Specific Absorption Rate (SAR) Test Report
for
Symbol Technologies, Inc.
on the
PDT 7530 Diamond WAN Terminal with Datatac Radio
Model: PDT 7530

Job # J2018638
Test Report: 20186381
Date of Report: July 31, 2000

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

Tested by:	Suresh Kondapalli	
Reviewed by:	David Chernomordik	David Chernomordik

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1 JOB DESCRIPTION

1.1 Client Information

The EUT has been tested at the request of

Company:	Symbol Technologies, Inc.
Address:	1 Symbol Plaza, Holtsvillie, N.Y. 11742-1300 U.S.A
Name of contact:	Mr. Sandy Mazzola
Telephone:	631-738-5373
Fax:	631-738-3318

1.2 Equipment under test (EUT)

The Symbol Technologies Inc. PDT 7530 is based on the Symbol Technologies Diamond (PDT7500 series) terminal with a Motorola Datatac radio module imbedded inside. The Symbol terminal is a handheld portable data terminal with WAN capability supplied by Motorola Type 3 Datatac radio module. The Motorola module was FCC approved to FCC Part 90 under FCC ID: MKMPW1100-1. This test report is a part of the Symbol terminal's application for FCC ID: H9PPDT7530.

The PDT 7500 series family of portable data terminals puts the proccssing power of 485 PC in the user's hand. The terminal uses a rechargeable Lithium-Ion 1400 mAH smart battery, and incorporates pen technology and bar code scanning capability in key-based terminal.

The Datatac radio module is a 1 watt transmitter that is duty cycle limited to a maximum of 16% as per the Motorola's users manual. This is due to overheating and shutdown considerations of the module itself.

The normal operation of the Motorola Datatac RF module is very much different than that of a continuous use voice transmitter. These devices are primarily used in dispatch, telemetry, simple two-way messaging type of applications; mostly bursty data retrieval/delivery tapes of profiles. This is the intended use for Ardis RD-LAP WAN (Datatac).

Equipment	Terminal with Datatac Radio		
Trade Name	Symbol Technologies	Model No.	PDT 7530
FCC ID	H9PPDT7530	S/N No.	Not Labeled
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band (uplink)	824 MHz – 849 MHz	System	Datatac Radio

EUT Antenna Description			
Type	Monopole	Configuration	External, Removable
Dimensions	57.15 mm (L)	Gain	0 dBi
Location	Right side top		

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

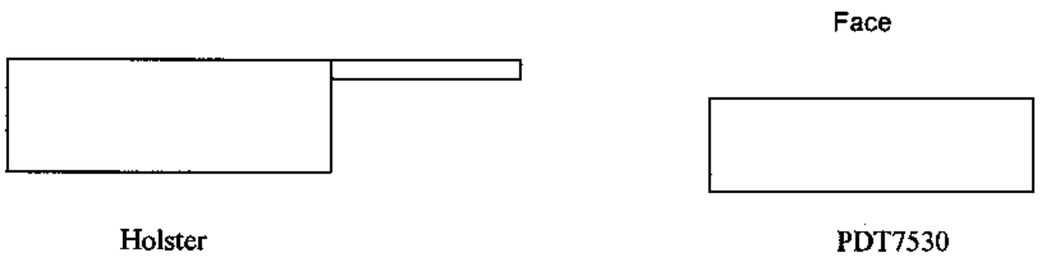
1.4.1 System block diagram & Support equipment

Support Equipment:

None, the unit is a standalone device.

System Block Diagram:

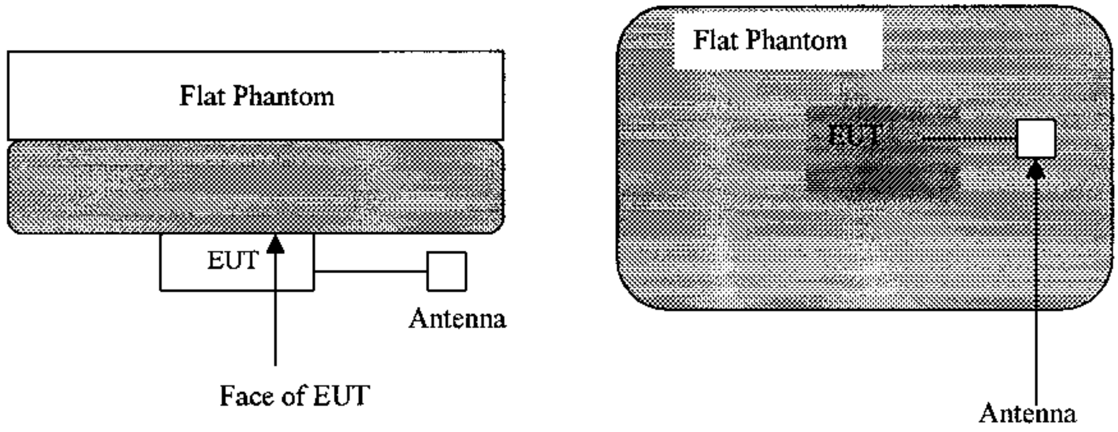
The diagram shown below details test configuration of the equipment under test.



