Specific Absorption Rate (SAR) Test Report

for

Sierra Wireless, Inc.

on the

CDPD RF Modem
Models: AirPath 300
FCC ID: N7NACRD2

Test Report: 20378431
Date of Report: February 21, 2001

Total number of pages in report: 34 .

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

Tested by:	Xi-Ming Yang	Review Date:
Reviewed by:	David Chernomordik	Review Date:

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1.0 JOB DESCRIPTION

1.1 Client Information

The EUT has been tested at the request of:

Company: Sierra Wireless, Inc.
Address: 13811 Wireless Way
Richmond, BC
Canada, V6V 3A4

Name of contact: Mr. Gordon Carey

Telephone: (605) 231-1145
Fax: (604) 231-1109

1.2 Equipment under test (EUT)

Product Descriptions:

Equipment	The Sierra Wireless Model AirPath 300 is a CDPD RF modem with a removable antenna., used in the Handspring Visor line of PDAs		
Trade Name	Sierra Wireless, Inc.	Model No.	AirPath 300
FCC ID	N7NACRD2	S/N No.	Not Labeled
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band	824-849 MHz	System	CDPD, Release 1.1

EUT Antenna Description			
Type	Monopole	Configuration	Removable, 360° Rotation
Dimensions	13.5 cm (Length)	Gain	2 dBi
Location	Right		

Use of Product : Portable personal communications

Manufacturer: SAME as above.

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

EUT receive date: February 18, 2001

EUT received condition: Good condition prototype

Test start date: February 18, 2001

Test end date: February 18, 2001

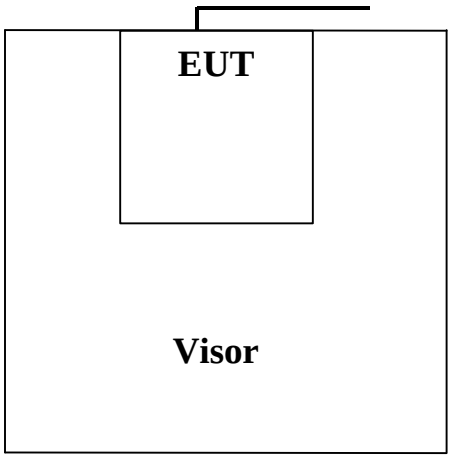
2.0 TEST PLAN REFERENCE

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

2.1 System test configuration

2.1.1 System block diagram & Support equipment

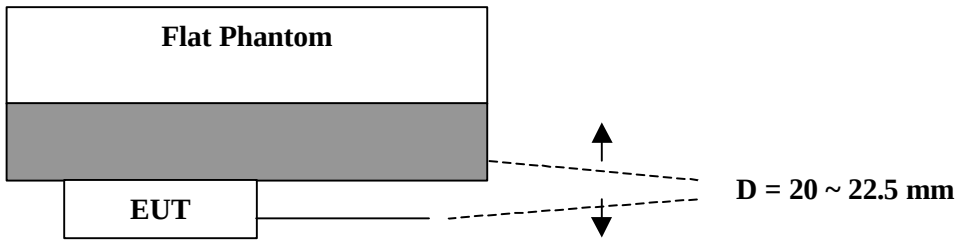
Tested with hand spring hand held PDA, model: Visor.



2.2 Test Position

Three test configurations were used to show compliance with the FCC RF human exposure requirements. In all configurations, the AirPath 300 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, 20 mm distance from antenna to Phantom. Simulating close proximity of human body.
B	• Antenna in horizontal position, 22.5 mm distance from antenna to Phantom. Simulating close proximity of human body.



2.3 Test Condition

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

EUT Antenna	Fixed	Orientation	Normal
Usage	Face-up	Distance between antenna axis at the joint and the liquid surface:	20.0 mm, Position: face-up 22.5 mm, Position: face-up
Simulating human hand	Not Used	EUT Battery	Fully Charged
Power output	26.4 dBm		

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

2.4 Modifications required for compliance

No modifications were implemented by Intertek Testing Services.

