

Specific Absorption Rate (SAR) Test Report
for
Sierra Wireless, Inc.
on the
CDPD Transceiver
Model: Aircard 350

Test Report: J99022431
Date of Report: September 10, 1999

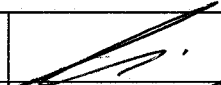
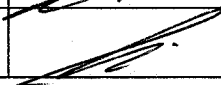
Test Report

Specific Absorption Rate (SAR) Test Report
for
Sierra Wireless, Inc.
on the
CDPD Transceiver
Model: Aircard 350

Test Report: J99022431
Date of Report: September 10, 1999



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

Tested by:	C. K. Li	
Prepared:	C. K. Li	

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

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.....	7
1.5 Modifications required for compliance.....	7
1.6 Additions, deviations and exclusions from standards.....	7
2 SAR EVALUATION	7
2.1 SAR Limits.....	7
2.2 Configuration Photographs	8
System Verification.....	10
2.3 Evaluation Procedures	10
2.4 Test Results	11
3.0 TEST EQUIPMENT	13
3.1 Equipment List	13
3.2 Muscle Tissue Simulating Liquid.....	14
3.3 E-Field Probe Calibration.....	14
3.4 Measurement Uncertainty	15
3.5 Measurement Tractability	15
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

Table of Contents

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.....	7
1.5 Modifications required for compliance.....	7
1.6 Additions, deviations and exclusions from standards.....	7
2 SAR EVALUATION	7
2.1 SAR Limits.....	7
2.2 Configuration Photographs	8
System Verification.....	10
2.3 Evaluation Procedures	10
2.4 Test Results	11
3.0 TEST EQUIPMENT	13
3.1 Equipment List	13
3.2 Muscle Tissue Simulating Liquid.....	14
3.3 E-Field Probe Calibration.....	14
3.4 Measurement Uncertainty	15
3.5 Measurement Tractability	15
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

JOB DESCRIPTION**1.1 Client Information**

The EUT has been tested at the request of

Company: Sierra Wireless, Inc.
#151-13575 Commerce Parkway
Richmond, B.C.
Canada V6V 2J2

Name of contact: Mr. Craig Gauld
Telephone: (604) 231 1115
Fax: (604) 231 1109

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

Equipment	CDPD Transceiver		
Trade Name	AirCard 300	Model No.	AC 300
FCC ID	N7NACRD2	S/N No.	N/A
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band (uplink)	825-850 MHz	System	CDPD

EUT Antenna Description			
Type	Dipole	Configuration	Removable, 360° Rotation
Dimensions	13.3cm (L),	Gain	-2 dBd
Location	Right		

Use of Product : Data communications

Manufacturer: SAME as above.

Production is planned: ☒ Yes, ☐ No

EUT receive date: 9/5/99

EUT received condition: Good working condition prototype

Test start date: 9/8/99

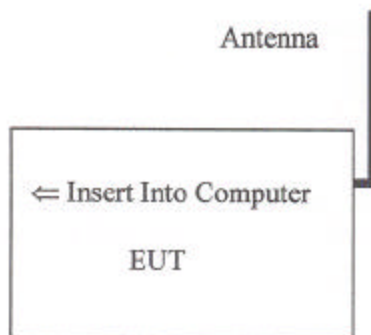
Test end date: 9/10/99

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
---	Notebook Computer	Toshiba	PA1123U	11513217	NA

1.4.2 Test Position

Three test configurations were used to show compliance with the FCC RF human exposure requirements. In all configuration, 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 is not necessary. Table 1 below describes the setup and condition:

Table 1, Equipment setup	
Configuration	Description
A	<ul style="list-style-type: none">• Antenna in vertical position, distance from antenna to Phantom = 30mm.• Simulating close proximity of human body
B	<ul style="list-style-type: none">• Antenna in horizontal position, distance from antenna to Phantom = 30mm.• Simulating close proximity of human body
C	<ul style="list-style-type: none">• Antenna in horizontal position, distance from antenna to Phantom = 30mm.• Simulating close proximity of human body
D	<ul style="list-style-type: none">• Antenna in Vertical position, distance from antenna to Phantom = 16mm (Laptop computer touching shell of Phantom).• Simulating touch position with human body (lap)

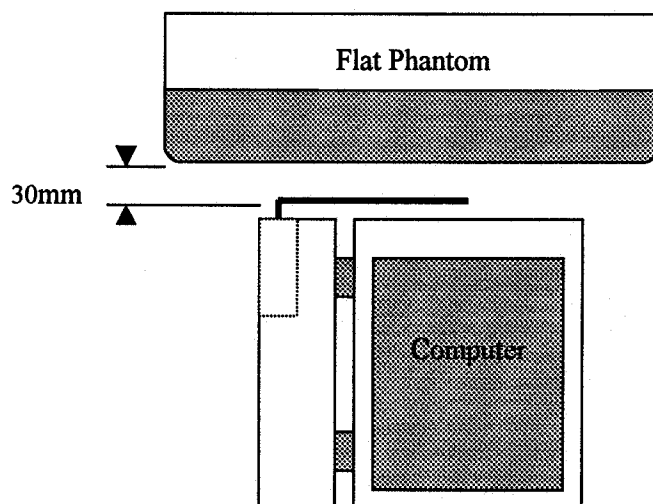


Figure 1a: Configuration A

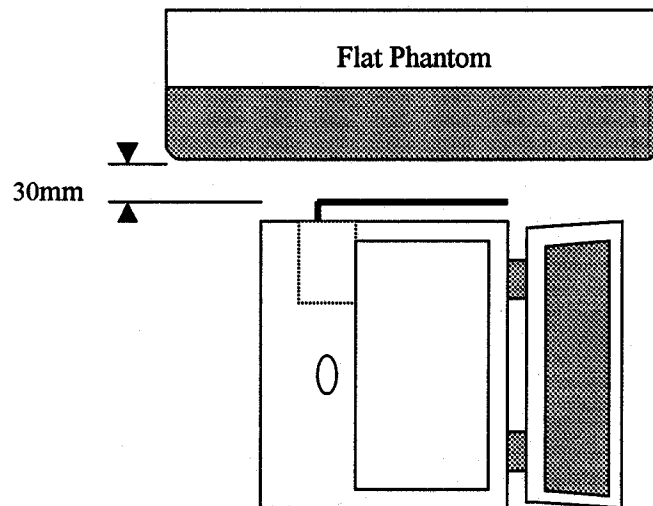


Figure 1b: Configuration B

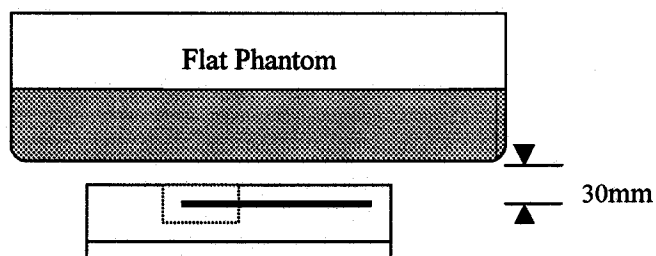


Figure 1c: Configuration C

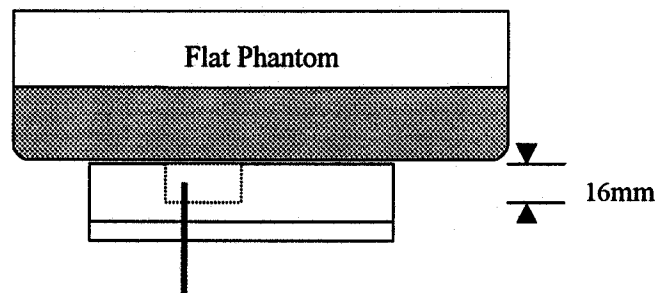


Figure 1d: Configuration D

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.	30 mm
Simulating human Body/hand	Yes	EUT Battery	Unit powered from host computer.
Power output	600 mW (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 SAR EVALUATION

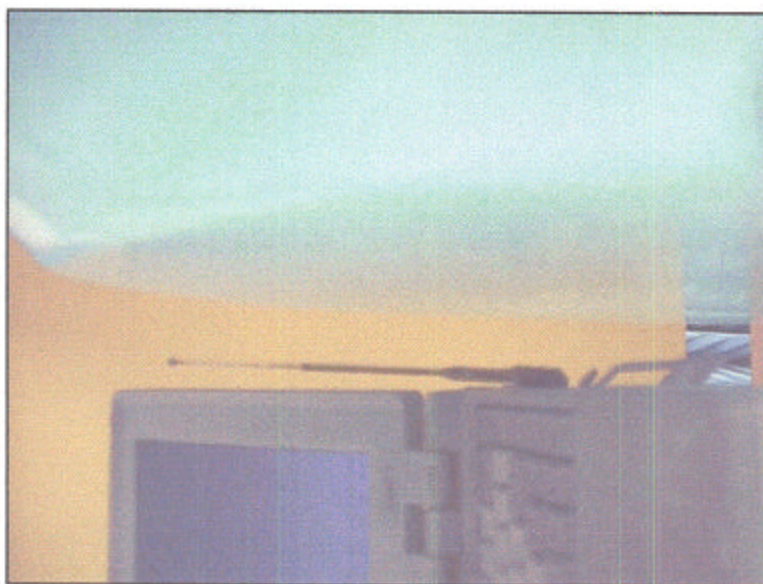
2.1 SAR Limits

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

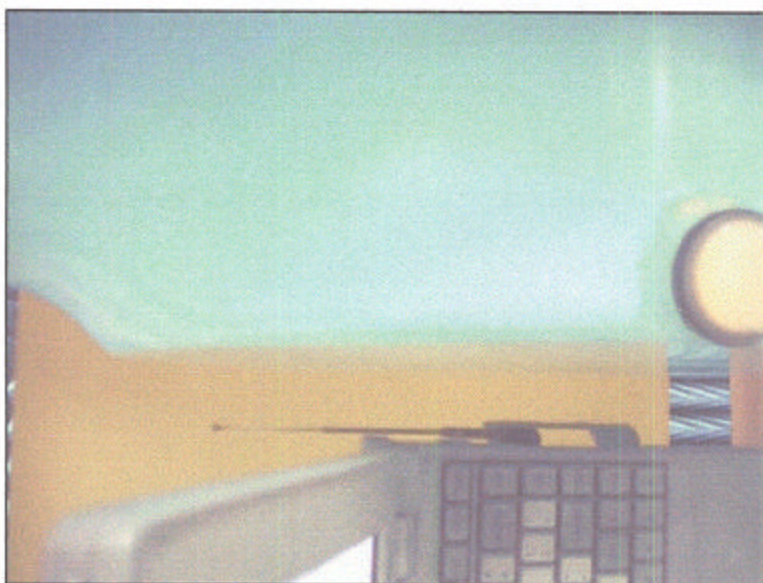
EXPOSURE (General Population/Uncontrolled Exposure environment)	SAR (W/kg)
Average over the whole body	0.08
Spatial Peak (1g)	1.60
Spatial Peak for hands, wrists, feet and ankles (10g)	4.00

2.2 Configuration Photographs

Worst-Case SAR measurement at 824 MHz



Configuration A



Configuration B



Configuration C



Configuration D

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 900 MHz.