S:	Shielded	U:	Unshield	F:	With Ferrite Core

1.4.2 Test Position

The EUT was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in C95.1 (1992) and Supplement C of OET 65 (1998). The EUT was placed in the intended use position, i.e. touching the human body or hand. Please refer to figure 1 below for the position details:



Side View

Top View

Figure 1: Intended use position

1.4.3 Test Condition

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

EUT Antenna	Fixed	Orientation	N/A
Usage	Body-worn and hand-held	Distance between base of EUT and the liquid surface:	See data below
Simulating human hand	Not Used	EUT Battery	Fully Charged
Power output	1.00W Conducted		

The spatial peak SAR values were accessed for lowest, middle and highest operating channels defined by the manufacturer. Tests were performed at 16% duty cycle. 30 milliseconds, transmitter "On" and 150 milliseconds, transmitter "Off". This is due to overheating and shut down considerations of the radio module.

Radiated emission measurement was performed, 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

2.3 System Verification

Prior to the assessment, the system was verified to the ±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	4.03	3.97

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 2.0 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.

The maximum spatial peak SAR values average over 1g assessed in "normal" position was 0.192 mW/g. The unit is in compliance with the requirements of the FCC for body requirements.

The maximum spatial peak SAR values average over 10g assessed in "normal" position was 0.134 mW/g. The unit is in compliance with the requirements of the FCC for hands and feet requirements.

Trade Name:	Wireless	Model No.:	PDT7530
Serial No.:	Unit # 1	Test Engineer:	Suresh Kondapalli

TEST CONDITIONS			
Ambient Temperature	24.8 °C	Relative Humidity	48 %
Test Signal Source	Test Mode	Signal Modulation	Unmodulated
Output Power Before SAR Test	0.925W	Output Power After SAR Test	0.950 W
Test Duration	25 Min.	Number of Battery Change	Every Scan

Usage (Touch position)							
Plots #	Channel (MHz)	Operating Mode	Position	Antenna	Distance From Phantom	Measured SAR_{1g} (mW/g)	Measured SAR_{10g} (mW/g)
1	815	Normal**	Face up	Fixed	Normal*	0.183	0.127
2	825	Normal**	Face up	Fixed	Normal*	0.192	0.134
3	806	Normal**	Face up	Fixed	Normal*	0.128	0.089

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

- PDT 7530 is normally inserted screen to long side of holster (facing user) as it was setup to protect the screen.

** Normal operation during the tests; was 30 milliseconds "On" and 150 milliseconds "Off" unmodulated.

3 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	**Stäubi RX60L**	597412-01	N/A
	Repeatability: ± 0.025mm Accuracy: 0.806×10^{-3} degree Number of Axes: 6		
E-Field Probe	**ET3DV5**	1333	04/10/00
	Frequency Range: 10 MHZ to 6 GHz Linearity: ± 0.2 dB Directivity: ± 0.1 dB in brain tissue		
Data Acquisition	**DAE3**	317	N/A
	Measurement Range: 1μV to >200mV Input offset Voltage: < 1μV (with auto zero) Input Resistance: 200 M		
Phantom	**Generic Twin V3.0**	N/A	N/A
	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)		
Simulated Tissue	**Mixture**	N/A	07/27/00
	Please see section 3.2 for details		
Power Meter	**HP 435A w/ 8481H sensor**	1312A01255	02/16/00
	Frequency Range: 100kHz to 18 GHz Power Range: 300μW to 3W		

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/m³)
835	56.1 ± 5%	0.95 ± 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 WARNING LABEL INFORMATION - USA

Not Applicable

5 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, "Dosimetic 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. Tayor and Chris E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994.