2.5 Additions, deviations and exclusions from standards

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

3.0 SAR EVALUATION

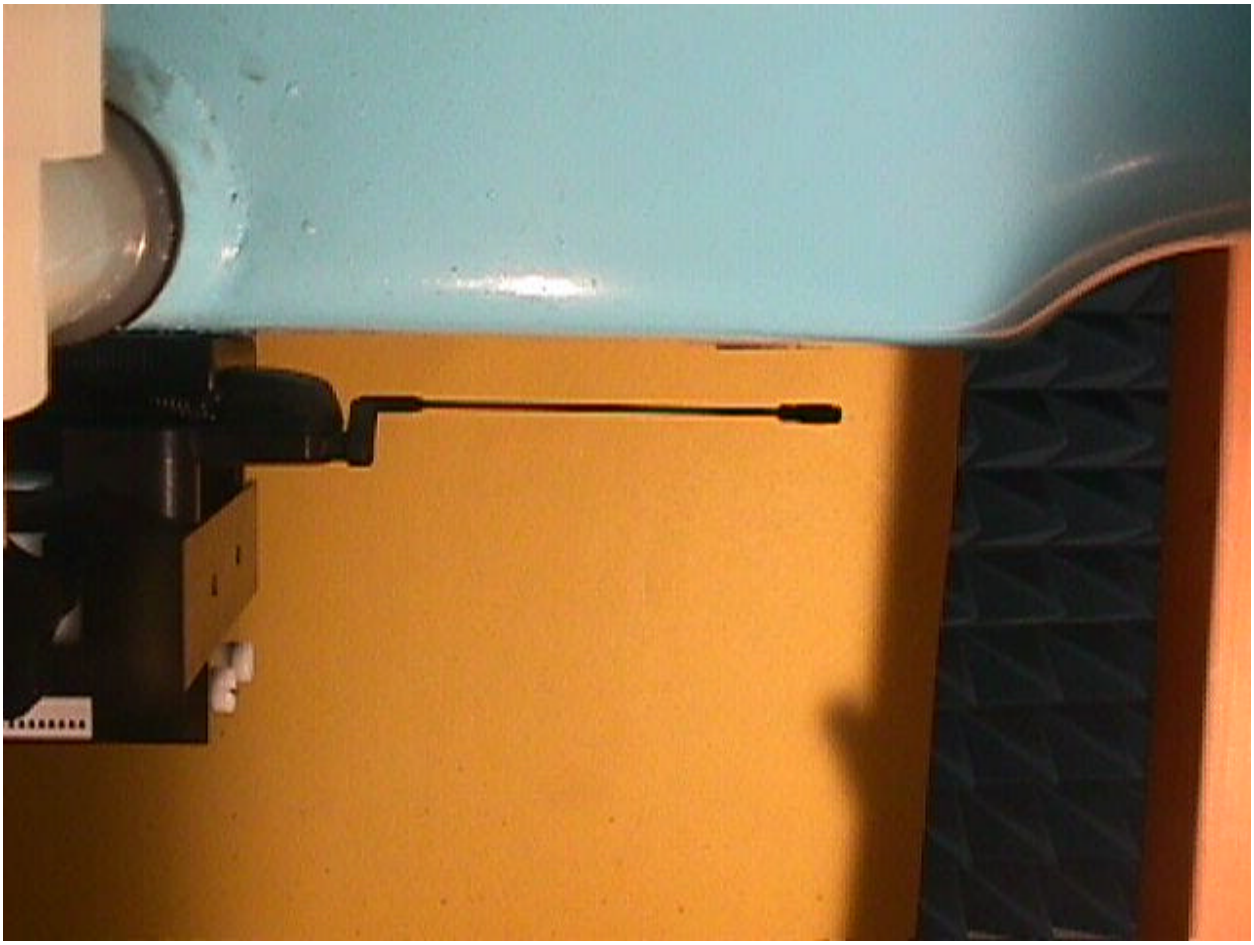
3.1 SAR Limits

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

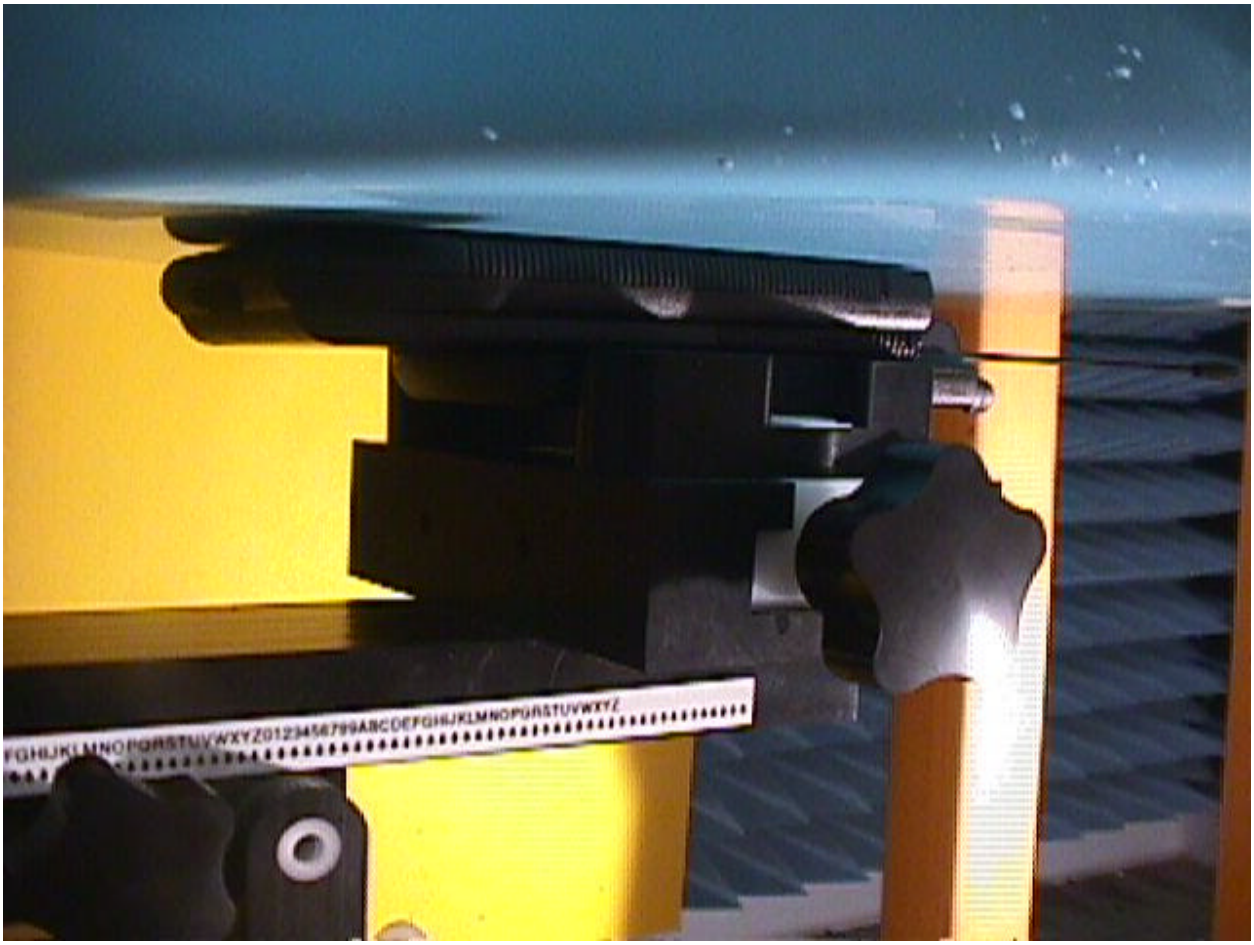
3.2 Configuration Photographs

SAR measurement Test Setup



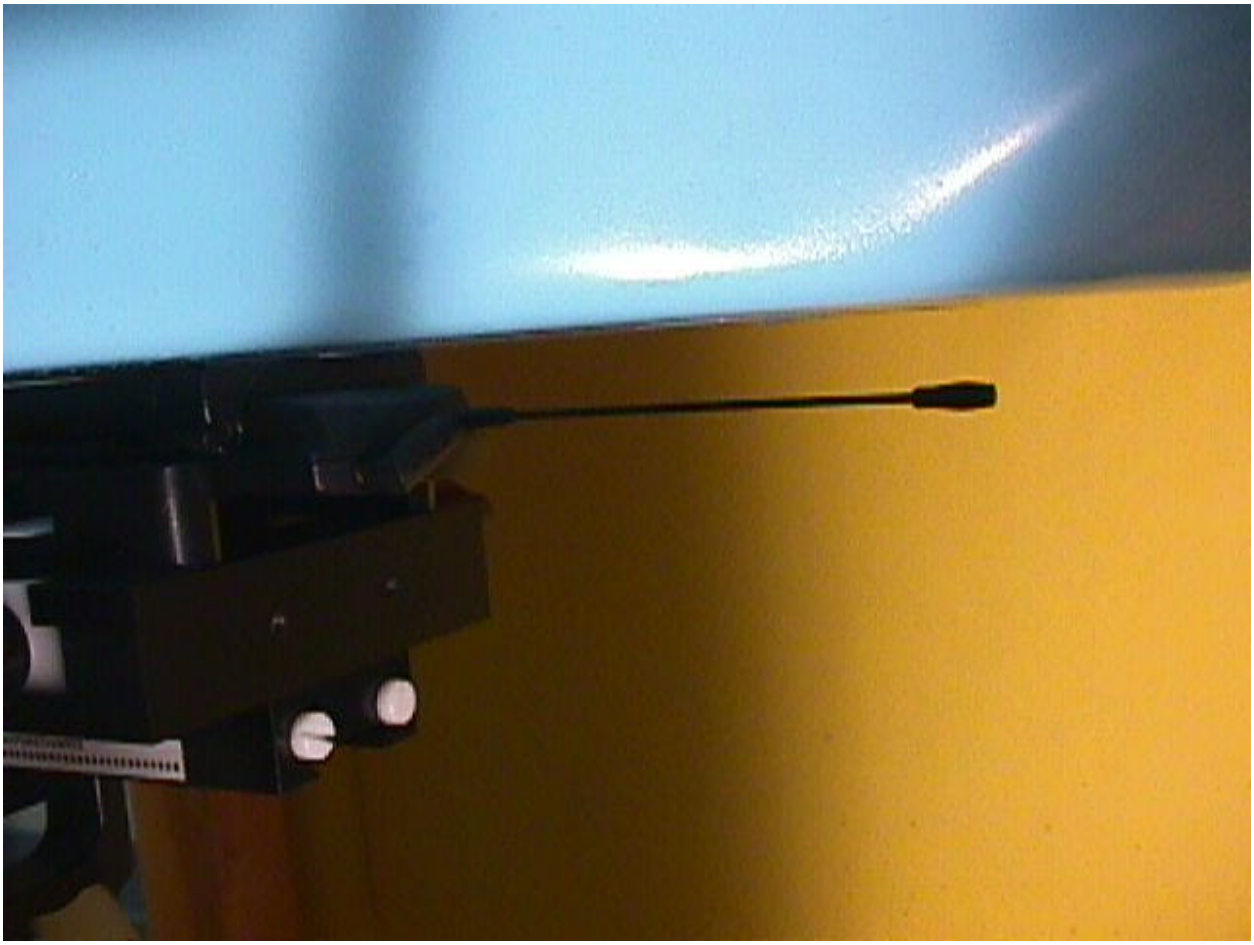
3.2 Configuration Photographs Continued

SAR Measurement Test Setup



3.2 Configuration Photographs – Continued

SAR Measurement Test Setup



3.3 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	3.92	3.83

3.4 Evaluation Procedures

The SAR evaluation was performed with the following procedures:

a. SAR was measured at a fixed location above the ear point and used as a reference value for the assessing the power drop.
b. The SAR distribution at the exposed side of the head was measured at a distance of 4.0 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.

4.0 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.

Trade Name:	Sierra Wireless, Inc.	**Model No.:**	AirPath 300
Serial No.:	Not Labeled	**Test Engineer:**	Xi-Ming Yang

TEST CONDITIONS			
Ambient Temperature	21.6 °C	Relative Humidity	40 %
Test Signal Source	Test Mode	Signal Modulation	CDPD