Validation kit	Targeted SAR _{1g} (mW/g)	Measured SAR _{1g} (mW/g)
D900V2, S/N #: 013	2.30	2.293

2.3 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.

2.4 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:	AirCard 300	Model No.:	AC 300
Serial No.:	Not Labeled	Test Engineer:	C.K. Li

TEST CONDITIONS			
Ambient Temperature	23.5 °C	Relative Humidity	55 %
Test Signal Source	Test Mode	Signal Modulation	CW
Output Power Before SAR Test	27.8 dBm	Output Power After SAR Test	27.8 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)
824 MHz	CDPD	1	Vertical	1.23	0.872
836 MHz	CDPD	1	Vertical	1.05	0.743
849 MHz	CDPD	1	Vertical	1.03	0.726

Configuration B (Human Body/Hand)					
Channel	Operating Mode	Duty Cycle ratio	Antenna Position *	Measured SAR _{1g} (mW/g)	Measured SAR _{10g} (mW/g)
824 MHz	CDPD	1	Horizontal	0.495	0.348
836 MHz	CDPD	1	Horizontal	0.692	0.487
849 MHz	CDPD	1	Horizontal	0.777	0.542

Configuration C (Human Body/Hand)					
Channel	Operating Mode	Duty Cycle ratio	Antenna Position *	Measured SAR _{1g} (mW/g)	Measured SAR _{10g} (mW/g)
824 MHz	CDPD	1	Horizontal	0.761	0.532
836 MHz	CDPD	1	Horizontal	0.883	0.612
849 MHz	CDPD	1	Horizontal	0.873	0.610

Configuration D (Human Body/Hand)					
Channel	Operating Mode	Duty Cycle ratio	Antenna Position *	Measured SAR _{1g} (mW/g)	Measured SAR _{10g} (mW/g)
824 MHz	CDPD	1	Vertical	0.166	0.132
836 MHz	CDPD	1	Vertical	0.138	0.111
849 MHz	CDPD	1	Vertical	0.148	0.120

- 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	1333	03/18/99
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	02/1/99

3.2 Muscle Tissue Simulating Liquid

Ingredient	Frequency (800 - 850 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^*	σ^* (mho/m)	ρ^{**} (kg/m ³)
835	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

Warning Text

User Guide text in the section **Safety and Hazards:**



WARNING – The FCC has developed guidelines to reduce any possible hazard due to exposure of the human body to electromagnetic radiation (i.e. to radio waves). In accordance with these guidelines, the antenna should be positioned at a distance greater than 9 cm (3.6”) from users and bystanders (3 cm (1.2”) from hands, wrists, feet, and ankles) when the modem is transmitting.

Back Label of the PC Card:

Sierra Wireless, Inc.

AirCard® 300 CDPD Adapter

This device complies with Part 15 of FCC Rules.

Operation is subject to the condition that this device does not cause harmful interference.

FCC guidelines stipulate that the antenna should be more than 9 cm (3.6”) from all persons;
3 cm (1.2”) from hands, wrists, feet, and ankles.

FCC ID: xxxxxxxx

Designed & manufactured by Sierra Wireless

Product of Canada

Part # 12000xx

00-A0-D5-00-00-00

206-00000000

[**BAR CODE**]

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 know 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, Teddinton, 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)
AirCard350 A	A	Vertical	824
AirCard350 A	A	Vertical	836
AirCard350 A	A	Vertical	849
AirCard350 B	B	Horizontal	824
AirCard350 B	B	Horizontal	836
AirCard350 B	B	Horizontal	849
AirCard350 C	C	Vertical	824
AirCard350 C	C	Vertical	836
AirCard350 C	C	Vertical	849
AirCard350 D	D	Horizontal	824
AirCard350 D	D	Horizontal	836
AirCard350 D	D	Horizontal	849

Aircard350_A

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 824 MHz

Probe: ET3DV5 - SNI333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz; $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

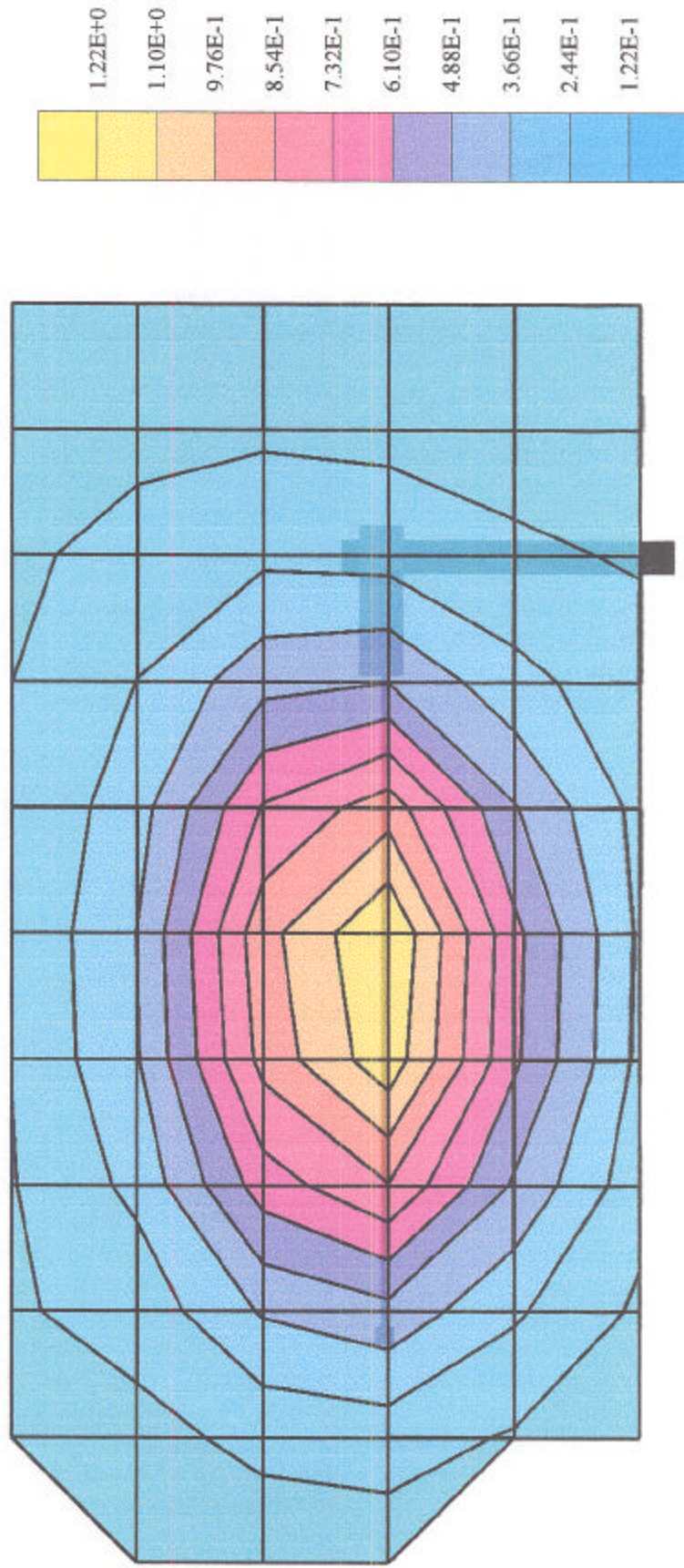
Cube 5x5x7; SAR (1g): 1.23 mW/g, SAR (10g): 0.872 mW/g, (Worst-case extrapolation)

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

Powerdrift: -0.02 dB

Antenna O/P = 27.8 dBm

SAR_{Tot} [mW/g]



Aircard350_A

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 836 MHz

Probe: ET3DV5 - SN1333; ConvF(5.85,5.85,5.85); Crest factor: 1.0; Muscle 815 MHz; $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

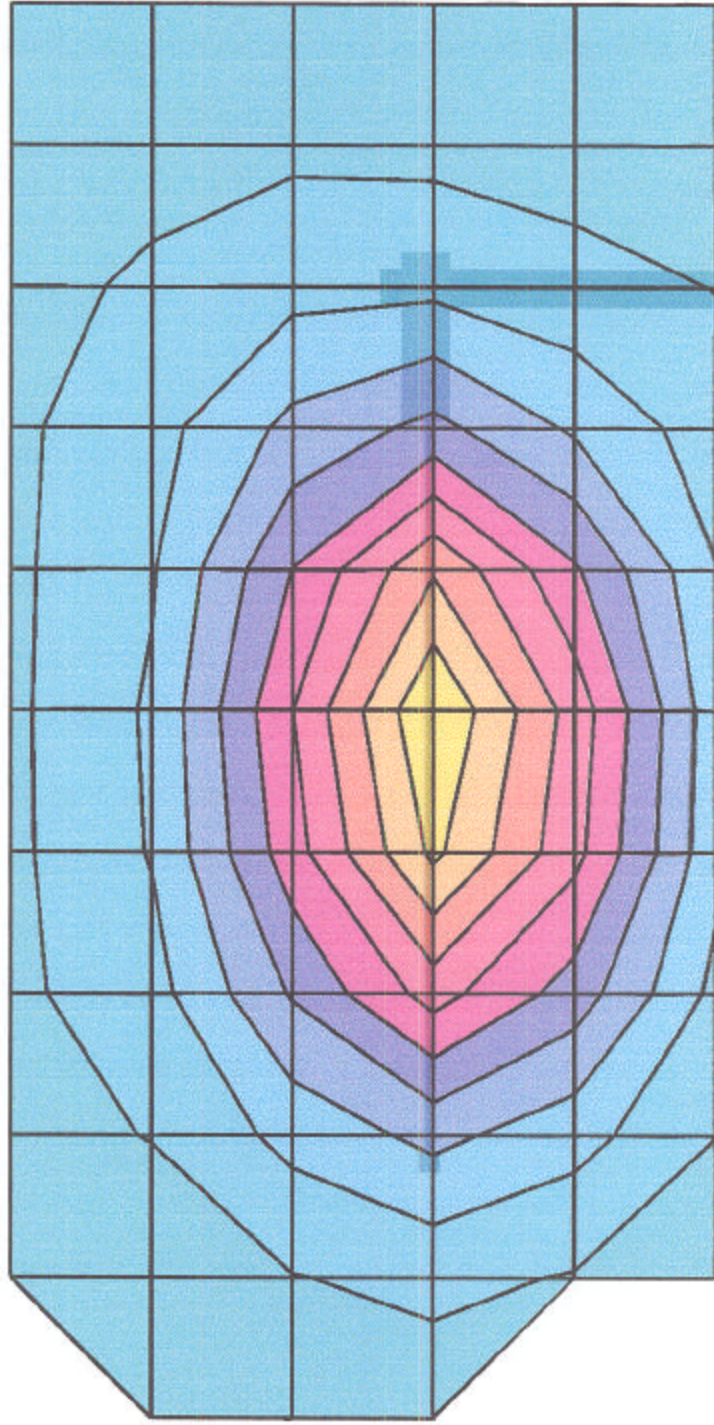
Cube 5x5x7; SAR (1g): 1.05 mW/g, SAR (10g): 0.743 mW/g, (Worst-case extrapolation)