6 APPENDIX A - SAR EVALUATION DATA

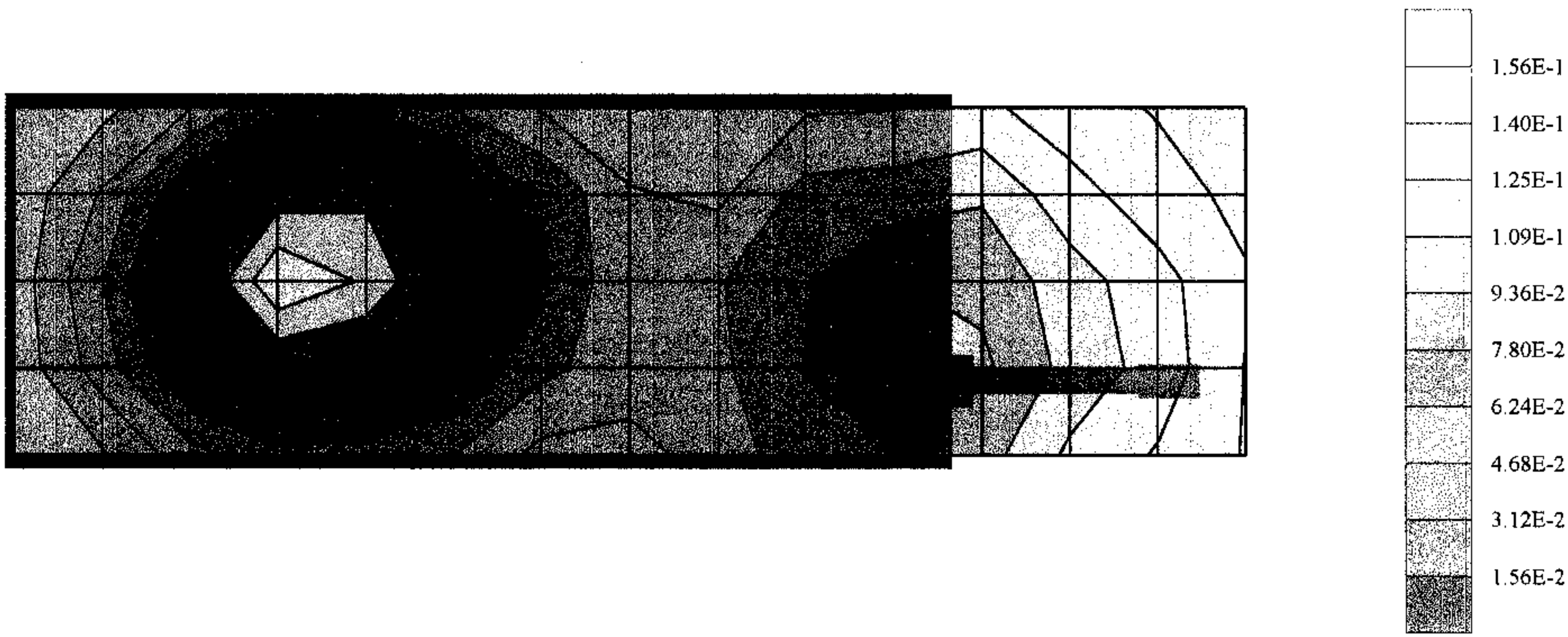
Please note that the graphical visualization of the phone position onto the SAR distribution gives only limited information on the current distribution of the device, since the curvature of the head results in graphical distortion. Full information can only be obtained either by H-field scans in free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

