ITS Intertek Testing Services
ETL SEMKO

Specific Absorption Rate (SAR) Test Report
for
Symbol Technologies, Inc.
on the
NETVISION
Model Number: NP-4046 w Auxiliary Antenna

Test Report: 20363692B
Date of Report: January 31, 2001

Job #: J20036369B
Date of Test: January 8 to 12, & 31 2001

Total No. of Pages Contained in this Report: 25 + Data Sheets

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Tested by: 01/31/01	Suresh Kondapalli
Reviewed by: David Chernomordik	EMC Site Manager

Review Date: 01/31/01

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Table of Contents

1.0 Job description

1.1 Client Information

The NP-4046 w Auxiliary Antenna has been tested at the request of

Company: Symbol Technologies, Inc.
6480 Via Del Oro
San Jose, CA 95119-1208
USA

Name of contact: Mr. Norm Nelson
Telephone: (408) 528-2649
Fax: 408 528-2740

1.2 Equipment under test (EUT)

Product Descriptions:

Equipment	NETVISION		
Trade Name	Symbol Technologies, Inc.	Model No:	NP-4046 w Auxiliary Antenna
FCC ID	H9PDM4046	S/N No.	Not Labeled
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band (uplink)	2402-2480MHz	System	DSS

EUT Antenna Description			
Type	Internal	Configuration	Fixed
Dimensions	N/A	Gain	0 dBi
Location	Built in		

Use of Product : Spectrum 24Hr Netvision Data Phone NP-4046

Manufacturer: SAME as above.

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

EUT receive date: January 7, 2001

EUT received condition: Good working condition prototype

Test start date: January 8, 2001

Test end date: January 31, 2001

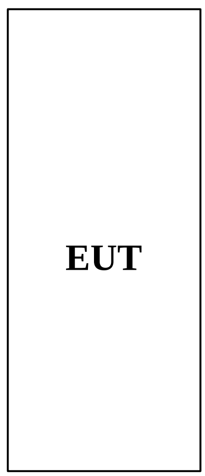
1.3 Test plan reference

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.



1.4.2 Test Position

The NP-4046 w Auxiliary Antenna 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. CENELEC 80^o position. This position is defined by a reference plane and a line. The reference plane of the head is given by three points, the auditory canal opening of both ears and center of the closed mouth. The reference line of the EUT is defined by the line, which connects the center of the ear piece with the center of the bottom of the case and lies on the surface of the case facing the phantom. The reference line of the EUT lies in the reference plane of the head. The center of the ear-piece of the EUT is placed at the entry of the auditory canal. The angle between the reference line of the phone and the line connecting both auditory canal openings is 80^o. Please refer to figure 1 below for the position details:

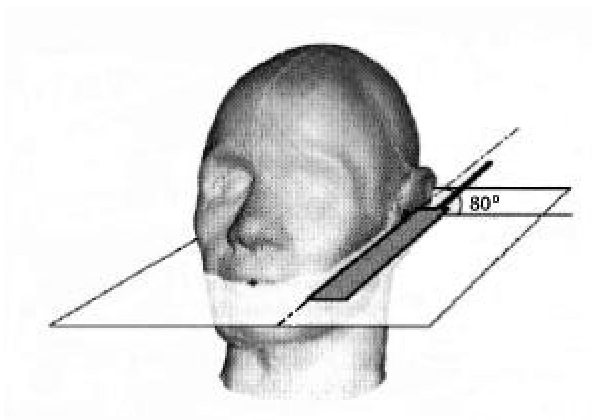


Figure 1: Intended use position

Additionally, the EUT was tested in a second position from the normal 80^o angle between the reference line of the phone and the line connecting both auditory canal openings. The center of the ear piece of the EUT is placed at the entry of the auditory canal. The angle between the reference line of the phone and the line connecting both auditory canal openings was adjusted from 80^o to the angle where two points of the phone were in contact with the phantom (ear hole and cheek).

Data pages indicate the position of the EUT during testing. The first position of 80^o has data pages labeled ‘1 point touch’. The second position has data pages labeled ‘2 point touch’.

The left hand and right hand sections of the phantom were used for measuring the low, middle, and high channels in the 1 point touch and 2 point touch positions.