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

Powerdrift: 0.03 dB

Antenna O/P = 27.8 dBm

SAR_{Tot} [mW/g]



1.06E+0

9.58E-1

8.52E-1

7.46E-1

6.39E-1

5.32E-1

4.26E-1

3.20E-1

2.13E-1

1.07E-1

Aircard350_A

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 849 MHz

Probe: ET3DV5 - SN1333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz; $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

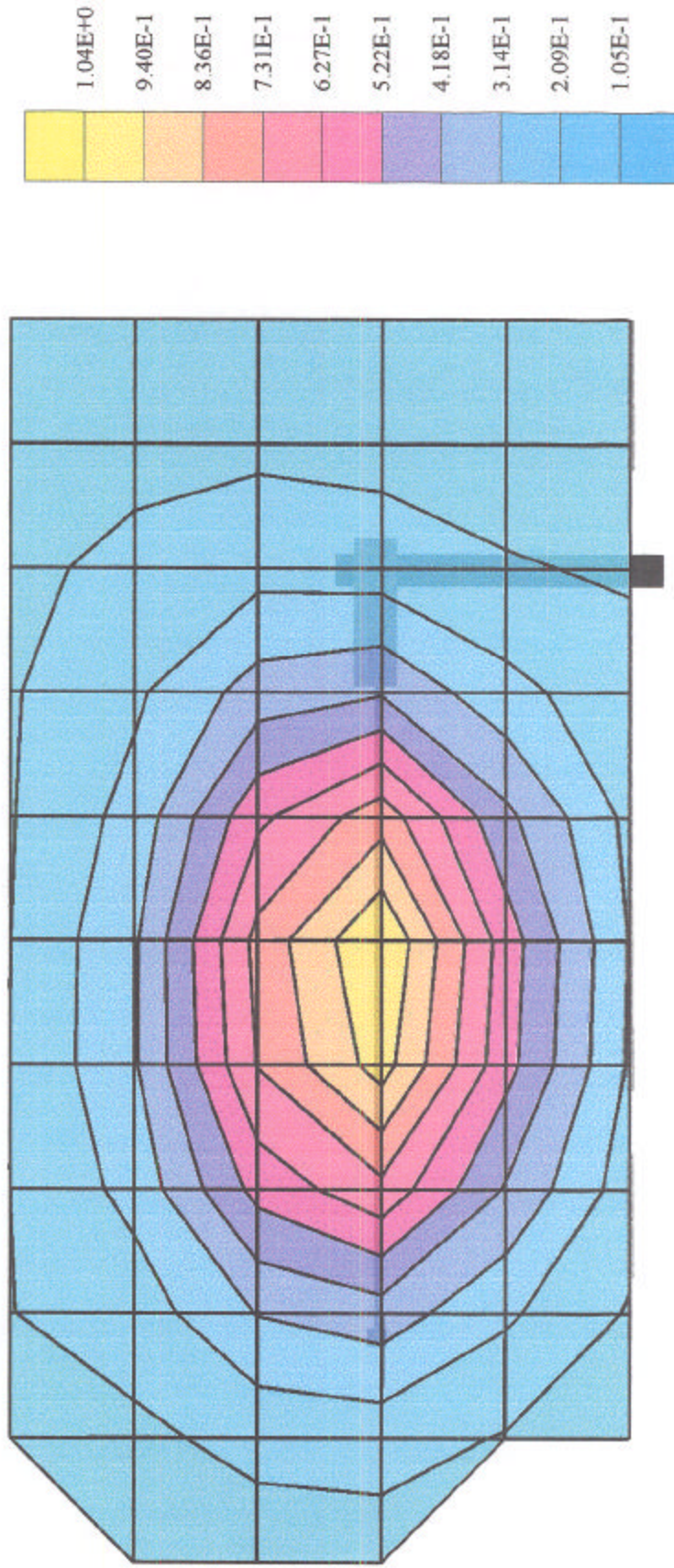
Cube 5x5x7: SAR (1g): 1.03 mW/g, SAR (10g): 0.726 mW/g, (Worst-case extrapolation)

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

Powerdrift: -0.27 dB

Antenna O/P = 27.8 dBm

SAR_{Tot} [mW/g]



Aircard350_B

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 824 MHz

Probe: ET3DV5 - SN1333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz: $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

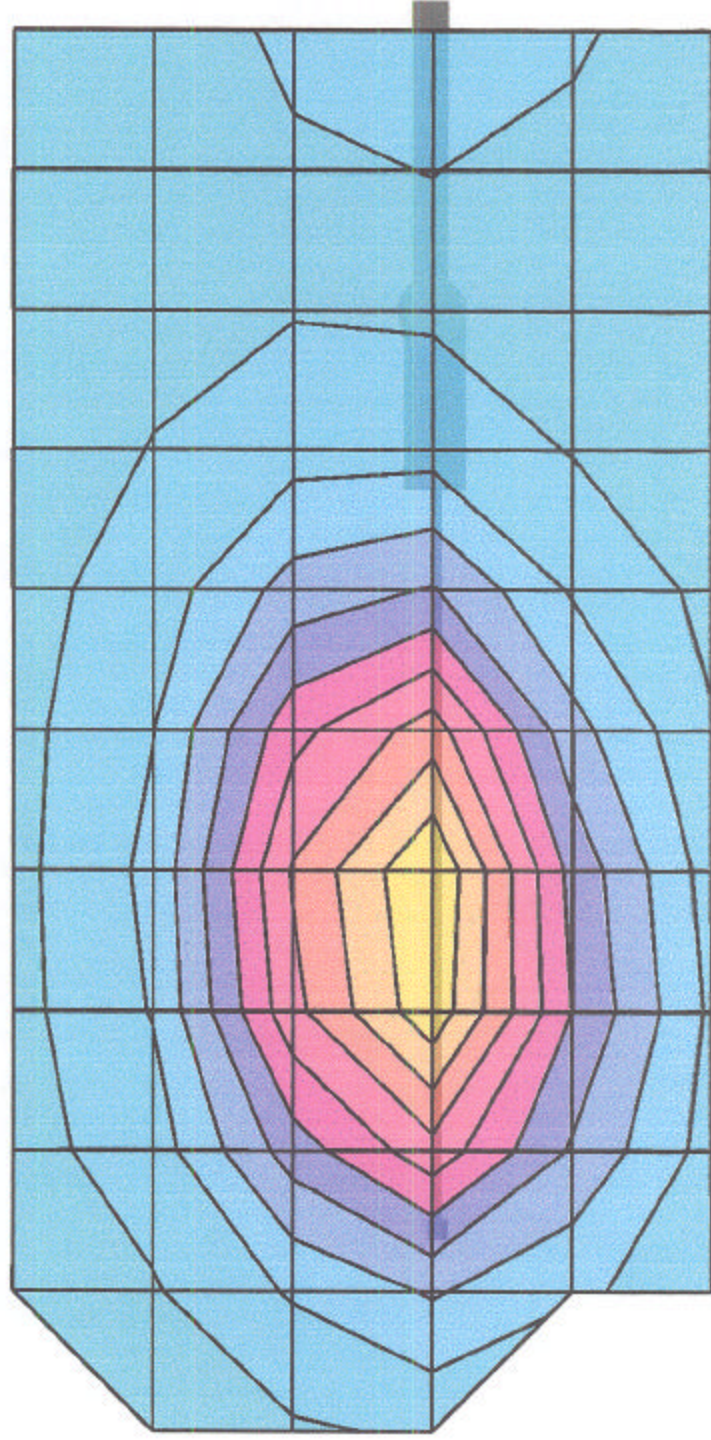
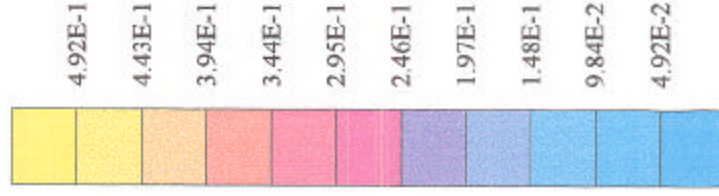
Cube 5x5x7: SAR (1g): 0.495 mW/g, SAR (10g): 0.348 mW/g, SAR (10g): 0.348 mW/g, SAR (10g): 0.348 mW/g (Worst-case extrapolation)

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

Powerdrift: -0.06 dB

Antenna O/P = 27.8 dBm

SAR_{10g} [mW/g]



Aircard350_B

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 836 MHz

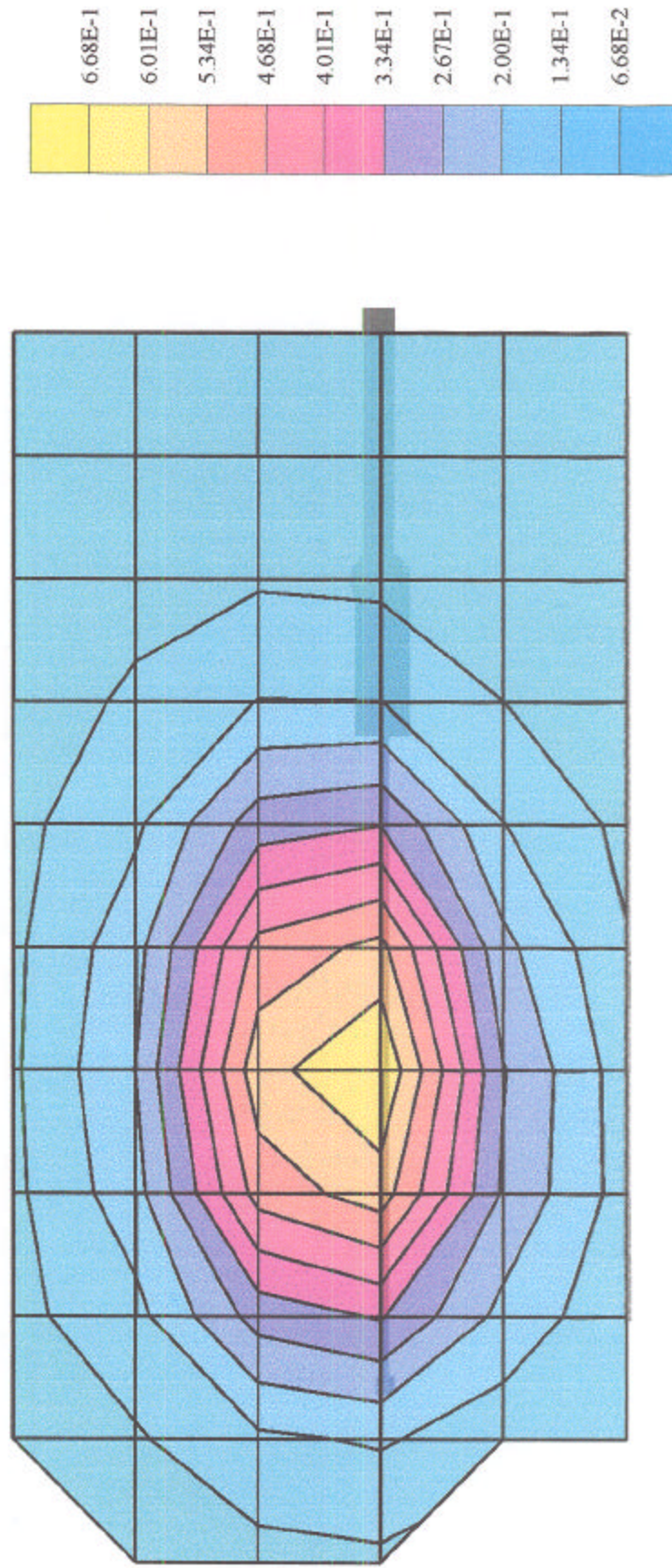
Probe: ET3DV5 - SN1333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz: $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 0.692 mW/g, SAR (10g): 0.487 mW/g (Worst-case extrapolation)