Output Power Before SAR Test	26.4 dBm	Output Power After SAR Test	26.4 dBm
Test Duration	23 Min.	Number of Battery Change	Every Scan

EUT Position: Face-up					
Channel MHz	Operating Mode	Crest Factor	Antenna Position From Phantom	Measured SAR_{1g} (mW/g)	Plot Number
824	CW	1	22.5 mm	1.21	1
836	CW	1	22.5 mm	1.03	2
849	CW	1	22.5 mm	1.14	3
824	CW	1	20 mm	1.44	4
836	CW	1	20 mm	1.22	5
849	CW	1	20 mm	1.39	6

Note: a) Worst case data were reported
b) Uncertainty of the system is not included

5.0 EQUIPMENT

5.1 Equipment List

The Specific Absorption Rate (SAR) tests were performed with the SPEAG model DASY 3 automated near-field scanning system, which is a 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	02/17/01
	Please see section 6.2 for details		
Power Meter	**HP 8900D** w/ 84811A sensor	3607U00673	08/01/00
	Frequency Range: 100kHz to 18 GHz Power Range: 300µW to 3W		

5.2 Tissue Simulating Liquid

Muscle	
Ingredient	**Frequency** (800 – 900 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$^{3)}$
835	51.1± 5%	0.88 ± 10%	1000

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

Note: The amounts 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 water, sugar, and/or salt to calibrate the solution to meet the proper dielectric parameters.

5.3 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 B.

