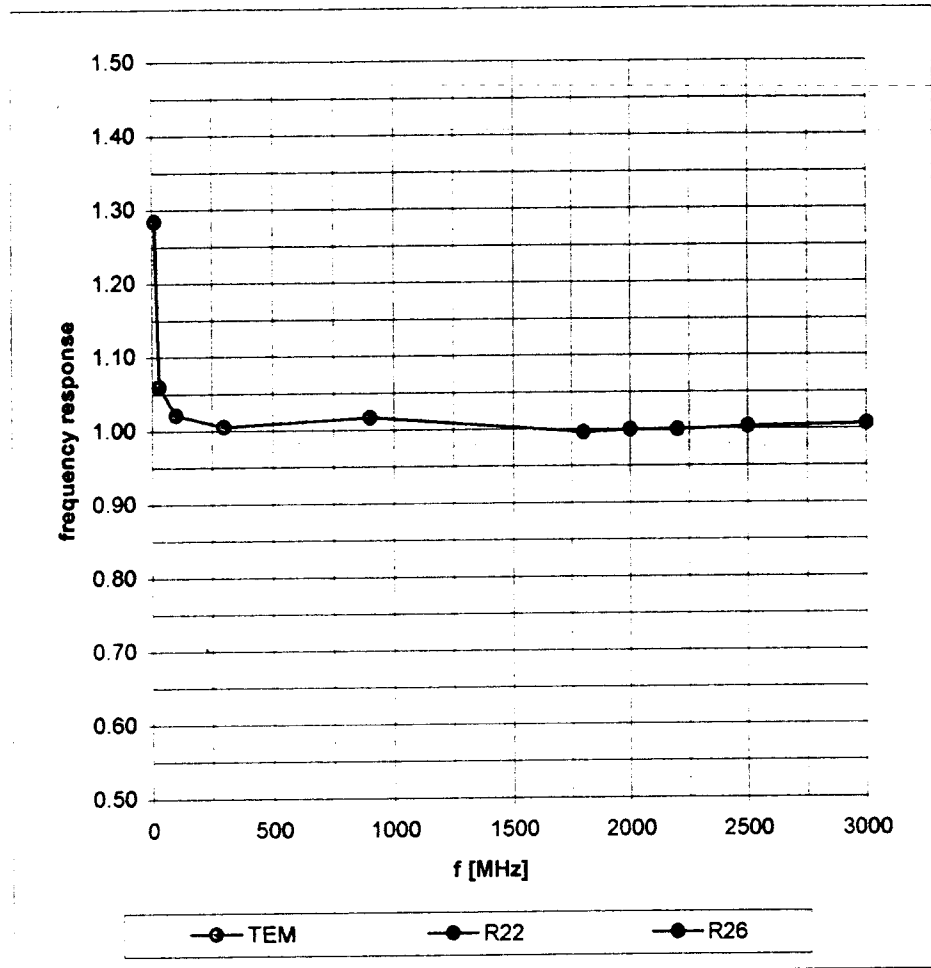


Isotropy Error (ϕ), $\theta = 0^\circ$