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

Powerdrift: -0.12 dB

SAR_{Tot} [mW/g]



Aircard350_B

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 849 MHz

Probe: ET3DV5 - SN1333; ConvF(5.85,5.85,5.85); Crest factor: 1.0; Muscle 815 MHz; $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

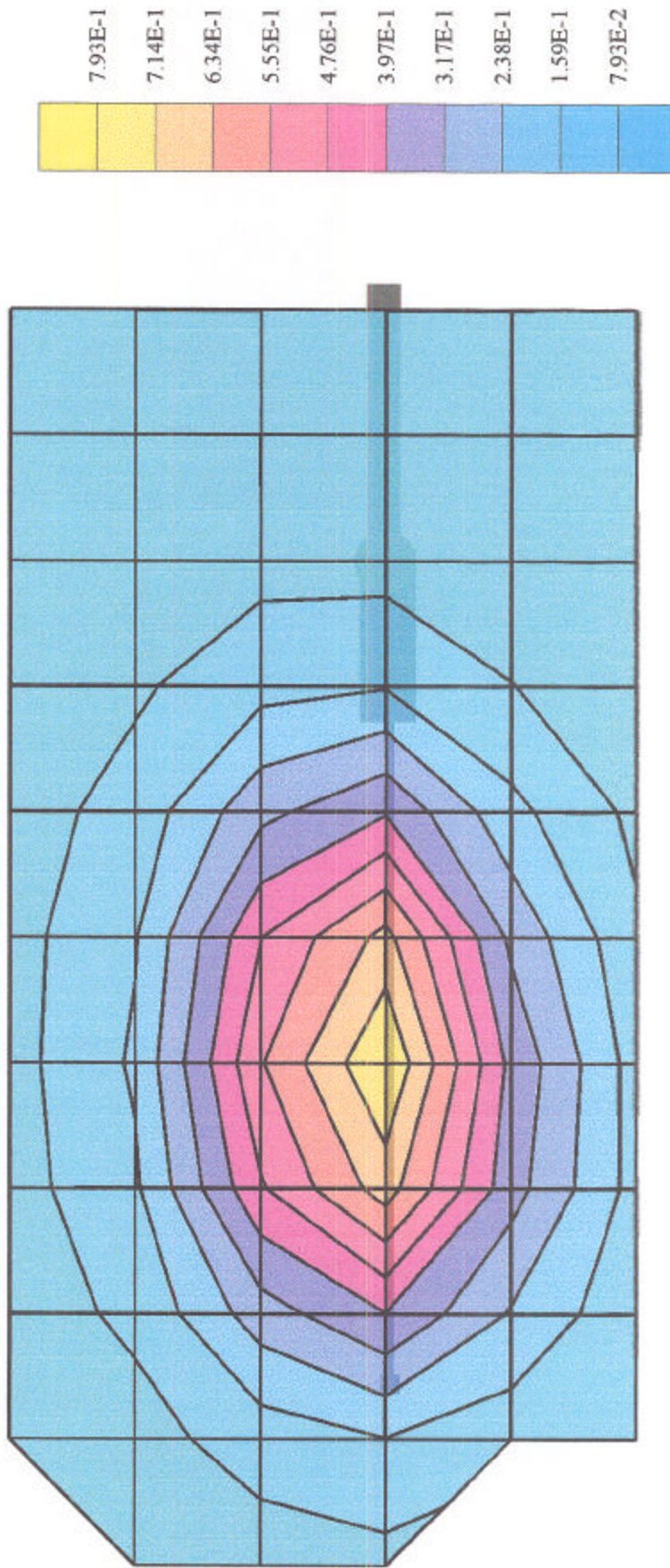
Cube 5x5x7: SAR (1g): 0.777 mW/g, SAR (10g): 0.542 mW/g, (Worst-case extrapolation)

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

Powerdrift: -0.07 dB

Antenna O/P = 27.8 dBm

SAR_{Tot} [mW/g]



Aircard350_C

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 824 MHz

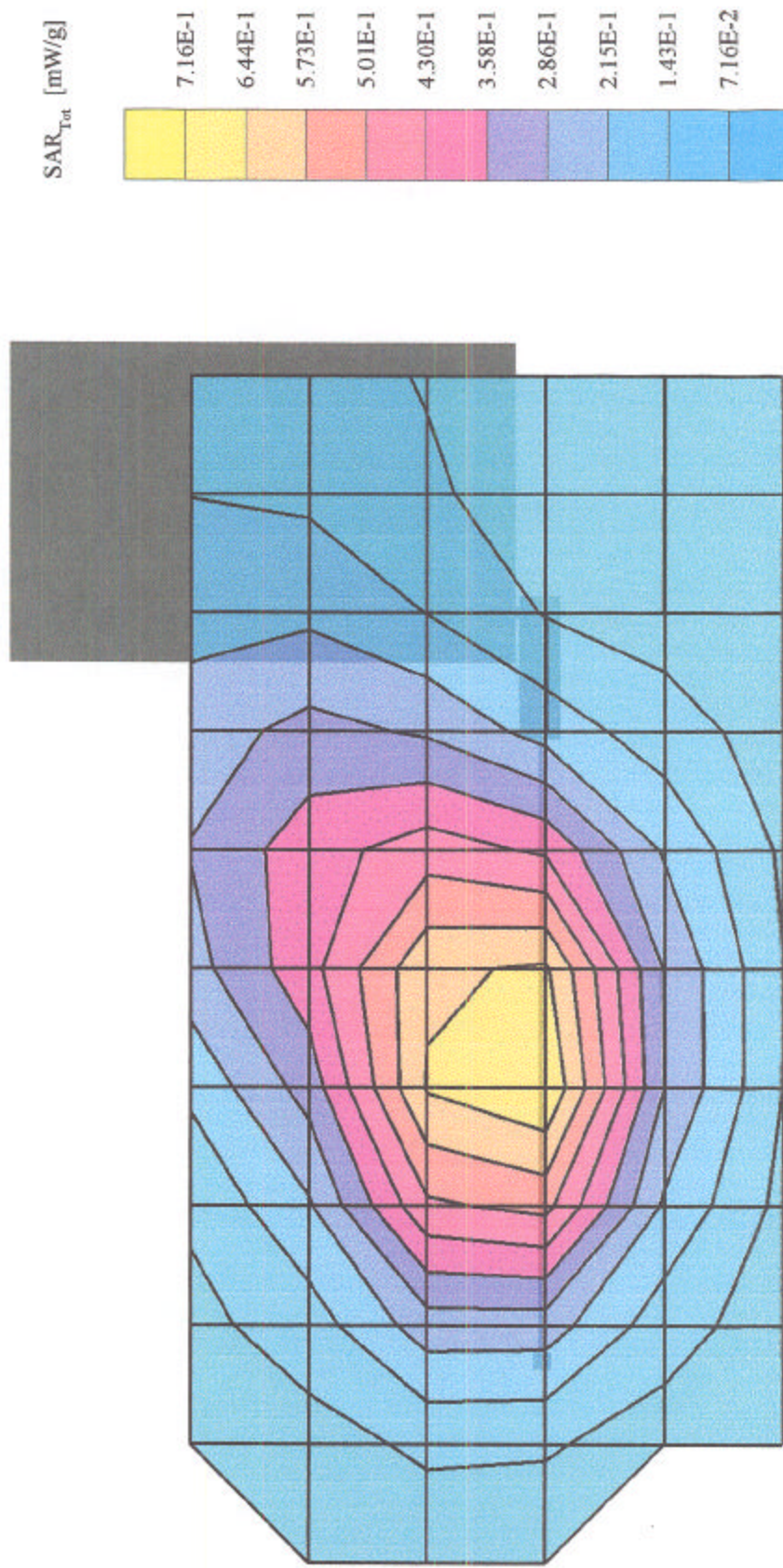
Probe: ET3DV5 - SN1333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz; $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 0.761 mW/g, SAR (10g): 0.532 mW/g, (Worst-case extrapolation)