5.4 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 Uncertanties				**±11.7 %**

5.5 Measurement Traceability

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

6.0 WARNING LABEL INFORMATION - USA

To satisfy FCC radio-frequency exposure requirements, the antenna for this device must be placed 2.25 centimeters or more from all persons, while it is in operation.

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.

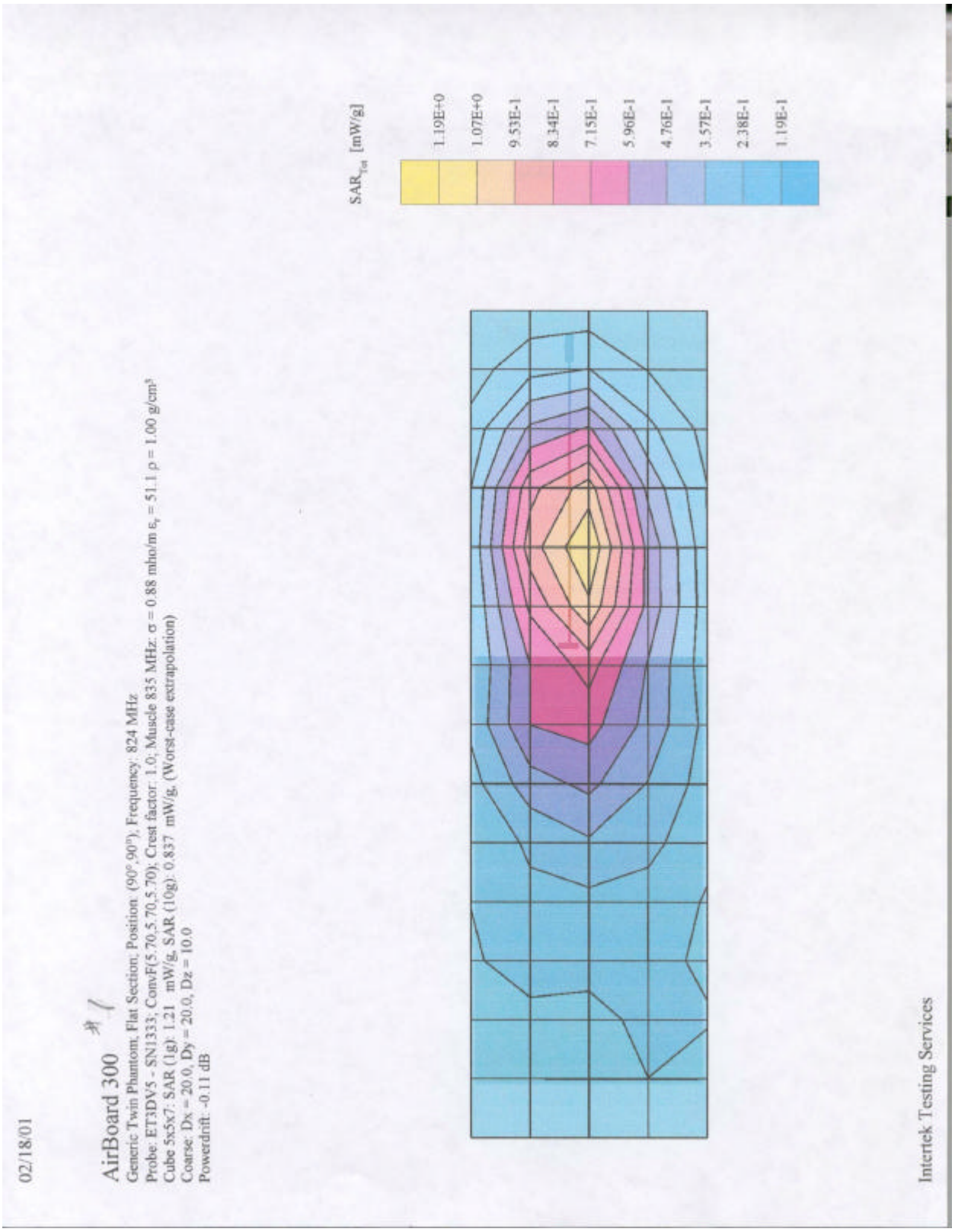
[4] Niels Kuster, Ralph Kastle, and Thomas Schmid, "Dosimetic evaluation of mobile communications equipment with know precision", IEICE Transactions on Communications, vol. E80-B, no. 5, pp.645-652, May 1997.