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	Left Hand	Distance between antenna axis at the joint and the liquid surface:	8mm
Simulating human Body/hand	Brain & muscle	EUT Battery	Fully charged
Power output	21.7 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, by the manufacturer.

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:

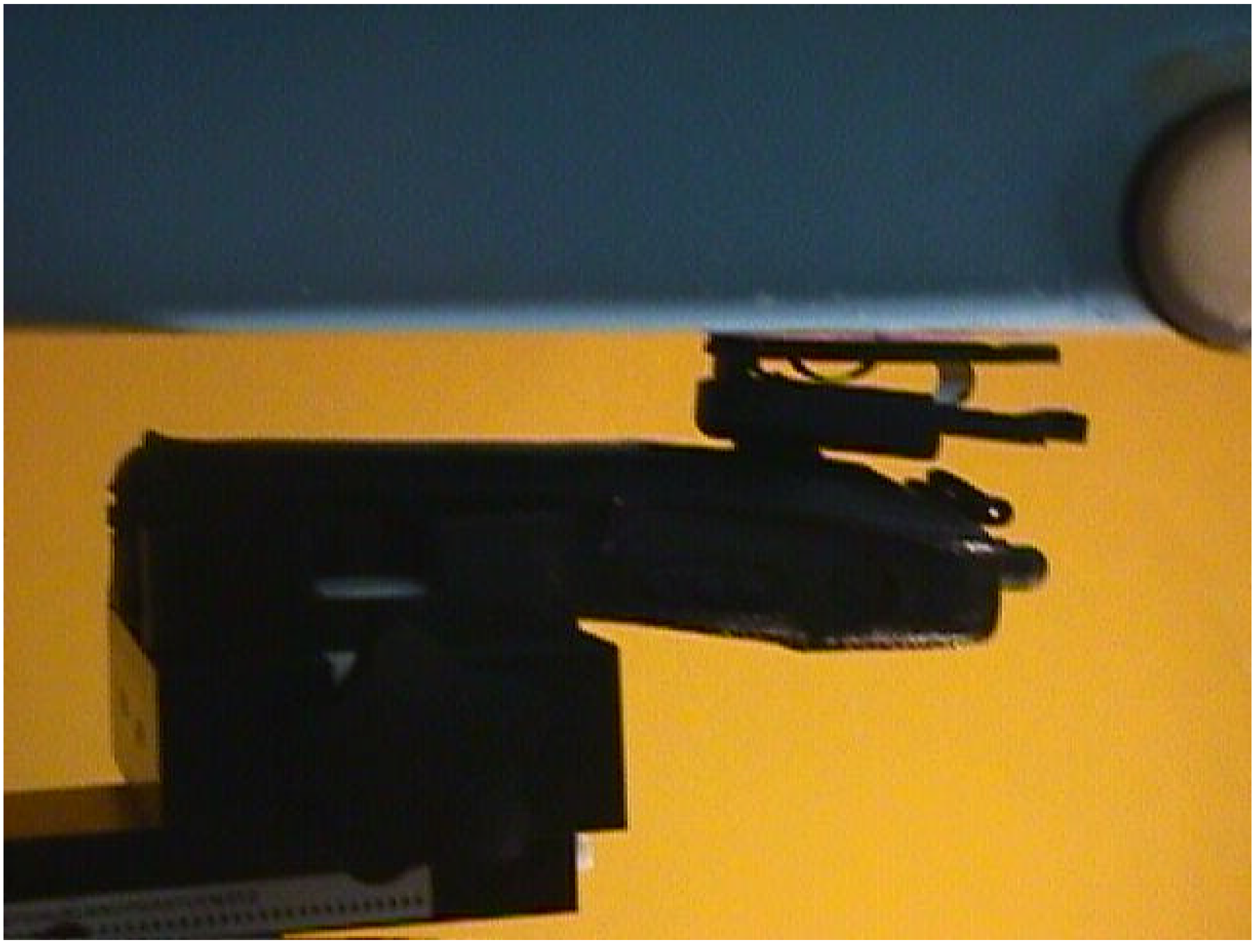
EXPOSURE (General Population/Uncontrolled Exposure environment)	SAR (W/kg)
Average over the whole body	0.08
Spatial Peak (1g)	1.60
Spatial Peak for hands, wrists, feet and ankles (10g)	4.00