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

Symbol PDT7530

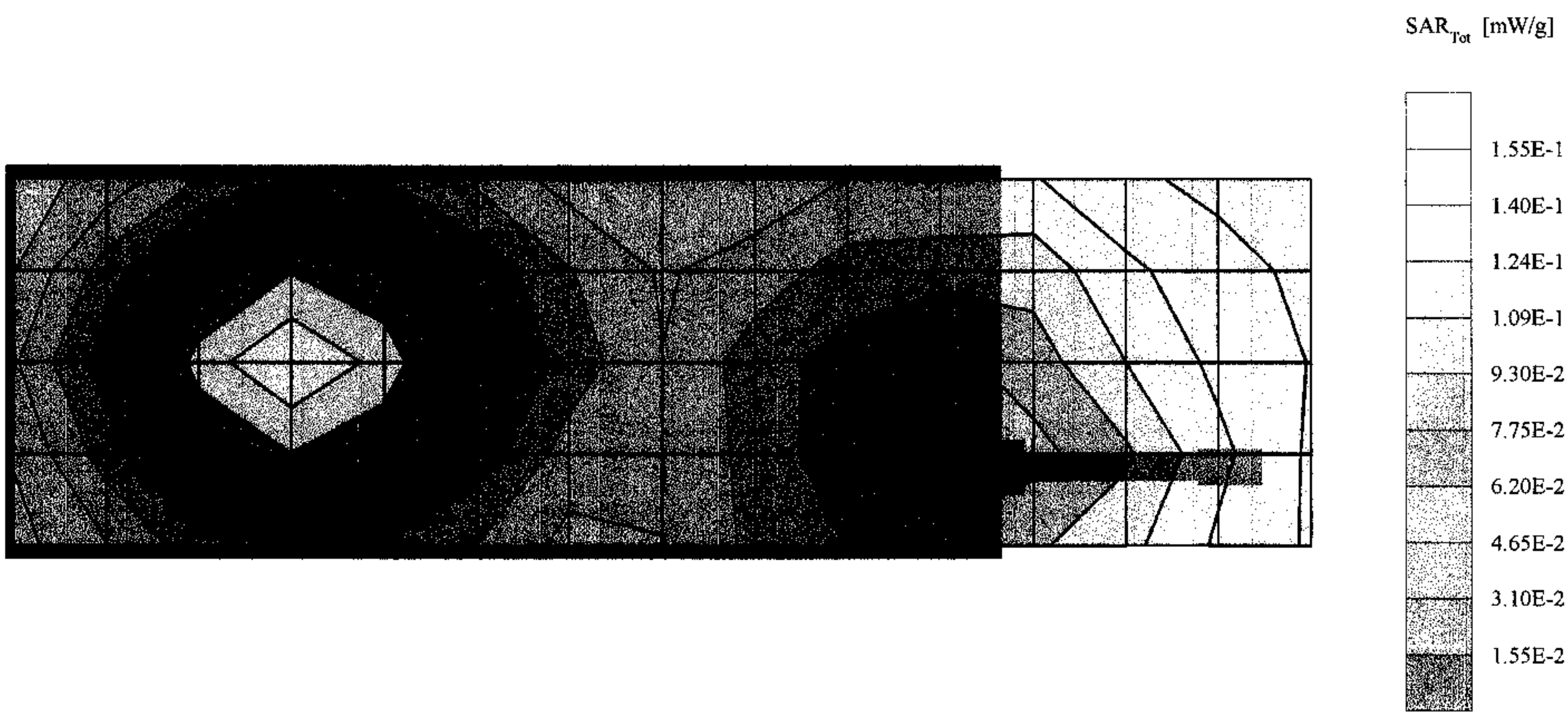
Plot #1

Generic Twin Phantom; Flat Section; Position: (90°,90°); Frequency: 815 MHz
Probe: ET3DV5 - SN1333; ConvF(5.70,5.70,5.70); Crest factor: 6.0; Muscle 815 MHz: σ = 0.94 mho/m ε_r = 56.5 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 0.183 mW/g, SAR (10g): 0.127 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: 0.15 dB



Symbol PDT7530 *Plot #2*

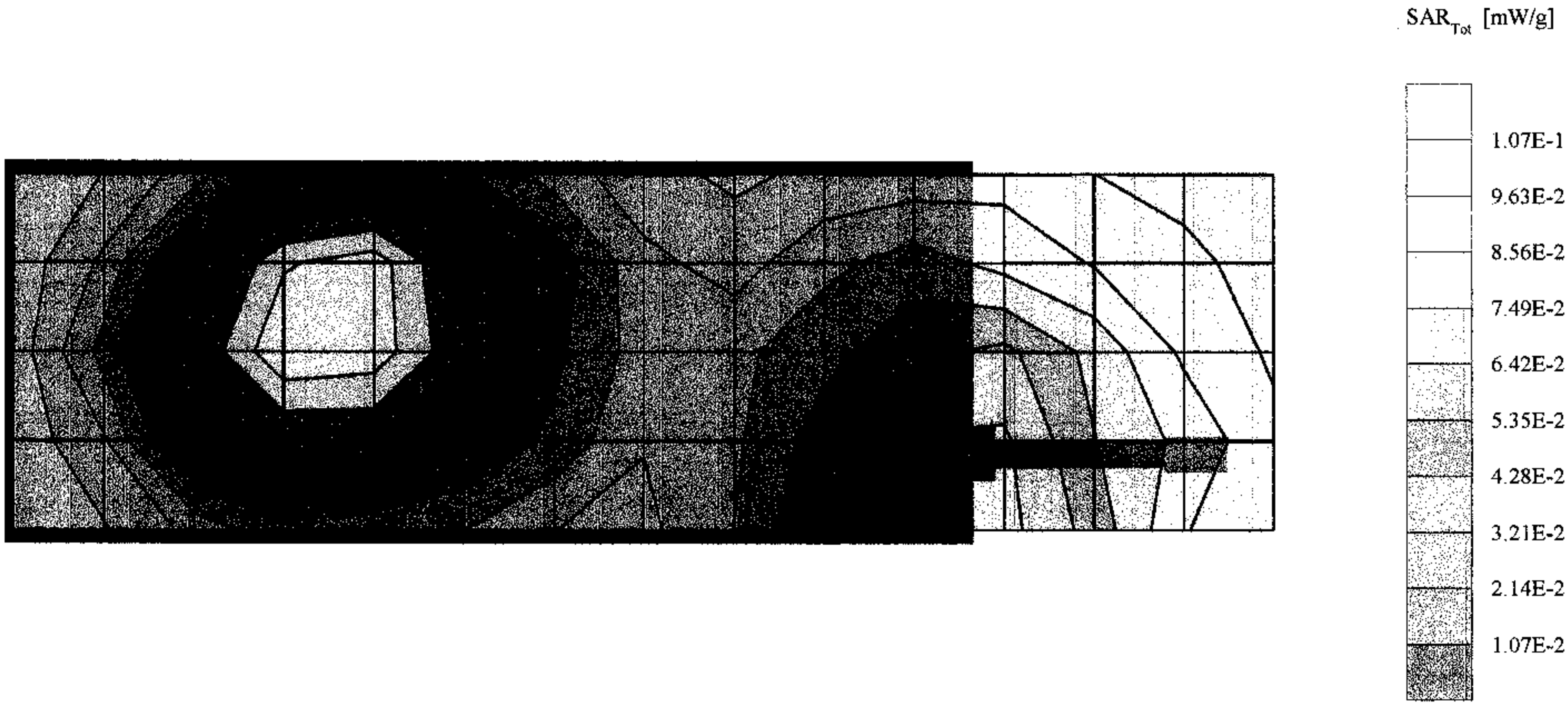
Generic Twin Phantom; Flat Section; Position: (90°,90°); Frequency: 825 MHz
Probe: ET3DV5 - SN1333; ConvF(5.70,5.70,5.70); Crest factor: 6.0; Muscle 815 MHz: $\sigma = 0.94$ mho/m $\varepsilon_r = 56.5$ $\rho = 1.00$ g/cm³
Cube 5x5x7: SAR (1g): 0.192 mW/g, SAR (10g): 0.134 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: 0.10 dB