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

Powerdrift: -0.09 dB

Antenna O/P = 27.8 dBm



Aircard350_C

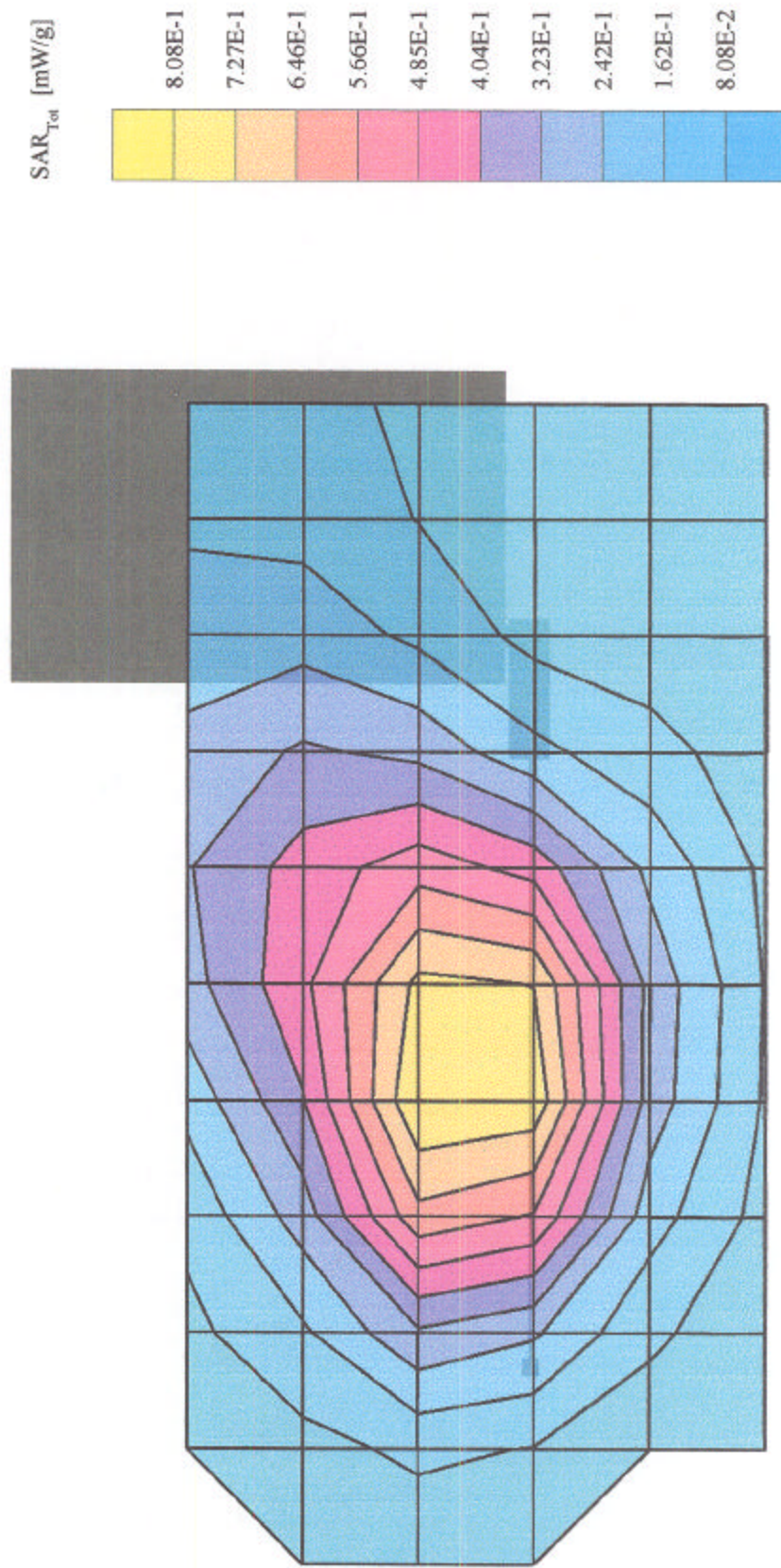
Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 836 MHz

Probe: ET3DV5 - SN1333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz: $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 0.883 mW/g, SAR (10g): 0.612 mW/g, (Worst-case extrapolation)

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

Powerdrift: -0.33 dB



Aircard350_C

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 849 MHz

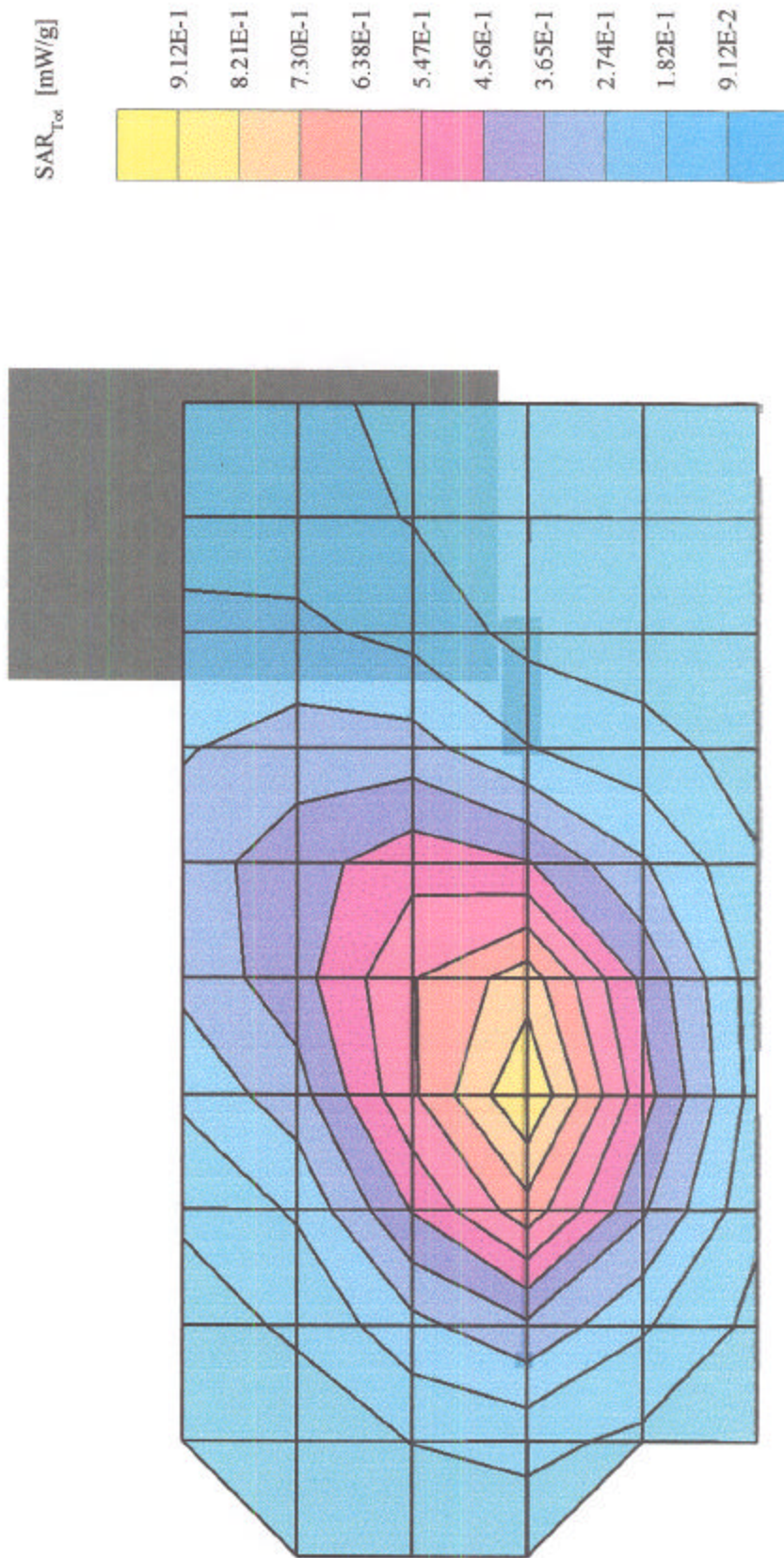
Probe: ET3DV5 - SN1333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz; $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 0.873 mW/g, SAR (10g): 0.610 mW/g, SAR (Worst-case extrapolation)