2.2 Configuration Photographs

SAR measurement Test Setup

2.2 Configuration Photographs (Continued)

SAR measurement Test Setup



2.2 Configuration Photographs (Continued)

SAR measurement Test Setup

2.2 Configuration Photographs (Continued)

EUT Front-side

Auxiliary Antenna is built-in and not visible in the photo

2.2 Configuration Photographs (Continued)

EUT Back

2.2 Configuration Photographs (Continued)

EUT Side with Holder & Clip

2.2 Configuration Photographs (Continued)

EUT Back with Holder & Clip

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 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:	Symbol Technologies, Inc.	**Model No.:**	NP-4046 w Auxiliary Antenna
Serial No.:	Not Labeled	**Test Engineer:**	Suresh Kondapalli

TEST CONDITIONS			
Ambient Temperature	21 ^{o}C	Relative Humidity	40 %
Test Signal Source	Test Mode	Signal Modulation	CW
Output Power Before SAR Test	21.7 dBm	Output Power After SAR Test	21.7 dBm
Test Duration	23 Min.	Number of Battery Change	Battery changed for every measurement

EUT Position: Left Hand; 80 Deg				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2412	CW	1	0.113	1
2440	CW	1	0.134	2
2462	CW	1	0.139	3

EUT Position: Left Hand; Two Points Touching Phantom				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2402	CW	1	0.178	4
2440	CW	1	0.136	5
2480	CW	1	0.121	6

EUT Position: Right Hand; 80 Deg				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2402	CW	1	0.137	7
2480	CW	1	0.179	8

EUT Position: Right Hand; Two Points Touching Phantom				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2402	DSS	1	0.264	9
2440	DSS	1	0.191	10
2480	DSS	1	0.209	11

EUT Position: Middle, Face down, with holder & clip Touching Phantom*				
Channel MHz	Operating Mode	Duty Cycle ratio	Measured SAR_{1g} (mW/g)	Plot Number
2402	DSS	1	0.848	12
2440	DSS	1	1.16	13
2480	DSS	1	1.22	14

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) * clip is 18.7mm thick

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	**Stäubi RX60L**	597412-01	N/A
	Repeatability: ± 0.025mm Accuracy: 0.806×10^{-3} degree Number of Axes: 6		
E-Field Probe	**ET3DV5**	1333	4/10/00
	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	1/08/00
	Please see section 6.2 for details		
Power Meter	**HP 8900D** w/ 84811A sensor	3607U00673	8/01/01
	Frequency Range: 100kHz to 18 GHz Power Range: 300µW to 3W		

3.2 Brain Tissue Simulating Liquid

Brain	
Ingredient	**Frequency** (2400 – 2500 MHz)
Water	53.93 %
Sugar	44.97 %
Salt	0 %
HEC	1.0 %
Bactericide	0.1 %

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)	$_r$ *	*(mho/m)	**(kg/m$^{3)}$
2400	39.0±5%	2.3±10%	1000

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

** *worst case assumption*

Muscle	
Ingredient	**Frequency** (2400 – 2500 MHz)
Water	55.5 %
Sugar	43.4 %
Salt	0 %
HEC	1.0 %
Bactericide	0.1 %

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)	$_r$ *	*(mho/m)	**(kg/m$^{3)}$
2440	35.7±5%	2.36±10%	1000

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

** *worst case assumption*

Note: The amount of each ingredient specified in the tables are not the exact amounts of the final test solution. The final test solution was adjusted by adding small amounts of either water, sugar, and/or salt to calibrate the solution to meet the proper dielectric parameters.

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 user manual.

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, "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.

APPENDIX A - SAR Evaluation Data

APPENDIX B - E-Field Probe Calibration Data

See attached.

Schmid & Partner
Engineering AG

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

Calibration Certificate

Dosimetric E-Field Probe

Type:	**ET3DV5**
Serial Number:	**1333**
Place of Calibration:	**Zurich**
Date of Calibration:	**April 10, 2000**
Calibration Interval:	**12 months**

Schmid & Partner Engineering AG hereby certifies, that this device has been calibrated on the date indicated above. The calibration was performed in accordance with specifications and procedures of Schmid & Partner Engineering AG.