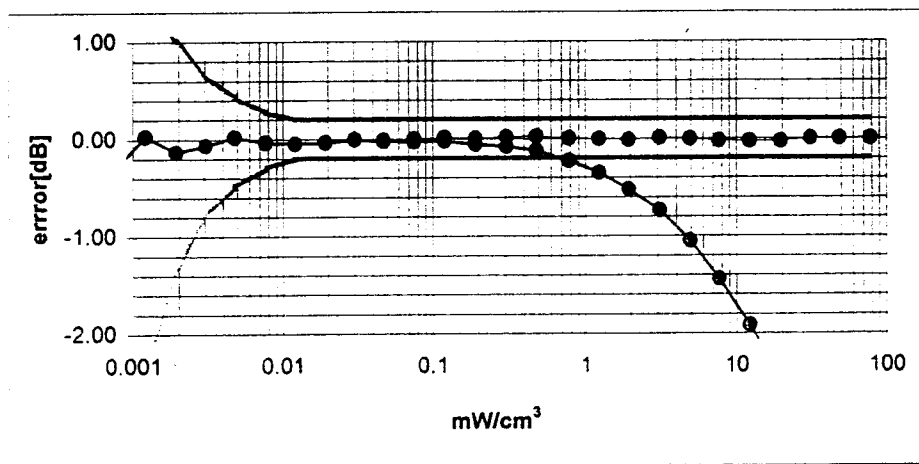
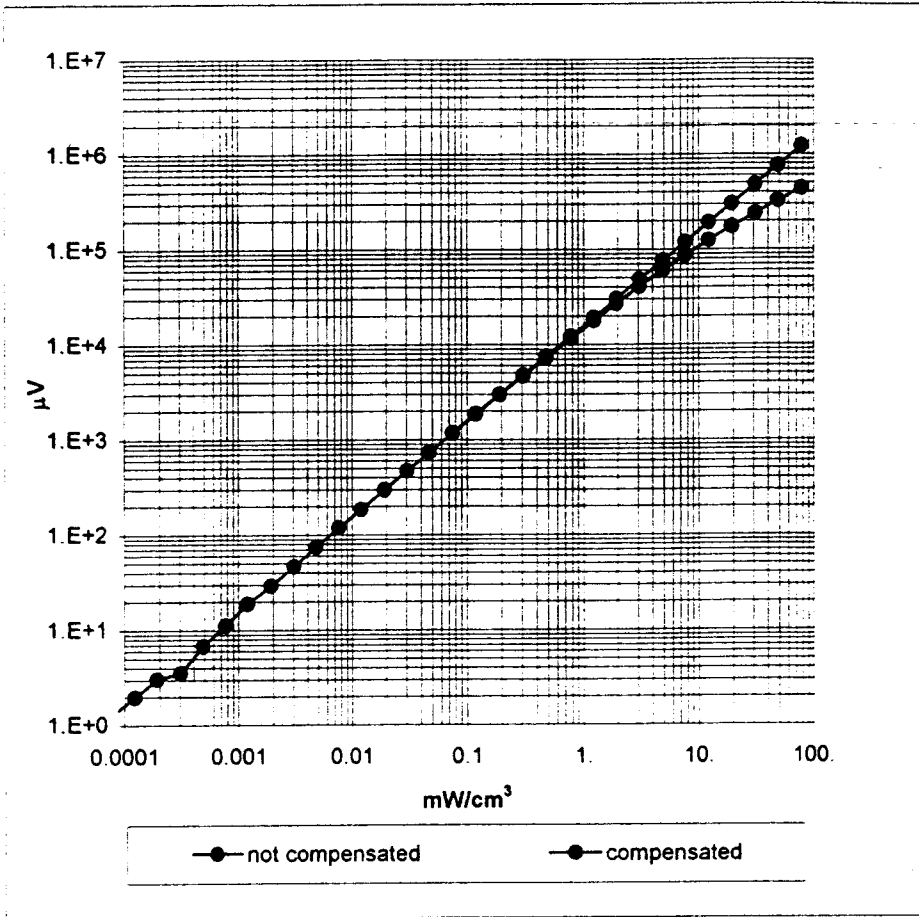