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

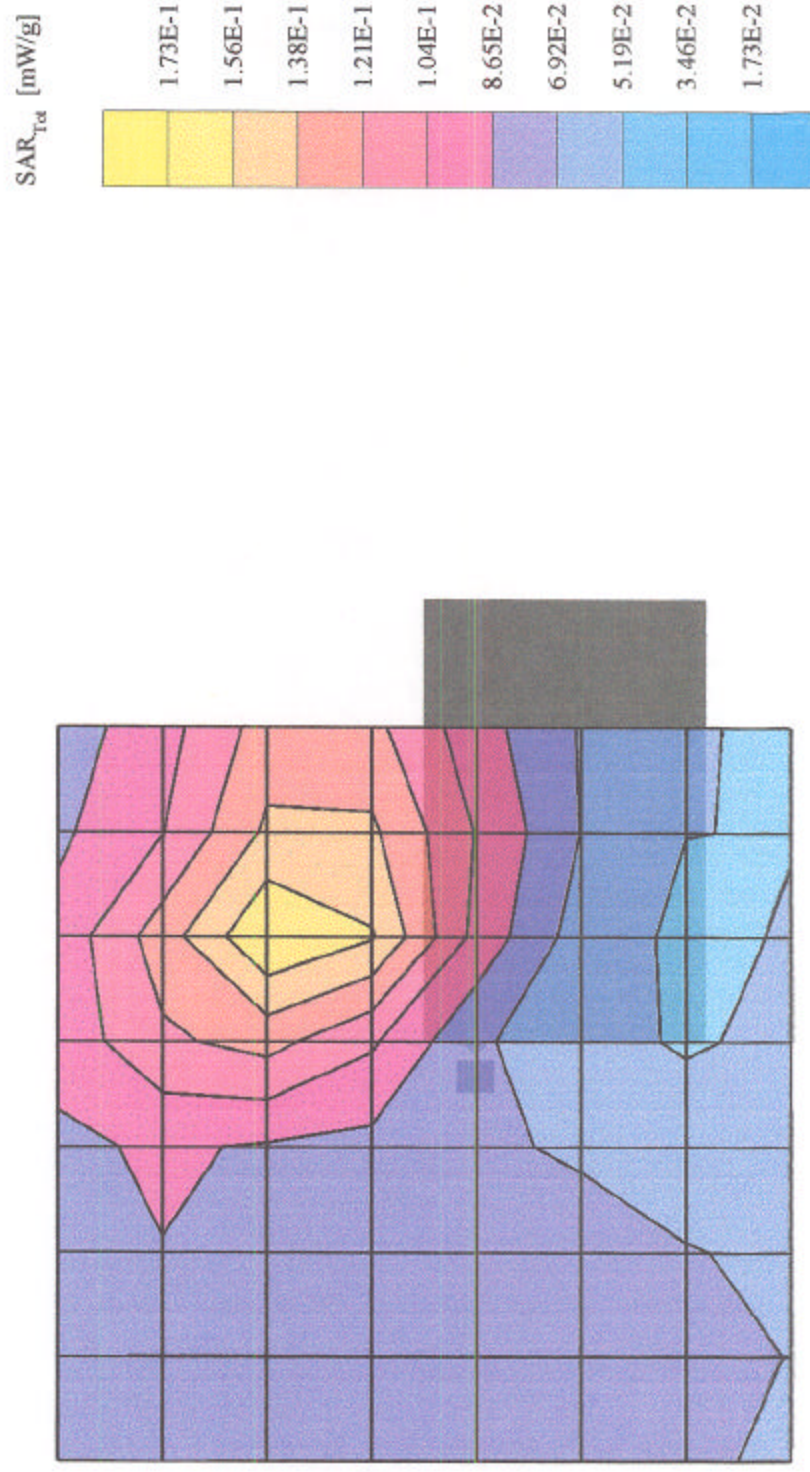
Powerdrift: -0.22 dB

Antenna O/P = 27.8 dBm



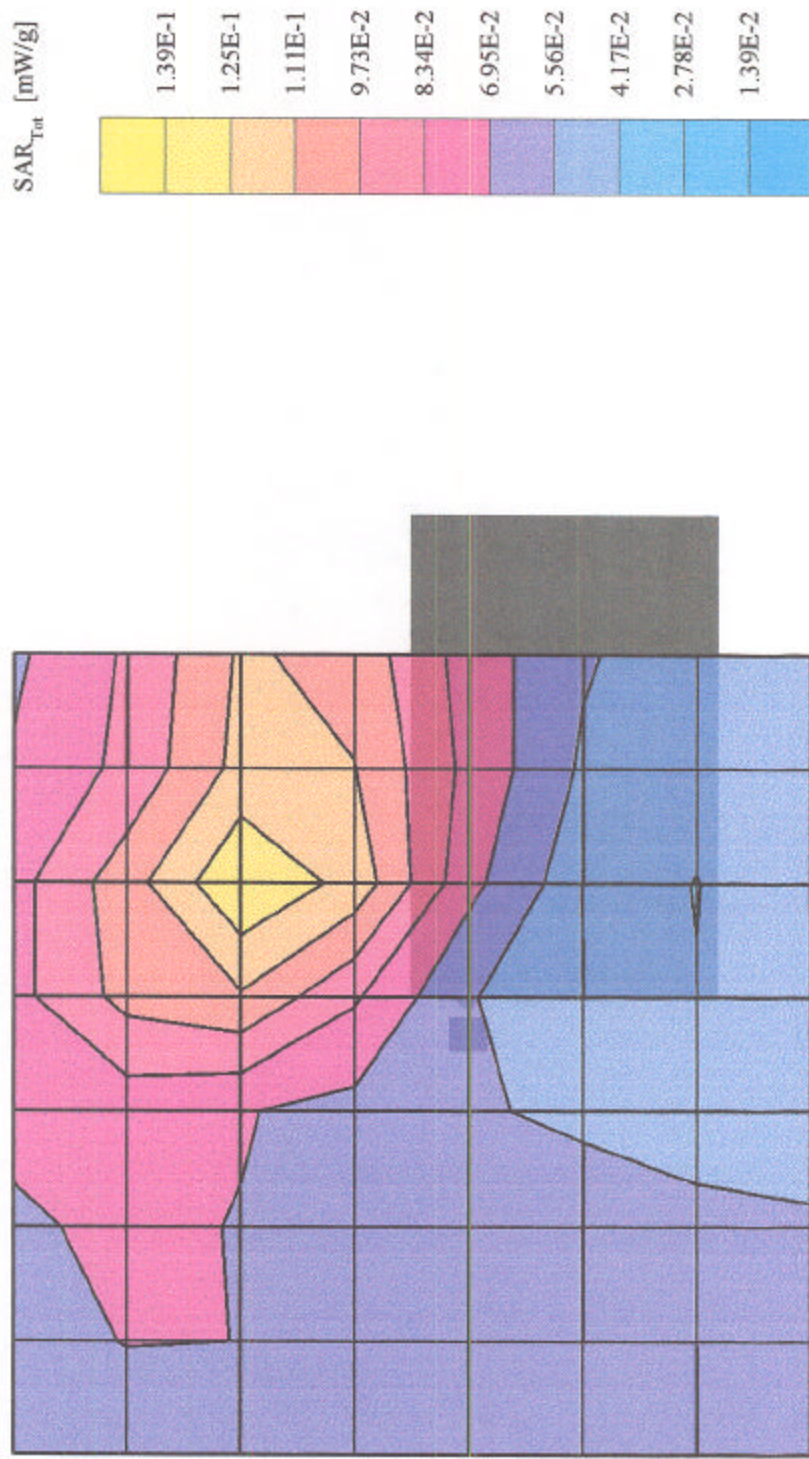
Aircard350_D

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 824 MHz
Probe: ET3DV5 - SN1333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz: $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³
Cube 5x5x7: SAR (1g): 0.166 mW/g, SAR (10g): 0.132 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.34 dB
Antenna O/P = 27.8 dBm



Aircard350_D

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 836 MHz
 Probe: ET3DV5 - SN1333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz: $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³
 Cube 5x5x7; SAR (1g): 0.138 mW/g, SAR (10g): 0.111 mW/g, SAR (10g): 0.111 mW/g, SAR (10g): 0.111 mW/g (Worst-case extrapolation)
 Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
 Powerdrift: -0.04 dB
 Antenna O/P = 27.8 dBm



Aircard350_D

Generic Twin Phantom; Flat Section; Position: (90°, 90°); Frequency: 849 MHz

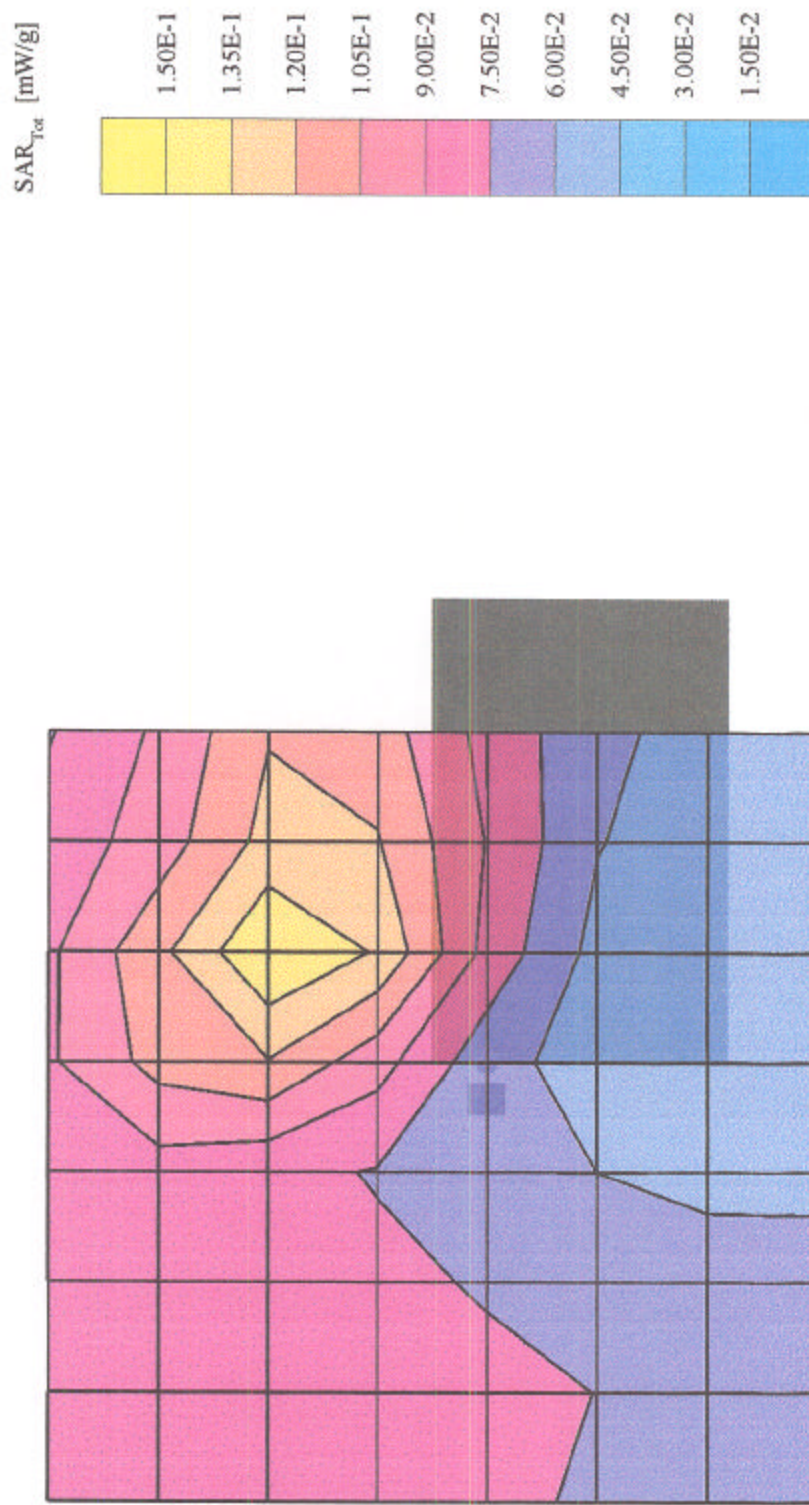
Probe: ET3DV5 - SN1333; ConvF(5.85, 5.85, 5.85); Crest factor: 1.0; Muscle 815 MHz: $\sigma = 0.94$ mho/m $\epsilon_r = 56.5$ $\rho = 1.00$ g/cm³

Cube 5x5x7: SAR (1g): 0.148 mW/g, SAR (10g): 0.120 mW/g, SAR (10g): 0.120 mW/g, SAR (10g): 0.120 mW/g (Worst-case extrapolation)

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

Powerdrift: -0.28 dB

Antenna O/P = 27.8 dBm



APPENDIX B - E-FIELD PROBE CALIBRATION DATA

Probe ET3DV5

SN:1333

Manufactured:	December 1997
Calibrated:	January 1998
Recalibrated:	March 1999

Calibrated for System DASY3

Introduction

The performance of all probes is measured before delivery. This includes an assessment of the characteristic parameters, receiving patterns as a function of frequency, frequency response and relative accuracy. Furthermore, each probe is tested in use according to a dosimetric assessment protocol. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe and some of the measurement diagrams are given in the following.

The performance of the individual probes varies slightly due to tolerances arising from the manufacturing process. Since the lines are highly resistive (several MOhms), the offset and noise problem is greatly increased if signals in the low μV range are measured. Accurate measurement below 10 $\mu\text{W/g}$ are possible if the following precautions are taken. 1) check the current grounding with the *multimeter*¹, i.e., low noise levels, 2) compensate the current *offset*¹, 3) use long integration time (approx. 10 seconds), 4) *calibrate*¹ before each measurement, 5) persons should avoid moving around the lab while measuring.

Since the field distortion caused by the supporting material and the sheath is quite high in the θ direction, the receiving pattern is poor in air. However, the distortion in tissue equivalent material is much less because of its high dielectricity. In addition, the fields induced in the phantoms by dipole structures close to the body are dominantly parallel to the surface. Thus, the error due to non-isotropy is much better than 1 dB for dosimetric assessments.

The probes are calibrated in the TEM cell if 110 although the field distribution in the cell is not very uniform and the frequency response is not very flat. To ensure consistency, a strict protocol is followed. The conversion factor (ConvF) between this calibration and the measurement in the tissue simulation solution is performed by comparison with temperature measurements and computer simulations. This conversion factor is only valid for the specified tissue simulating liquids at the specified frequencies. If measurements have to be performed in solutions with other electrical properties or at other frequencies, the conversion factor has to be assessed by the same procedure.

As the probes have been constructed with printed resistive lines on ceramic substrates (thick film technique), the probe is very delicate with respect to mechanical shocks.

Attention:

Do not drop the probe or let the probe collide with any solid object. Never let the robot move without first activating the emergency stop feature (i.e., without first turning the data acquisition electronics on).