Wherever applicable, the standards used in the calibration process are traceable to international standards. In all other cases the standards of the Laboratory for EMF and Microwave Electronics at the Swiss Federal Institute of Technology (ETH) in Zurich, Switzerland have been applied.

Calibrated by: [signature]

Approved by: [signature]

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**

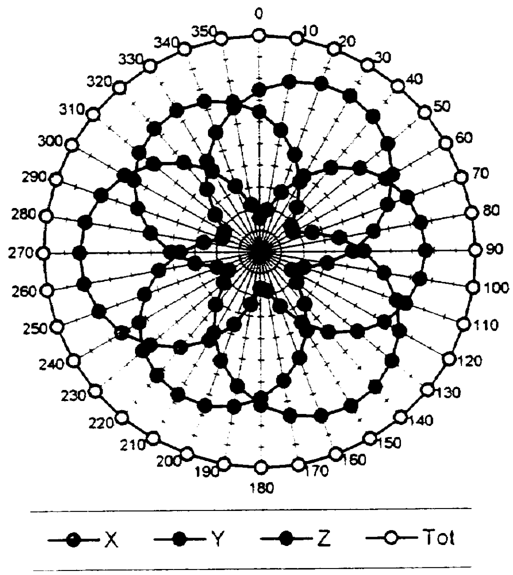
ConvF X	**5.03**	± 7% (k=2)	Boundary effect:	
ConvF Y	**5.03**	± 7% (k=2)	Alpha	**0.74**
ConvF Z	**5.03**	± 7% (k=2)	Depth	**1.85**

Sensor Offset

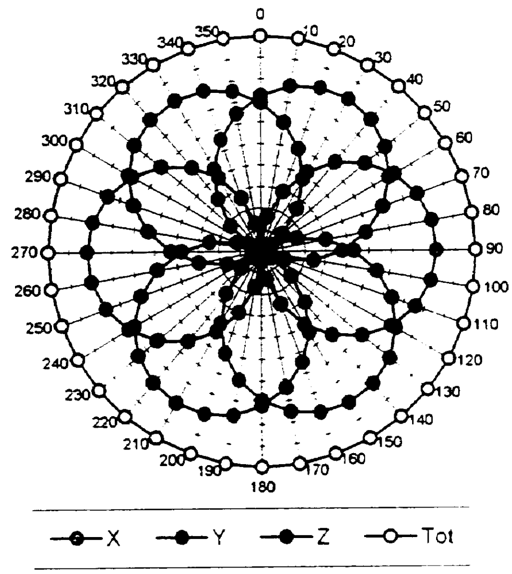
Probe Tip to Sensor Center	**2.7**	mm
Optical Surface Detection	**1.9 ± 0.2**	mm