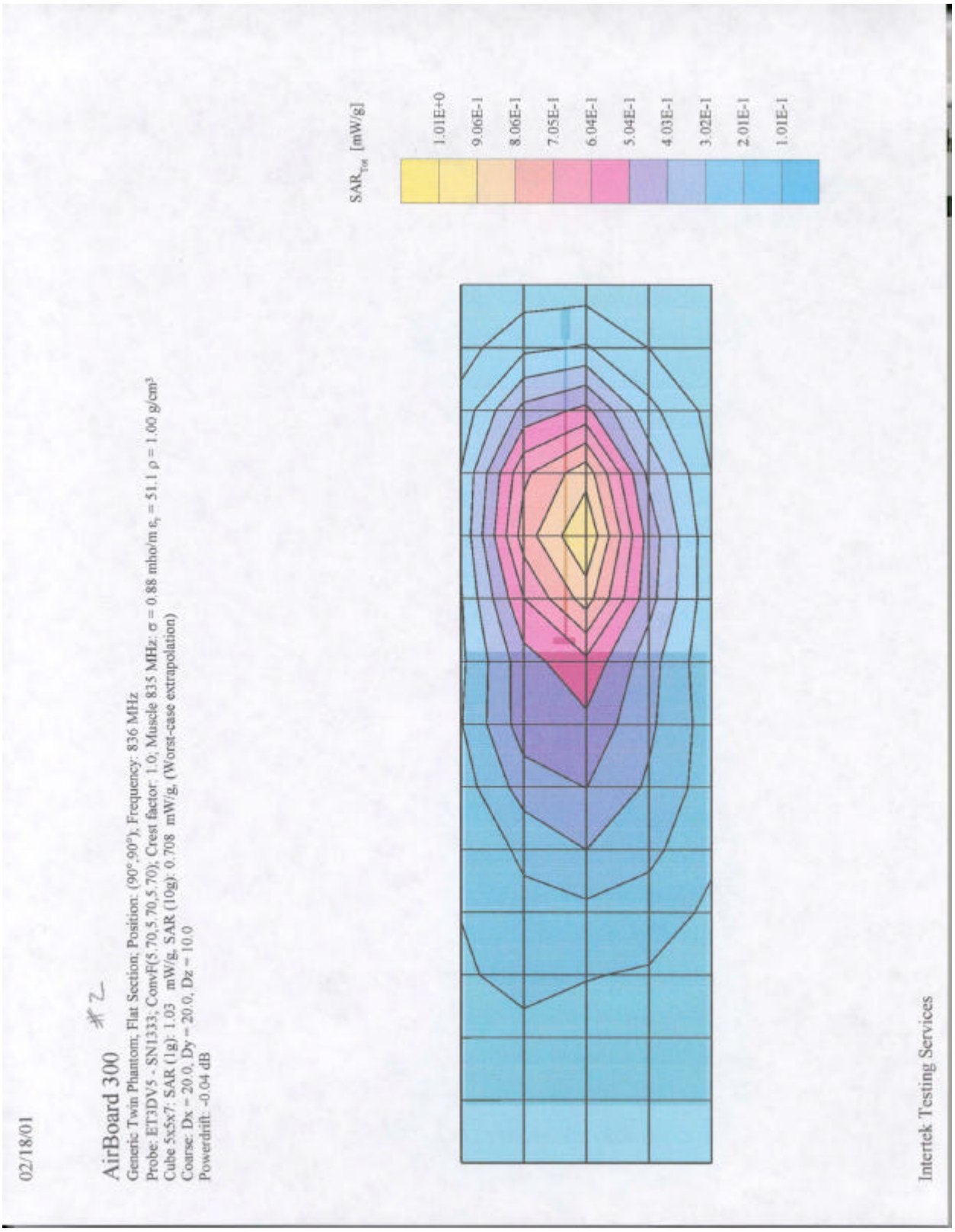
[5] NIS81, NAMAS, "The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddinton, Middlesex, England, 1994.

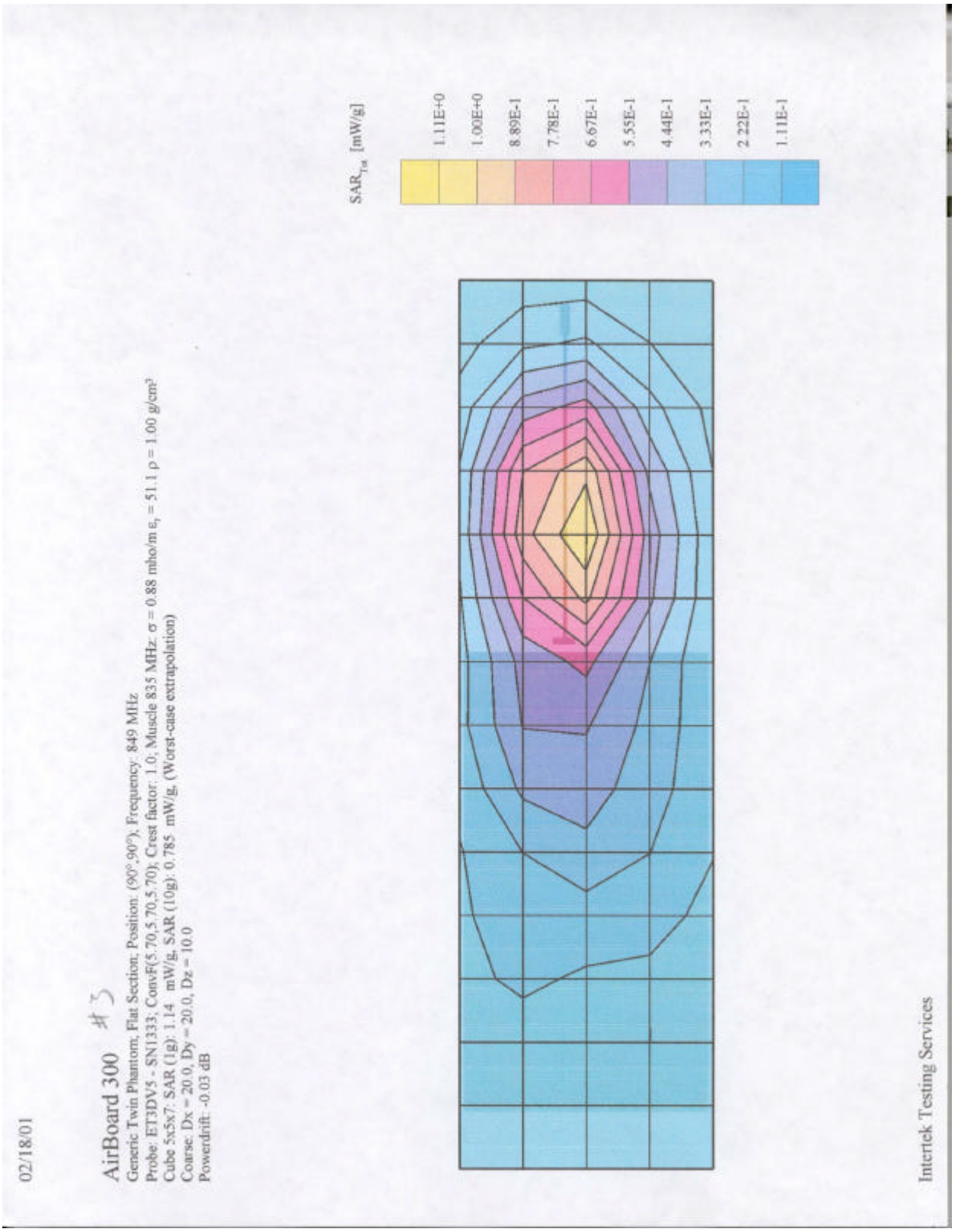
[6] Barry N. Tayor and Chris E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institude of Standards and Technology, 1994.