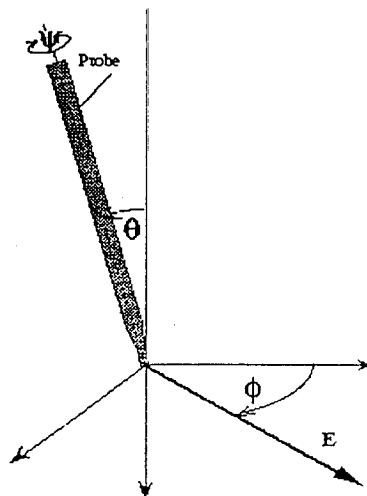


Fig 1: Due to the field distortion caused by the supporting material, the probe has two characteristic directions, referred to as angle ψ and θ .

¹ Feature of the DASY Software Tool.

ET3DV5 SN:1333

DASY3 - Parameters of Probe: ET3DV5 SN:1333

Sensitivity in Free Space

NormX	2.34	$\mu\text{V}/(\text{V}/\text{m})^2$
NormY	2.3	$\mu\text{V}/(\text{V}/\text{m})^2$
NormZ	2.3	$\mu\text{V}/(\text{V}/\text{m})^2$

Diode Compression

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

Sensitivity in Tissue Simulating Liquid

450 MHz	ConvF X	6.38	extrapolated
	ConvF Y	6.38	extrapolated
	ConvF Z	6.38	extrapolated

$\epsilon_r =$	$48 \pm 5\%$
$\sigma =$	$0.50 \pm 10\% \text{ mho/m}$
(brain tissue simulating liquid)	

900 MHz	ConvF X	6.03	$\pm 10\%$
	ConvF Y	6.03	$\pm 10\%$
	ConvF Z	6.03	$\pm 10\%$

$\epsilon_r =$	$42.5 \pm 5\%$
$\sigma =$	$0.86 \pm 10\% \text{ mho/m}$
(brain tissue simulating liquid)	

1500 MHz	ConvF X	5.55	interpolated
	ConvF Y	5.55	interpolated
	ConvF Z	5.55	interpolated

$\epsilon_r =$	$41 \pm 5\%$
$\sigma =$	$1.32 \pm 10\% \text{ mho/m}$
(brain tissue simulating liquid)	

1800 MHz	ConvF X	5.31	$\pm 10\%$
	ConvF Y	5.31	$\pm 10\%$
	ConvF Z	5.31	$\pm 10\%$

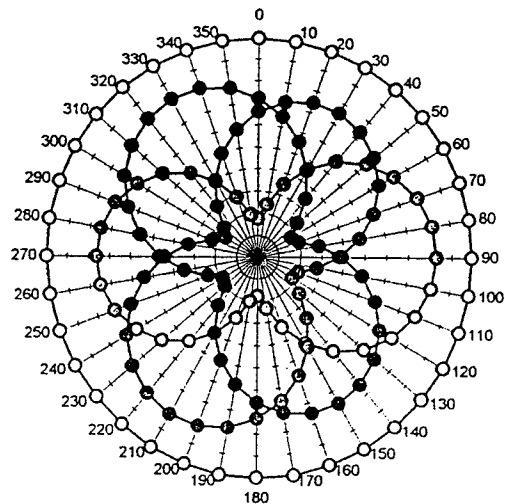
$\epsilon_r =$	$41 \pm 5\%$
$\sigma =$	$1.69 \pm 10\% \text{ mho/m}$
(brain tissue simulating liquid)	

Sensor Offset

Probe Tip to Sensor Center	2.7	mm
Surface to Probe Tip	1.7 ± 0.2	mm

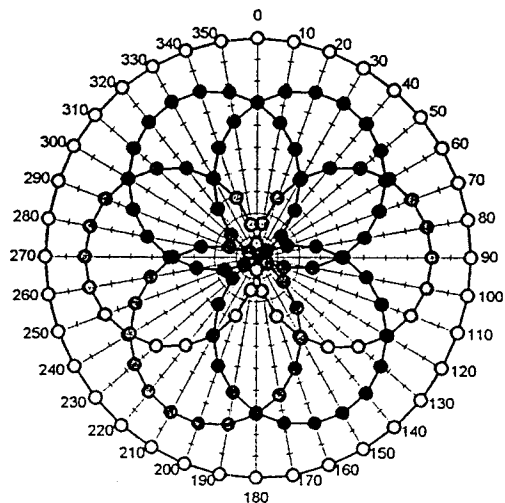
Receiving Pattern (ϕ), $\theta = 0^\circ$