Receiving Pattern (ϕ), θ = 0°

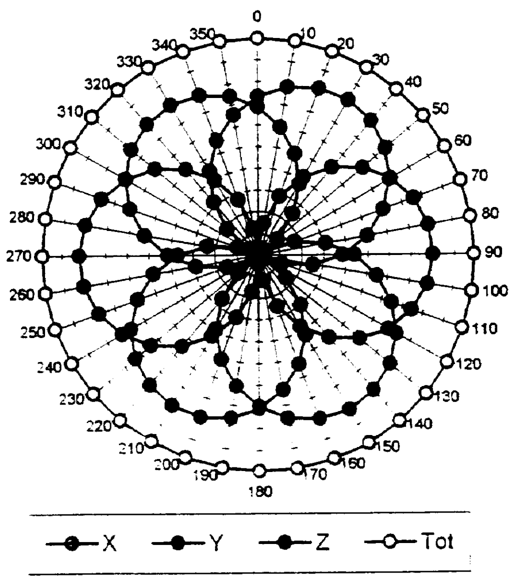
f = 30 MHz, TEM cell ifi110



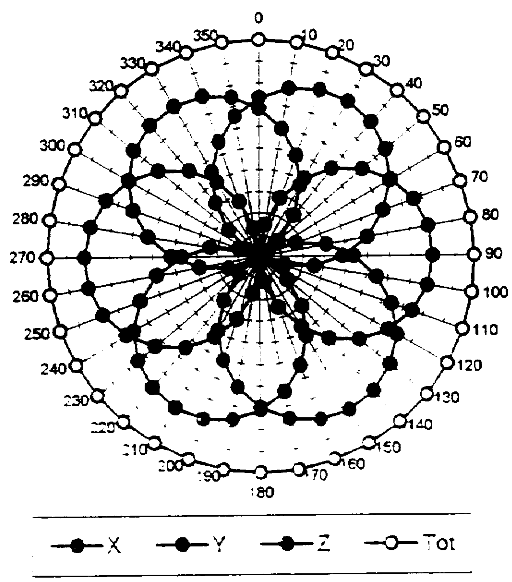
f = 100 MHz, TEM cell ifi110



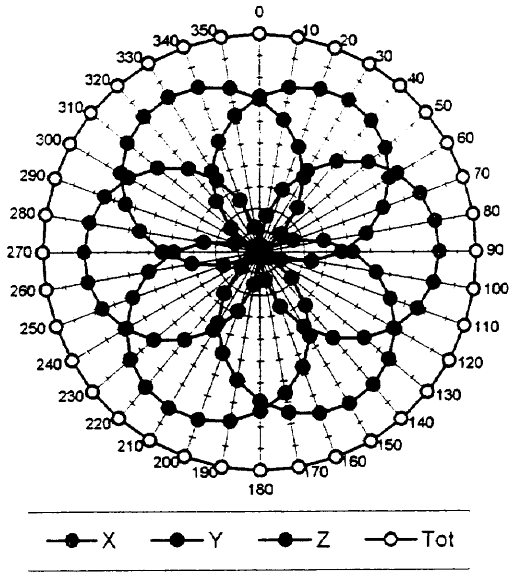