07/28/00

Symbol PDT7530 *Plot #3*

Generic Twin Phantom; Flat Section; Position: (90°,90°); Frequency: 806 MHz
Probe: ET3DV5 - SN1333; ConvF(5.70,5.70,5.70); Crest factor: 6.0; Muscle 815 MHz: $\sigma = 0.94$ mho/m $\varepsilon_r = 56.5$ $\rho = 1.00$ g/cm³
Cube 5x5x7: SAR (1g): 0.128 mW/g, SAR (10g): 0.0891 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.08 dB



7 APPENDIX B - E-FIELD PROBE CALIBRATION DATA

[X] See Separate Attachment
[ ] See Below

Schmid & Partner
Engineering AG

Staffelstrasse 8, 8045 Zurich, Switzerland, Telefon +41 1 280 08 60, Fax +41 1 280 08 64

Probe ET3DV5

SN:1333

Manufactured:	December 20, 1997
Last calibration:	March 18, 1999
Recalibrated:	April 10, 2000

Calibrated for System DASY3

DASY3 - Parameters of Probe: ET3DV5 SN:1333

Sensitivity in Free Space

NormX	2.39 $\mu V/(V/m)^2$
NormY	2.36 $\mu V/(V/m)^2$
NormZ	2.34 $\mu V/(V/m)^2$

Diode Compression

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

Sensitivity in Tissue Simulating Liquid

Brain **450 MHz** **ε_r = 48 ± 5%** **σ = 0.50 ± 10% mho/m**

ConvF X	6.03	extrapolated	Boundary effect:	
ConvF Y	6.03	extrapolated	Alpha	0.13
ConvF Z	6.03	extrapolated	Depth	3.57

Brain **900 MHz** **ε_r = 42.5 ± 5%** **σ = 0.86 ± 10% mho/m**

ConvF X	5.70	± 7% (k=2)	Boundary effect:	
ConvF Y	5.70	± 7% (k=2)	Alpha	0.34
ConvF Z	5.70	± 7% (k=2)	Depth	3.00

Brain **1500 MHz** **ε_r = 41 ± 5%** **σ = 1.32 ± 10% mho/m**

ConvF X	5.25	interpolated	Boundary effect:	
ConvF Y	5.25	interpolated	Alpha	0.61
ConvF Z	5.25	interpolated	Depth	2.23

Brain **1800 MHz** **ε_r = 41 ± 5%** **σ = 1.69 ± 10% mho/m**

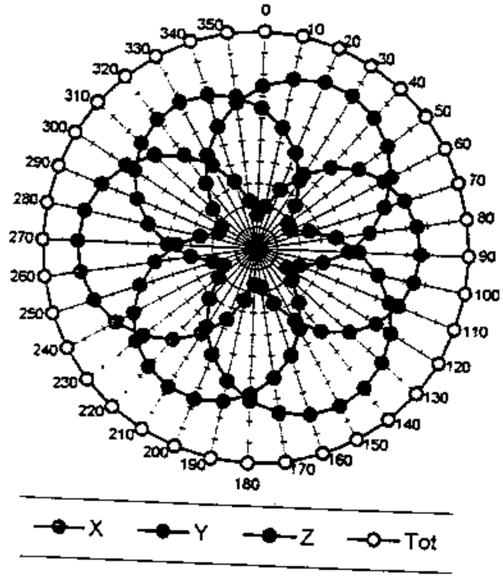
ConvF X	5.03	± 7% (k=2)	Boundary effect:	
ConvF Y	5.03	± 7% (k=2)	Alpha	0.74
ConvF Z	5.03	± 7% (k=2)	Depth	1.85