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



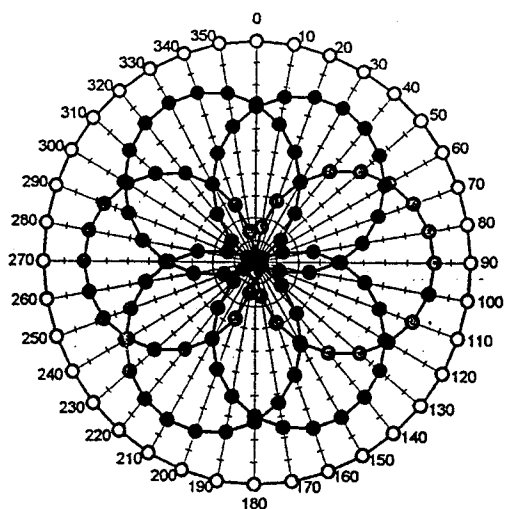
—○— X —●— Y —●— Z —○— Tot

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



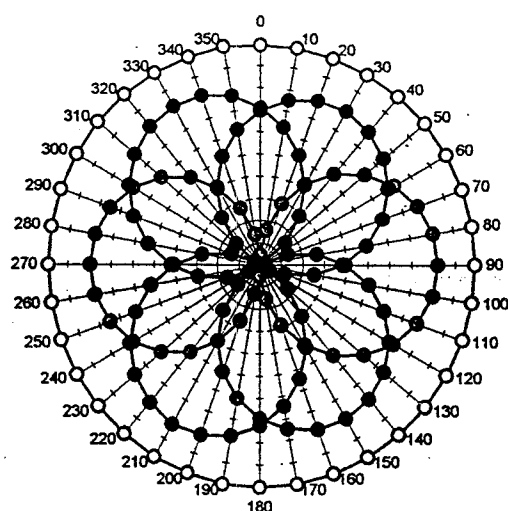
—○— X —●— Y —●— Z —○— Tot

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

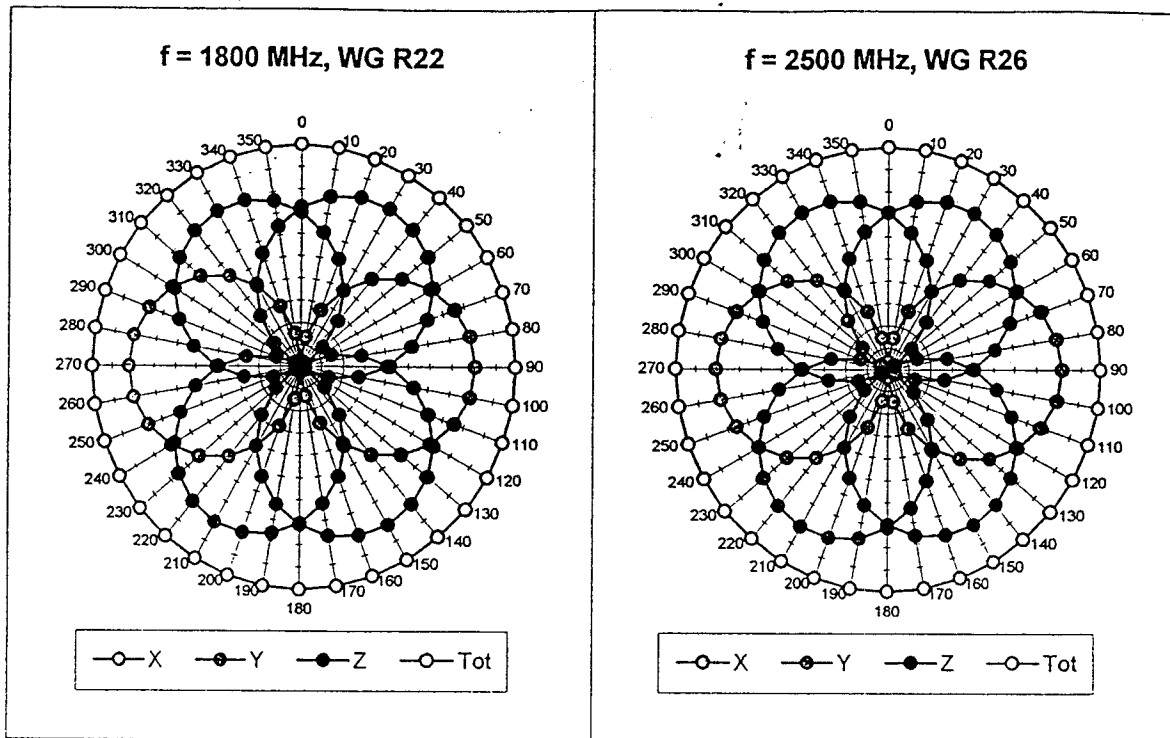


—●— X —●— Y —●— Z —○— Tot

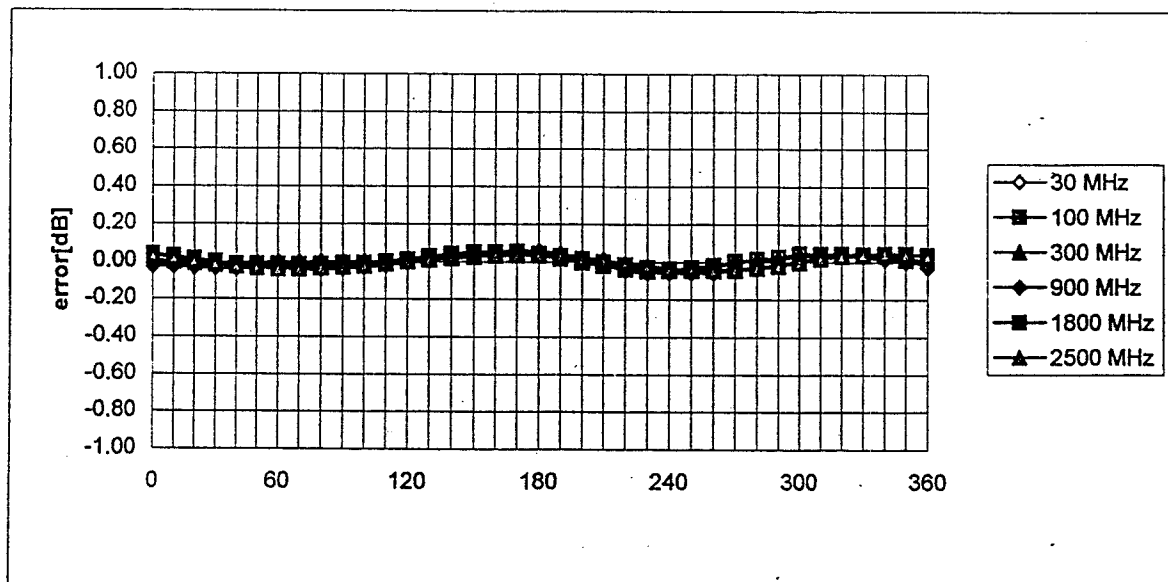
$f = 900 \text{ MHz}$, TEM cell ifi110



—●— X —●— Y —●— Z —○— Tot

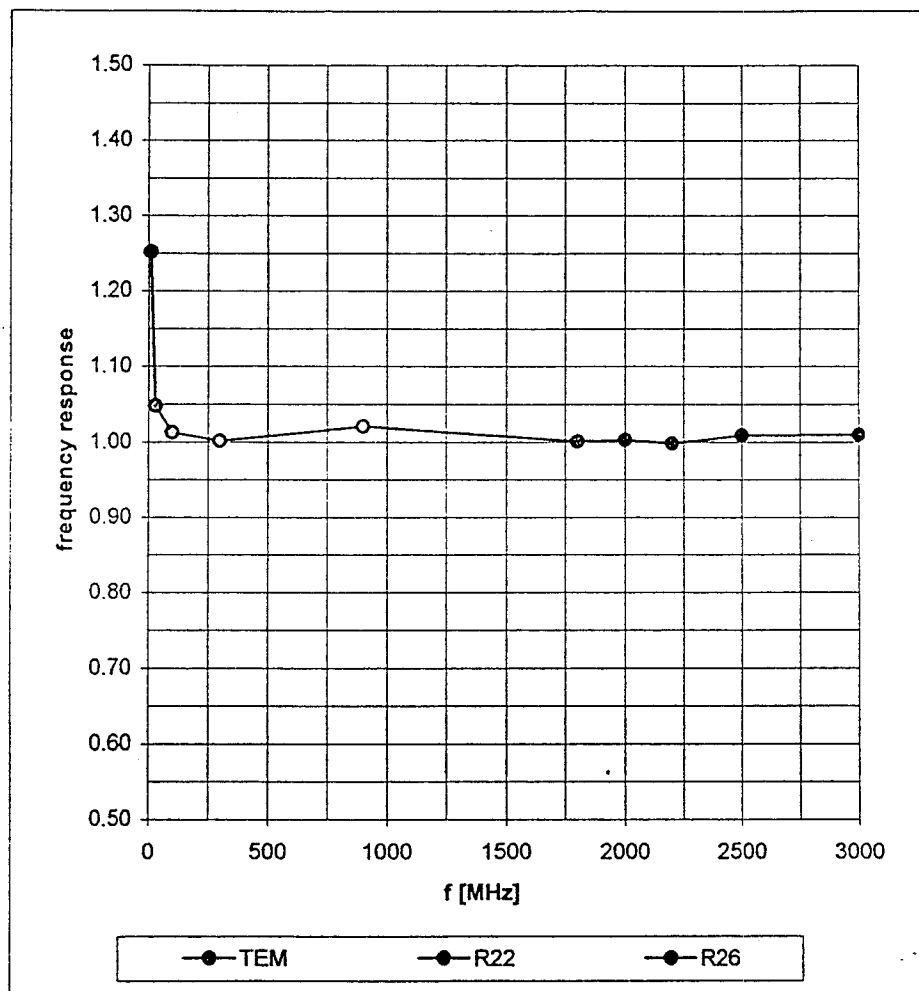


Isotropy Error (ϕ), $\theta = 0^\circ$



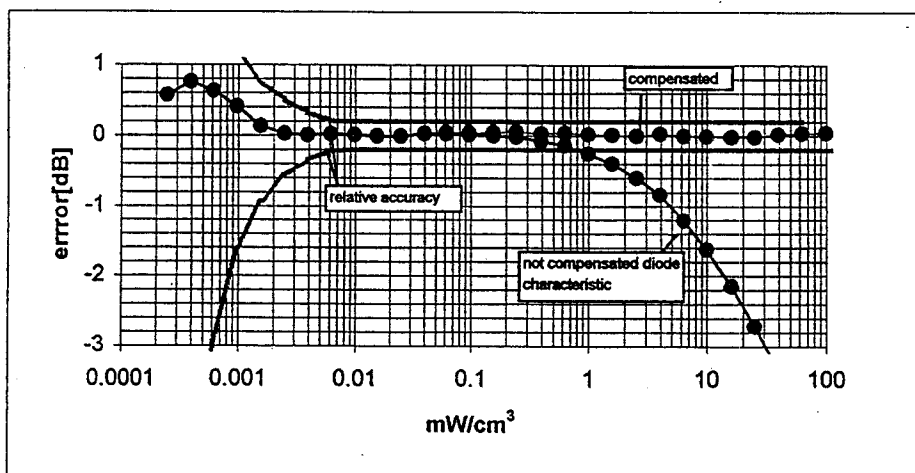
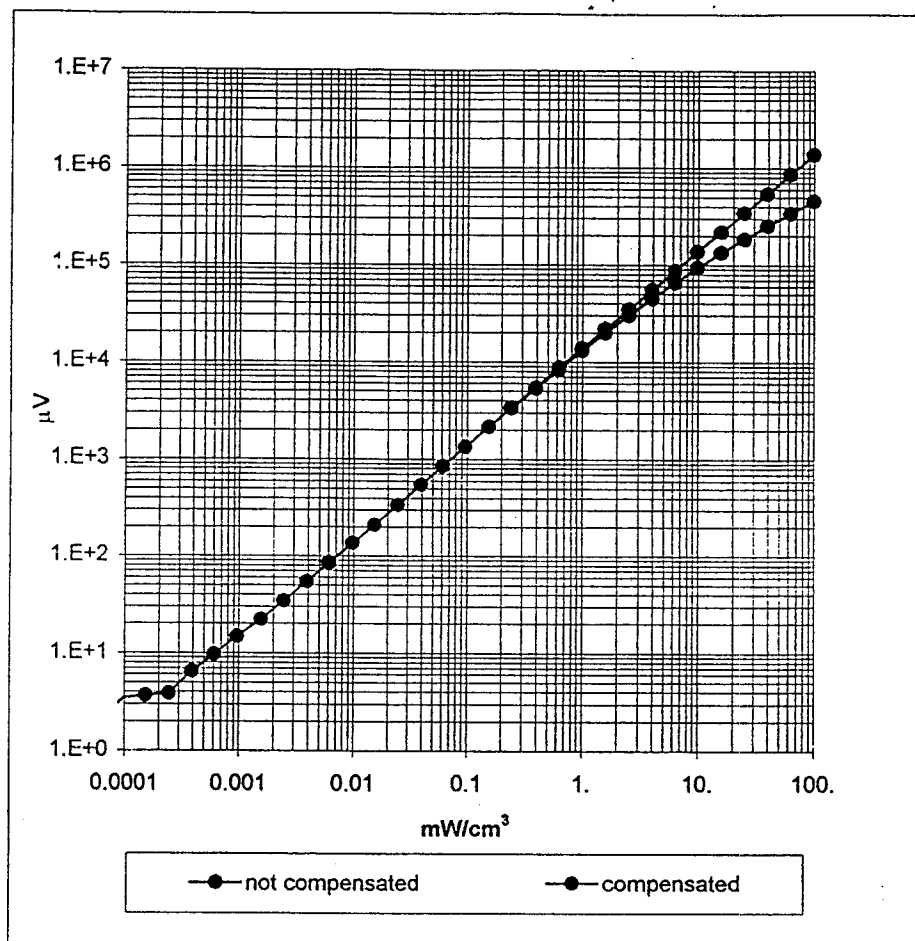
Frequency Response of E-Field

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

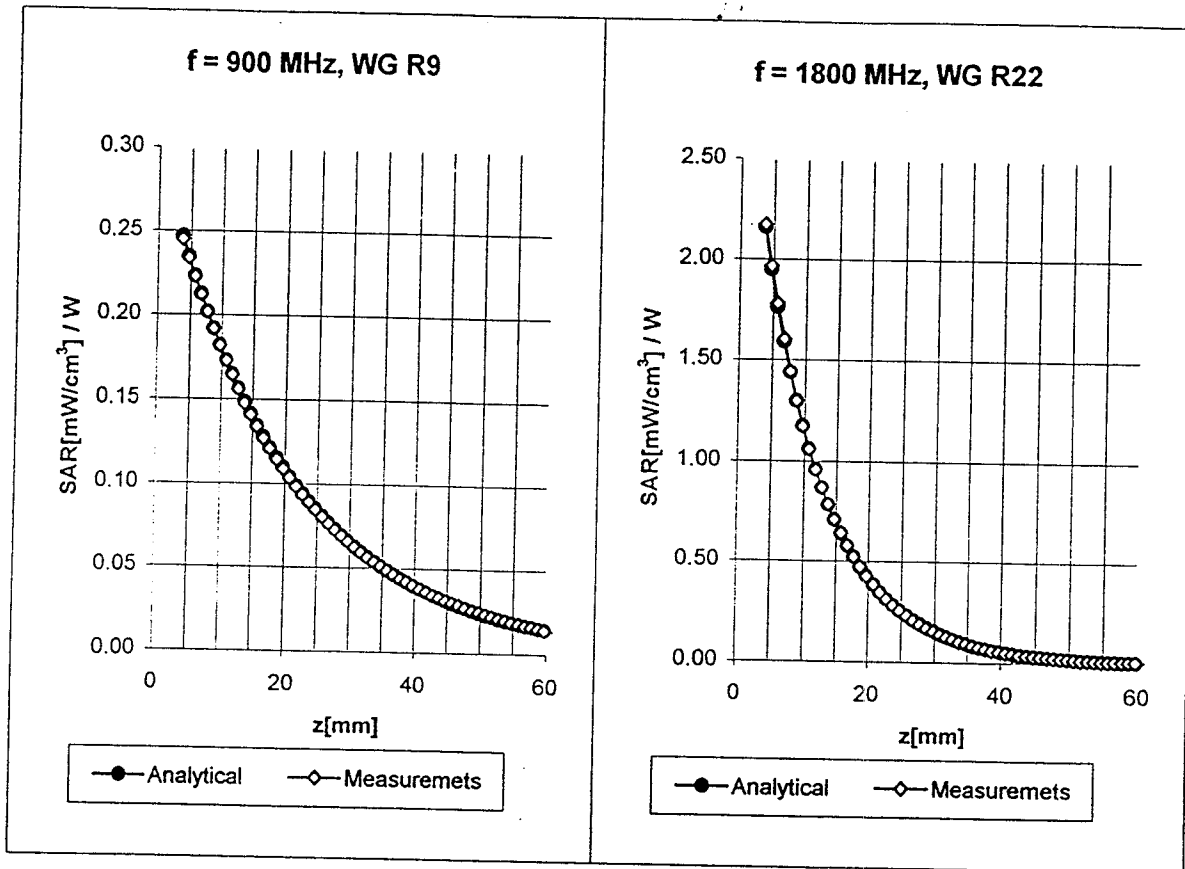


Dynamic Range f(SAR_{brain})

(TEM-Cell:ifi110)



Conversion Factor Assessment



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