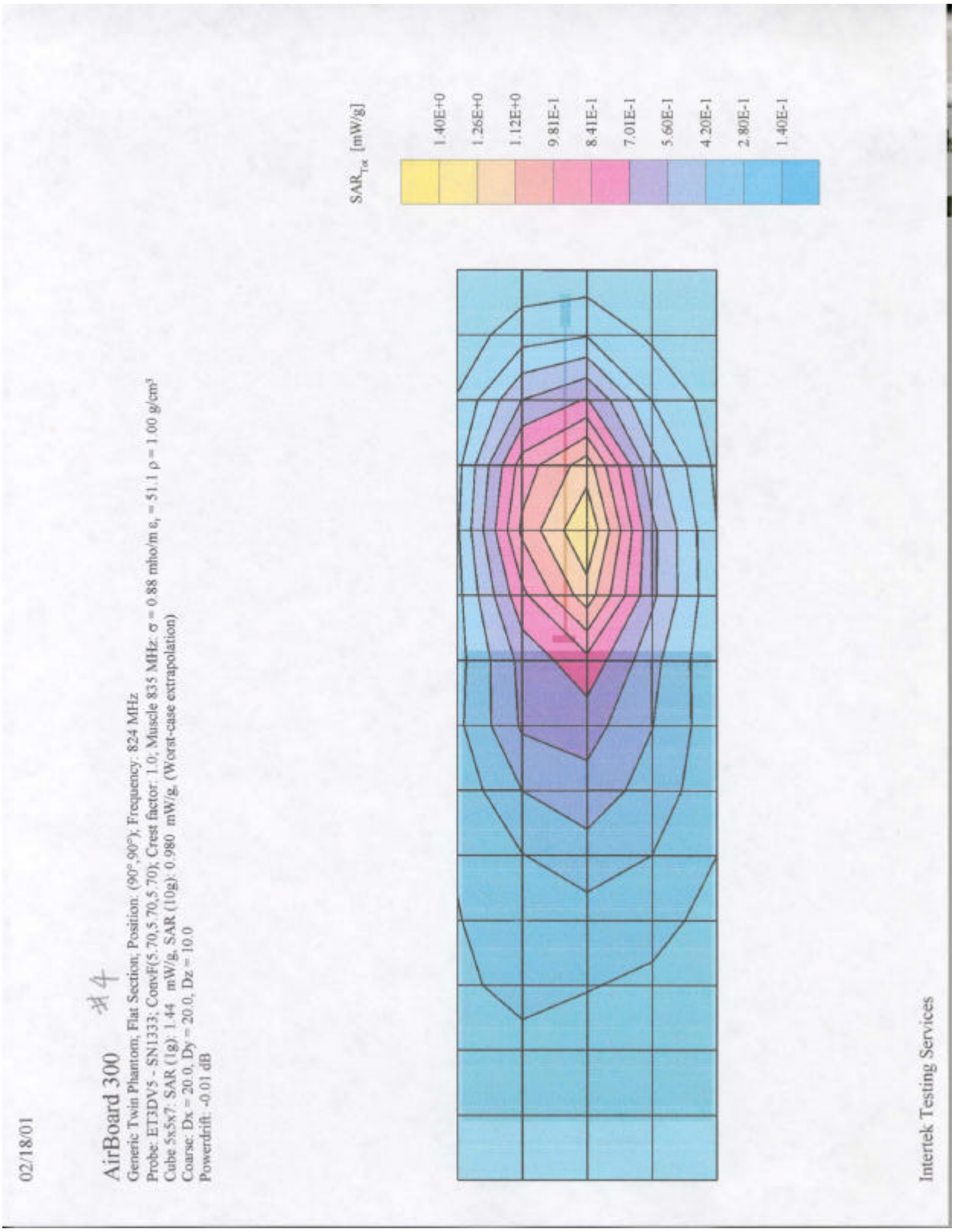
APPENDIX A - SAR Evaluation Data

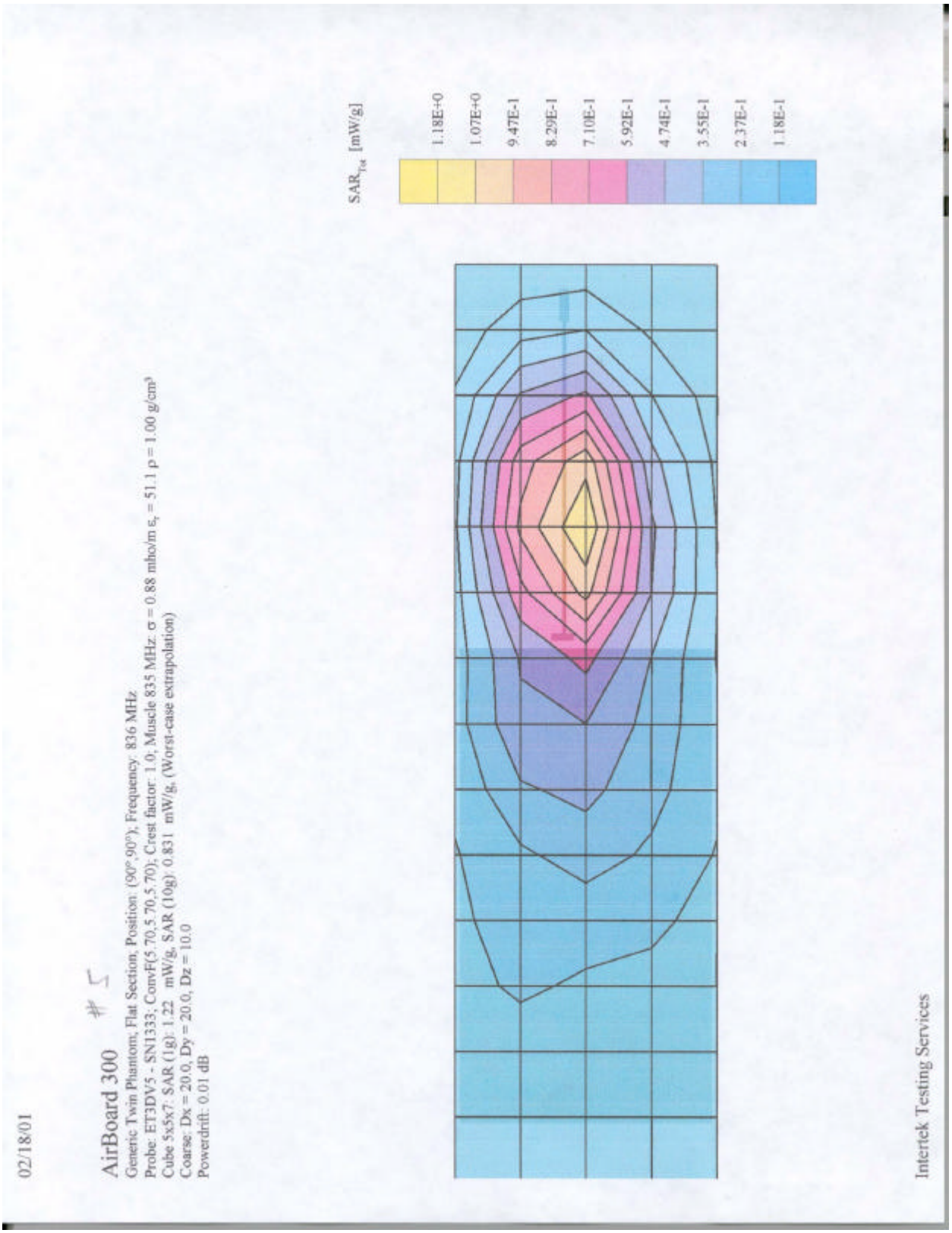
Please note that the graphical visualization of the phone position onto the SAR distribution gives only limited information on the current distribution of the device, since the curvature of the head results in graphical distortion. Full information can only be obtained either by H-field scans in free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

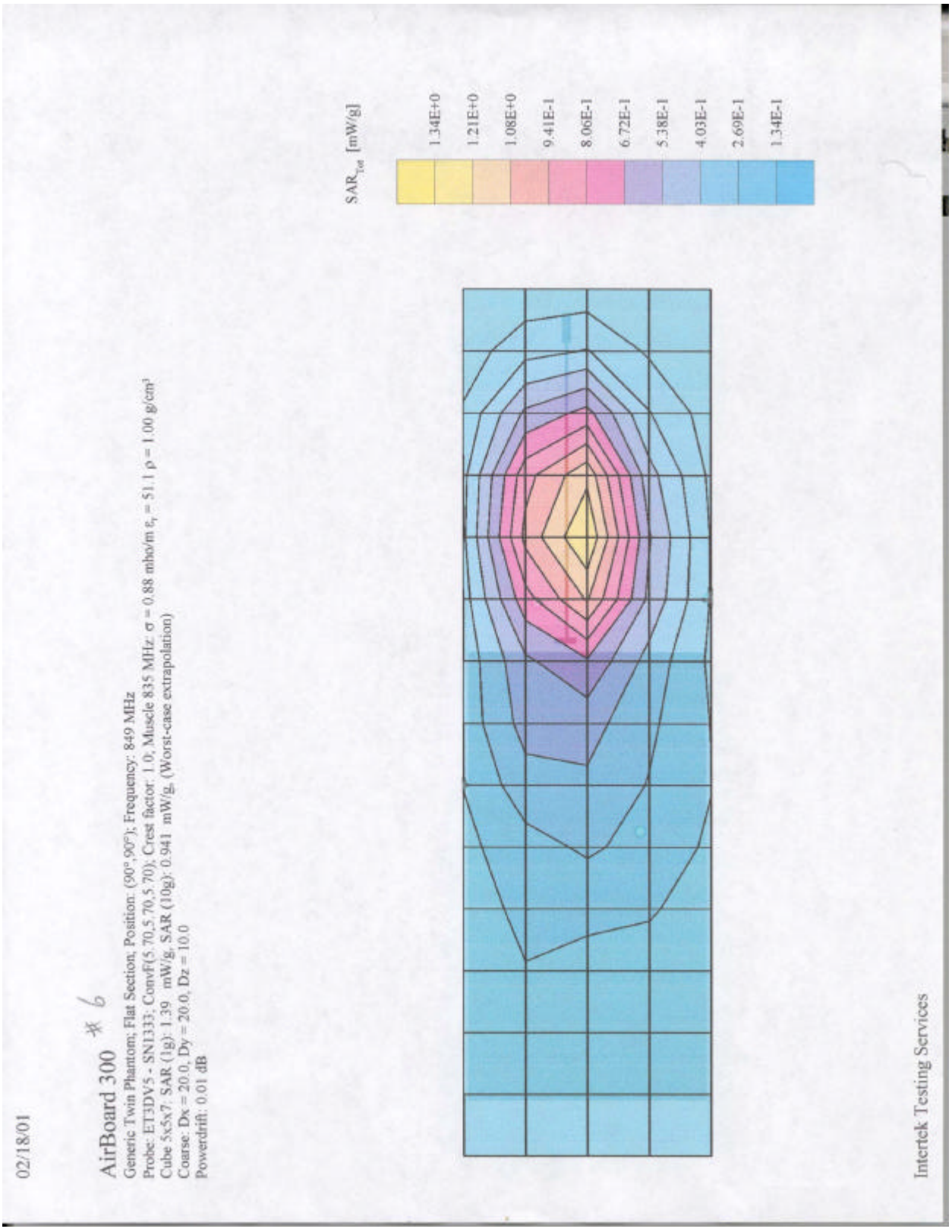

SAR$_{Tot}$ [mW/g]
1.19E+0
1.07E+0
9.53E-1
8.34E-1
7.15E-1
5.96E-1
4.76E-1
3.57E-1
2.38E-1
1.19E-1
02/18/01
AirBoard 300
Generic Twin Phantom; Flat Section; Position: (90°,90°); Frequency: 824 MHz
Probe: ET3DV5 - SN1333; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Muscle 835 MHz: σ = 0.88 mho/m ε$_r$ = 51.1 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.21 mW/g, SAR (10g): 0.837 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.11 dB
Intertek Testing Services