Sensor Offset

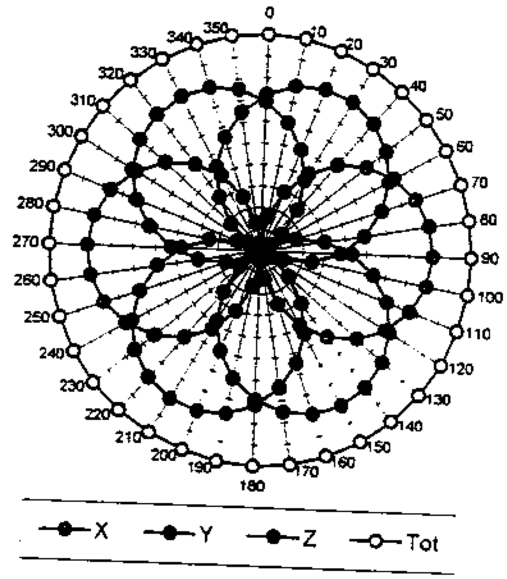
Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.9 ± 0.2	mm

Receiving Pattern (ϕ), θ = 0°

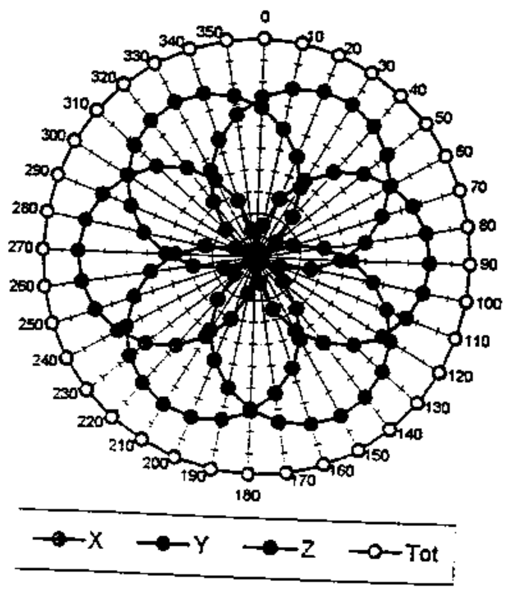
f = 30 MHz, TEM cell ifi110



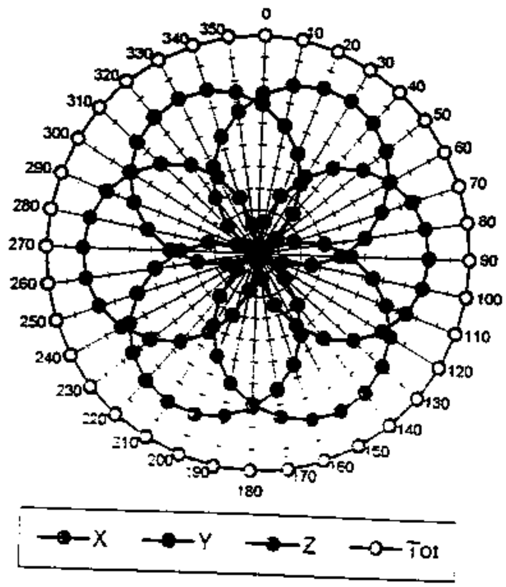
f = 100 MHz, TEM cell ifi110