f = 300 MHz, TEM cell ifi110



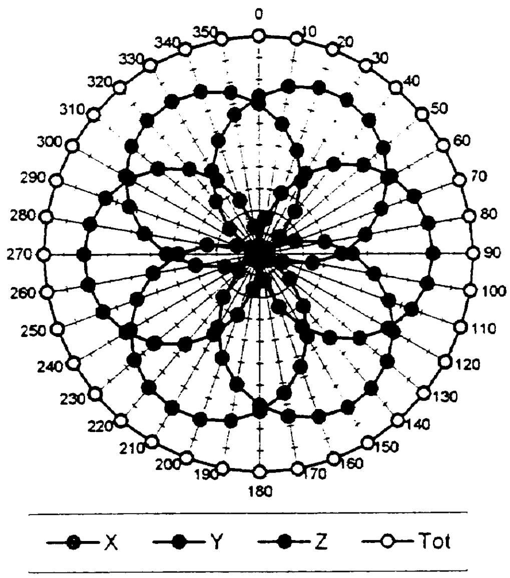
f = 900 MHz, TEM cell ifi110



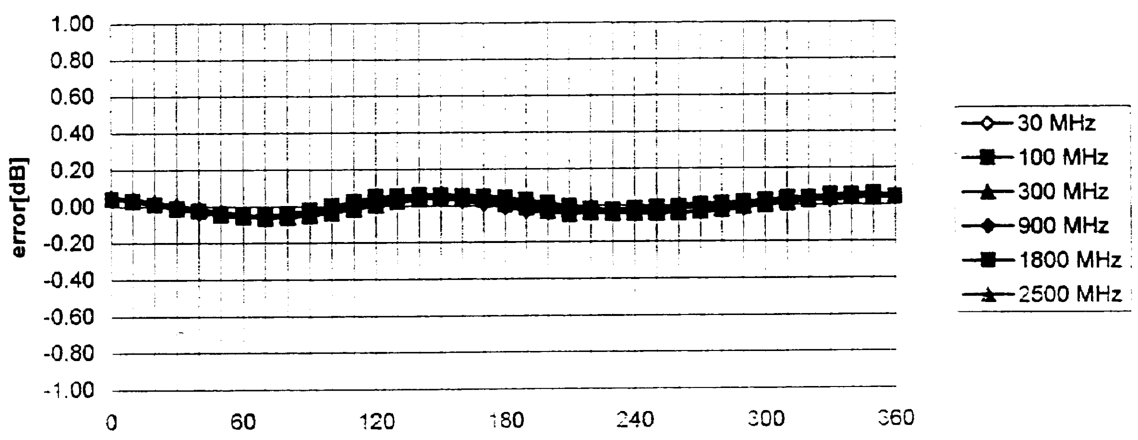
f = 1800 MHz, WG R22



f = 2500 MHz, WG R26