Frequency Response of E-Field

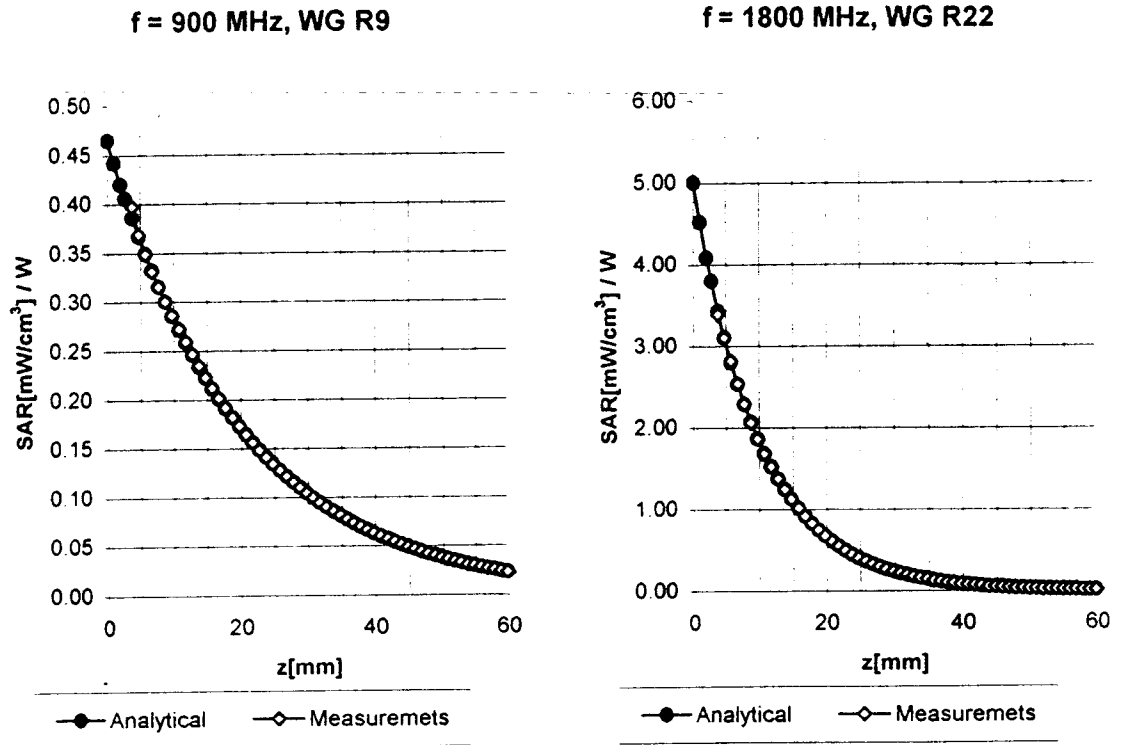
(TEM-Cell:ifi110, Waveguide R22, R26)



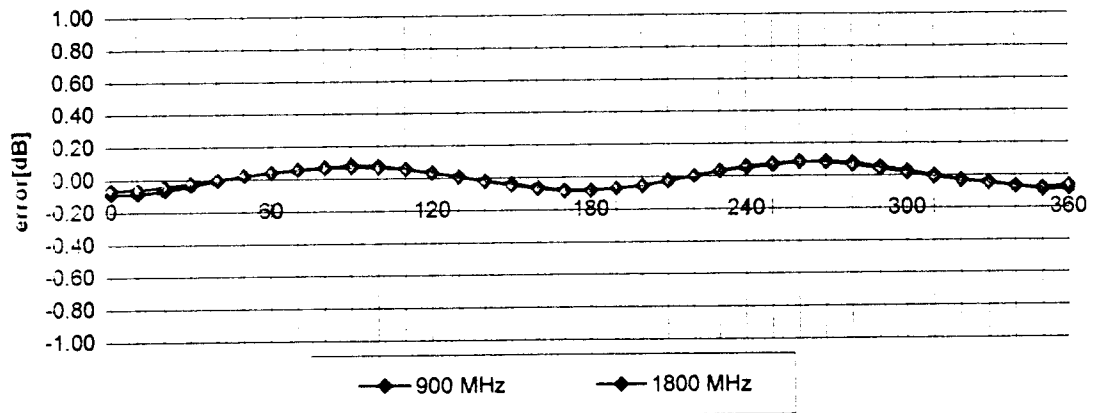
Dynamic Range $f(\text{SAR}_{\text{brain}})$ (TEM-Cell:ifi110)



Conversion Factor Assessment



Receiving Pattern (ϕ) (in brain tissue, z = 5 mm)





The ITS artwork
and ITS logos and
certification marks used
within this report
are the property of
Intertek Testing
Services NA Inc.