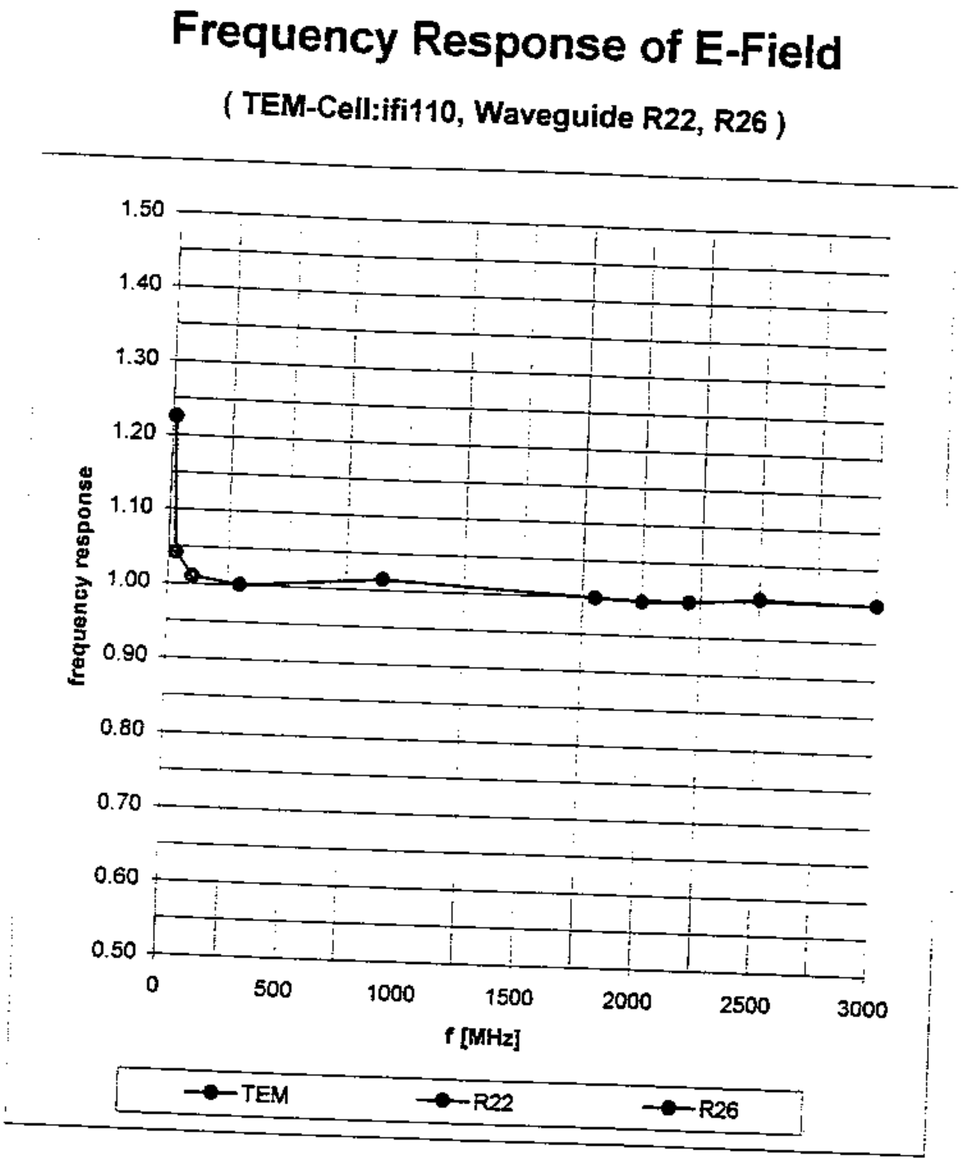


f = 300 MHz, TEM cell ifi110



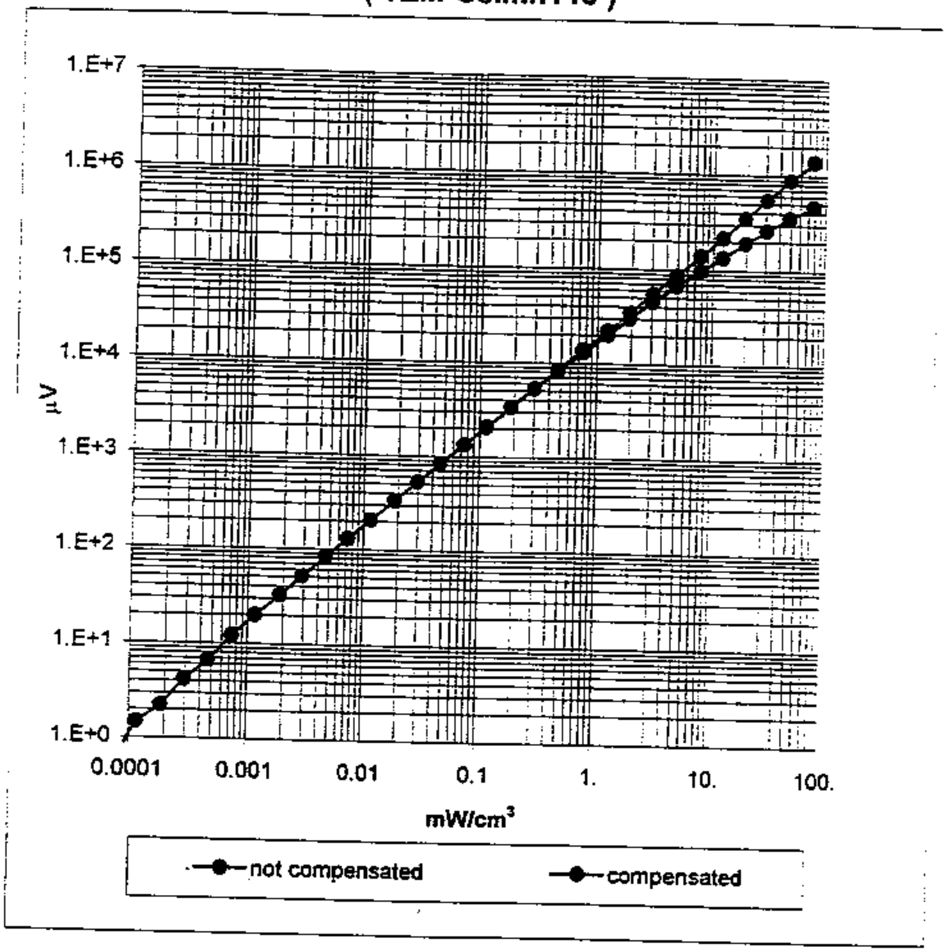
f = 900 MHz, TEM cell ifi110

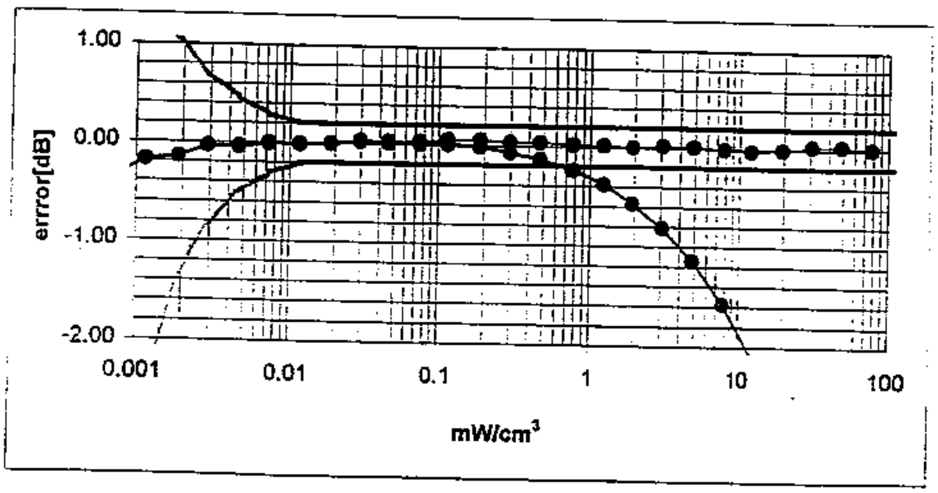



Frequency Response of E-Field
(TEM-Cell:ifi110, Waveguide R22, R26)
frequency response