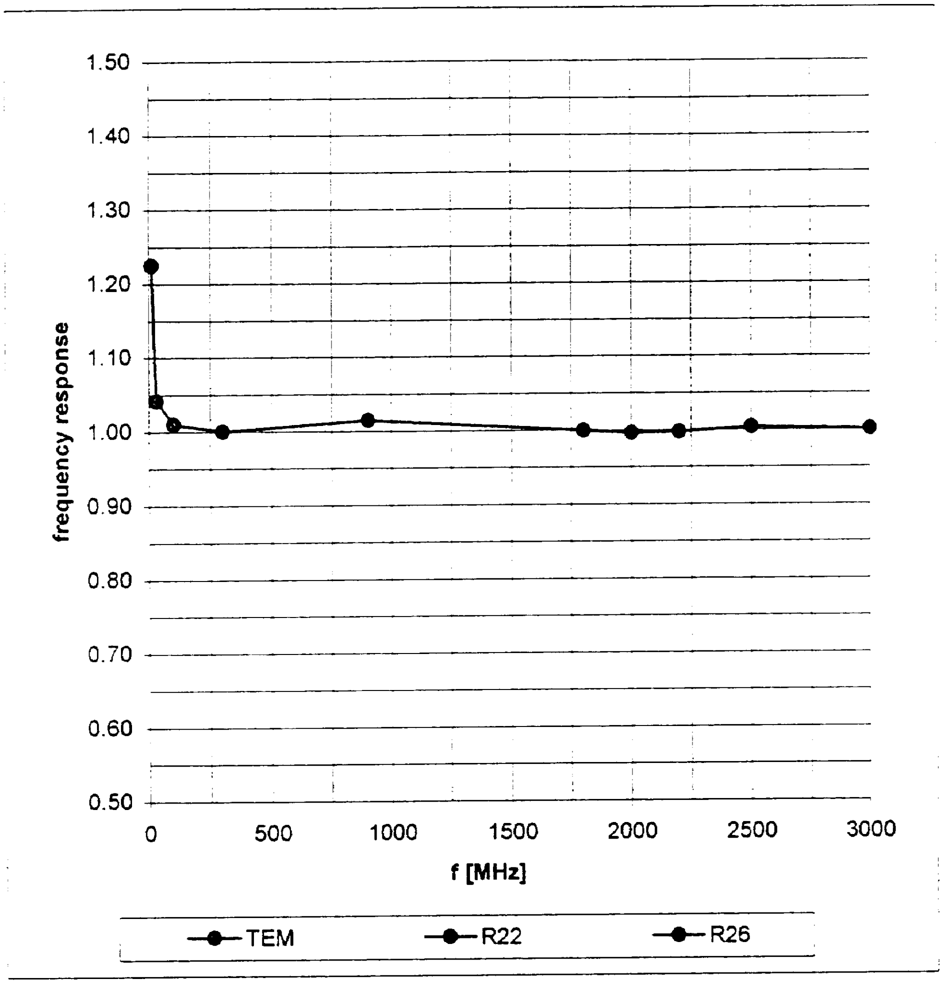


Isotropy Error (ϕ), θ = 0°



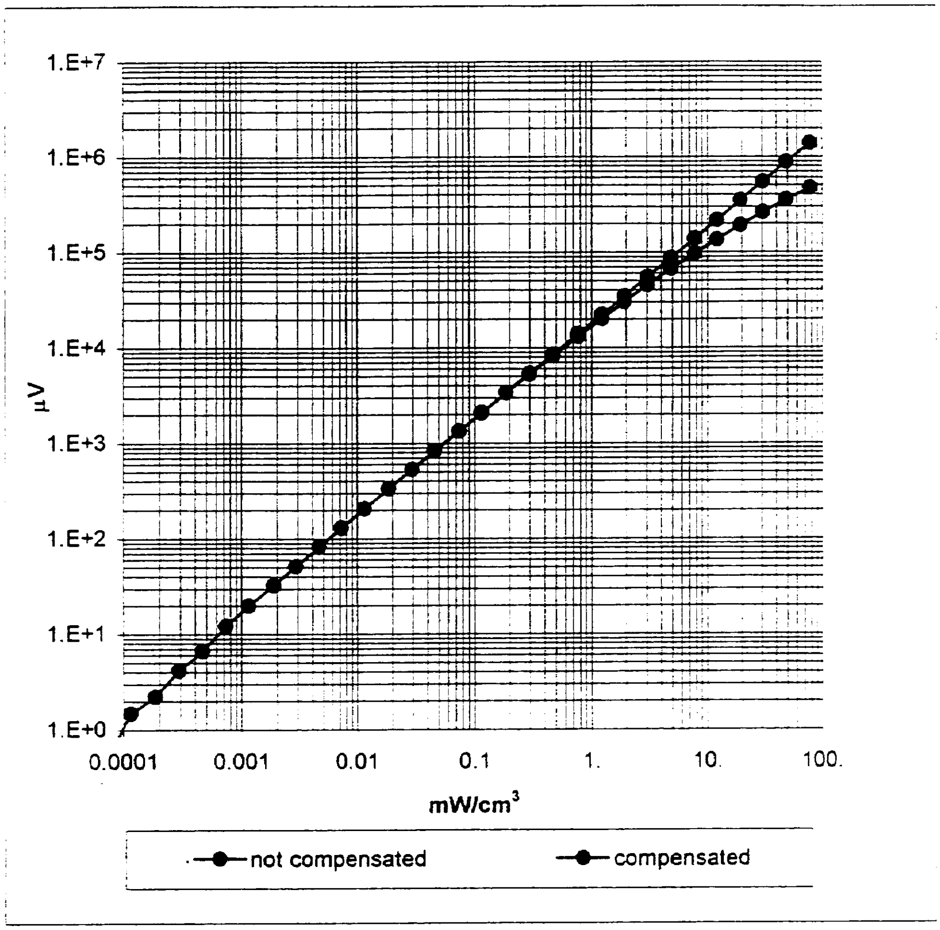
Frequency Response of E-Field

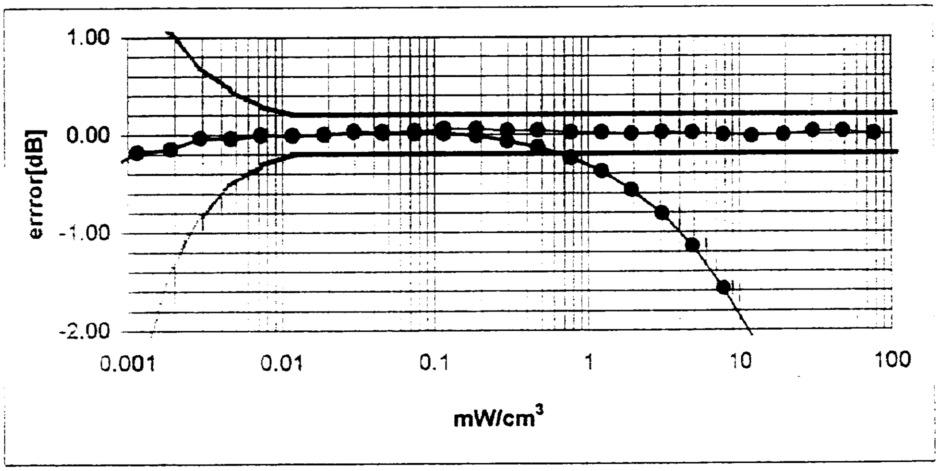
(TEM-Cell:ifi110, Waveguide R22, R26)