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0
500
1000
1500
2000
2500
3000
f [MHz]
TEM
R22
R26

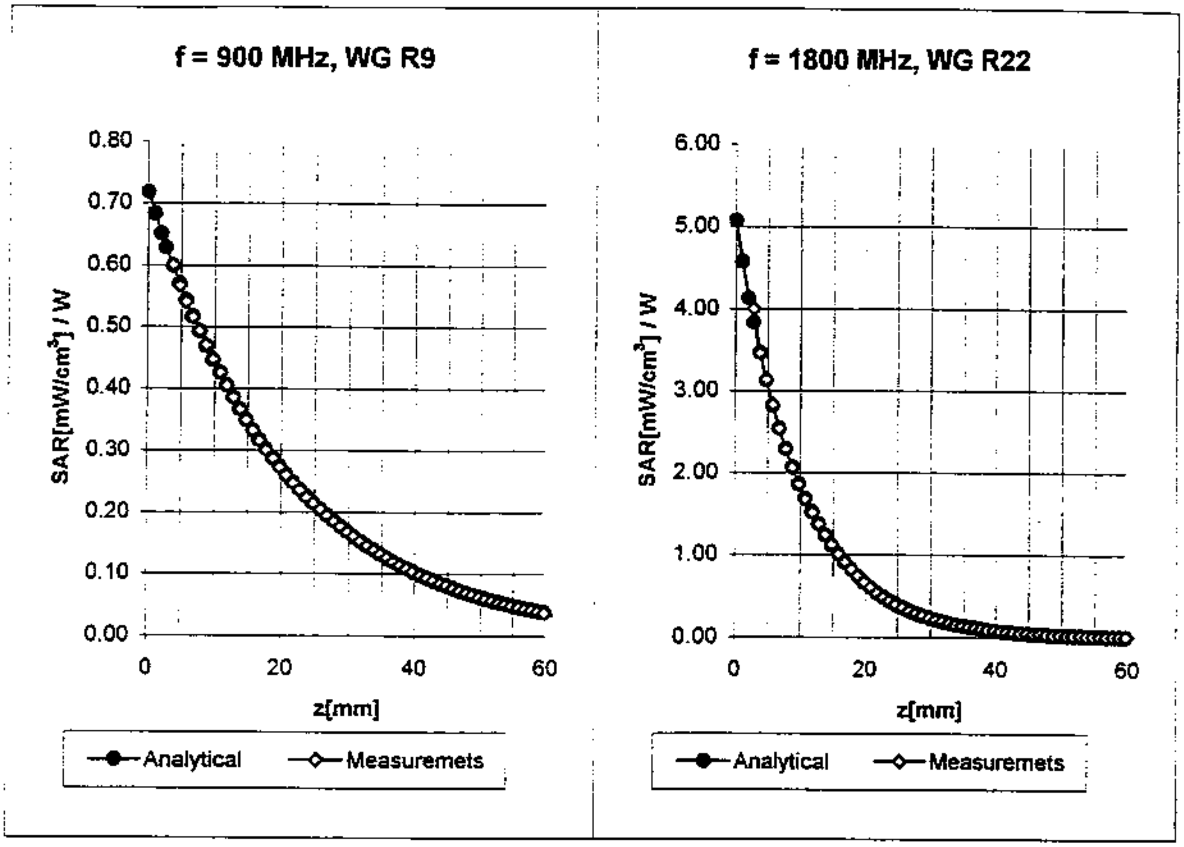
Dynamic Range f(SAR_{brain})

(TEM-Cell:ifi110)





Conversion Factor Assessment



Receiving Pattern (ϕ)

(in brain tissue, z = 5 mm)