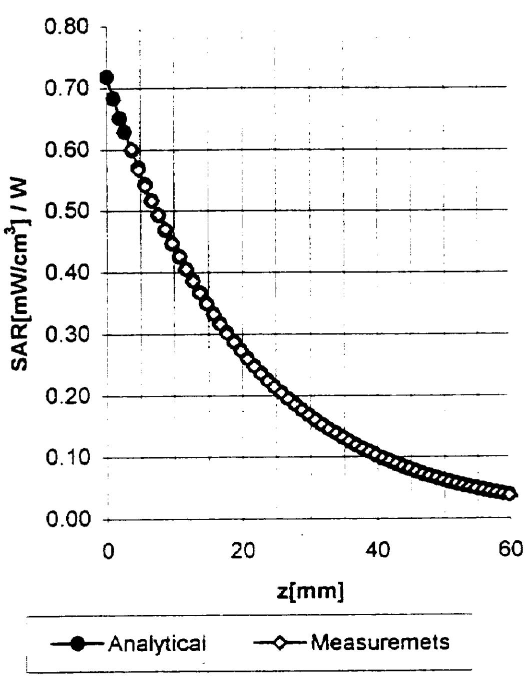
Dynamic Range f(SAR_{brain})

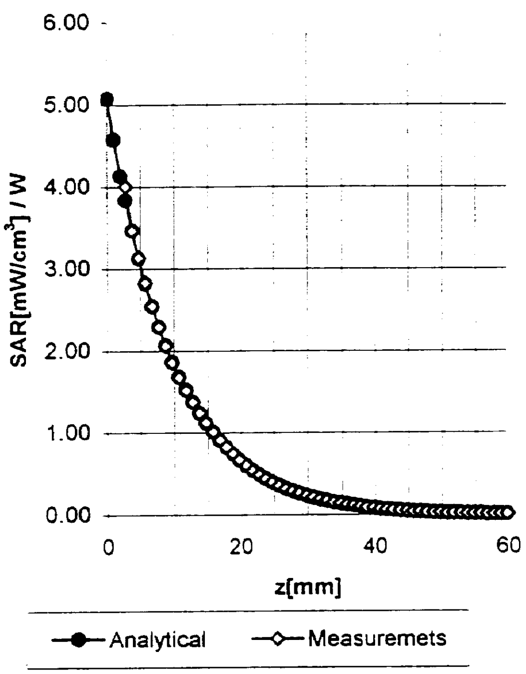
(TEM-Cell:ifi110)





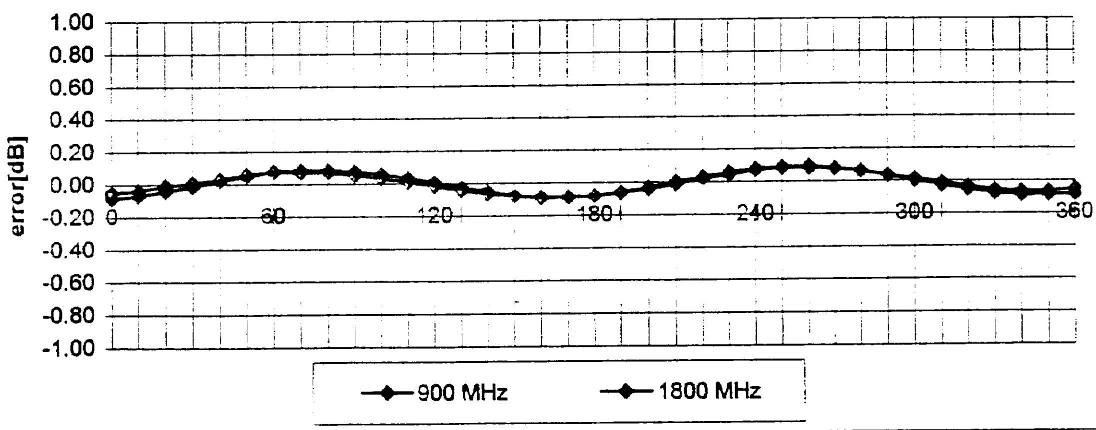
Conversion Factor Assessment





Receiving Pattern (ϕ)

(in brain tissue, z = 5 mm)



6.0 DOCUMENT HISTORY

Revision/ Job Number	Writer Initials	Date	Change
1.0 / J20036369B	SS	January 31, 2001	Original document