SAR$_{tot}$ [mW/g]
1.01E+0
9.06E-1
8.06E-1
7.05E-1
6.04E-1
5.04E-1
4.03E-1
3.02E-1
2.01E-1
1.01E-1
02/18/01
#7
AirBoard 300
Generic Twin Phantom; Flat Section; Position: (90°,90°); Frequency: 836 MHz
Probe: ET3DV5 - SN1333; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Muscle 835 MHz: σ = 0.88 mho/m ε$_r$ = 51.1 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.03 mW/g, SAR (10g): 0.708 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.04 dB
Intertek Testing Services


SAR$_{1g}$ [mW/g]
1.11E+0
1.00E+0
8.89E-1
7.78E-1
6.67E-1
5.55E-1
4.44E-1
3.33E-1
2.22E-1
1.11E-1
02/18/01
AirBoard 300 #3
Generic Twin Phantom; Flat Section; Position: (90°,90°); Frequency: 849 MHz
Probe: ET3DV5 - SN1333; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Muscle 835 MHz: σ = 0.88 mho/m ε$_r$ = 51.1 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.14 mW/g, SAR (10g): 0.785 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.03 dB
Intertek Testing Services


SAR$_{Tot}$ [mW/g]
1.40E+0
1.26E+0
1.12E+0
9.81E-1
8.41E-1
7.01E-1
5.60E-1
4.20E-1
2.80E-1
1.40E-1
02/18/01
AirBoard 300
#4
Generic Twin Phantom; Flat Section; Position: (90°,90°); Frequency: 824 MHz
Probe: ET3DV5 - SN1333; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Muscle 835 MHz: σ = 0.88 mho/m ε$_r$ = 51.1 ρ = 1.00 g/cm^3
Cube 5x5x7: SAR (1g): 1.44 mW/g, SAR (10g): 0.980 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: -0.01 dB
Intertek Testing Services


SAR$_{Tot}$ [mW/g]
1.18E+0
1.07E+0
9.47E-1
8.29E-1
7.10E-1
5.92E-1
4.74E-1
3.55E-1
2.37E-1
1.18E-1
02/18/01
AirBoard 300
#5
Generic Twin Phantom; Flat Section; Position: (90°,90°); Frequency: 836 MHz
Probe: ET3DV5 - SN1333; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Muscle 835 MHz: σ = 0.88 mho/m ε$_r$ = 51.1 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 1.22 mW/g, SAR (10g): 0.831 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: 0.01 dB
Intertek Testing Services


02/18/01
AirBoard 300 #6
Generic Twin Phantom; Flat Section; Position: (90°,90°); Frequency: 849 MHz
Probe: ET3DV5 - SN1333; ConvF(5.70,5.70,5.70); Crest factor: 1.0; Muscle 835 MHz: σ = 0.88 mho/m εr = 51.1 ρ = 1.00 g/cm³
Cube 5x5x7: SAR (1g): 1.39 mW/g, SAR (10g): 0.941 mW/g, (Worst-case extrapolation)
Coarse: Dx = 20.0, Dy = 20.0, Dz = 10.0
Powerdrift: 0.01 dB
SAR_Tot [mW/g]
1.34E+0
1.21E+0
1.08E+0
9.41E-1
8.06E-1
6.72E-1
5.38E-1
4.03E-1
2.69E-1
1.34E-1
Intertek Testing Services

APPENDIX B - E-Field Probe Calibration Data
See attached pages.

Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland, Phone +41 1 245 97 00, Fax +41 1 245 97 79

Calibration Certificate

Dosimetric E-Field Probe

Type:	**ET3DV5**
Serial Number:	**1333**
Place of Calibration:	**Zurich**
Date of Calibration:	**April 23, 2001**
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:	Nikolova Neviana
Approved by:	Jlusic Katja

Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland, Telephone +41 1 245 97 00, Fax +41 1 245 97 79

Probe ET3DV5

SN:1333

Manufactured:	December 20, 1997
Last calibration:	April 10, 2000
Recalibrated:	April 23, 2001

Calibrated for System DASY3

ET3DV5 SN:1333

DASY3 - Parameters of Probe: ET3DV5 SN:1333

Sensitivity in Free Space

NormX	2.37 $\mu V/(V/m)^2$	DCP X	100 mV
NormY	2.38 $\mu V/(V/m)^2$	DCP Y	100 mV
NormZ	2.33 $\mu V/(V/m)^2$	DCP Z	100 mV

Sensitivity in Tissue Simulating Liquid

Head **450 MHz** ε_r = 43.5 ± 5% σ = 0.87 ± 10% mho/m

ConvF X	6.25 extrapolated	Boundary effect:	
ConvF Y	6.25 extrapolated	Alpha	0.19
ConvF Z	6.25 extrapolated	Depth	3.06

Head **900 MHz** ε_r = 42 ± 5% σ = 0.97 ± 10% mho/m

ConvF X	5.83 ± 7% (k=2)	Boundary effect:	
ConvF Y	5.83 ± 7% (k=2)	Alpha	0.38
ConvF Z	5.83 ± 7% (k=2)	Depth	2.70

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

ConvF X	5.27 interpolated	Boundary effect:	
ConvF Y	5.27 interpolated	Alpha	0.63
ConvF Z	5.27 interpolated	Depth	2.23

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

ConvF X	4.99 ± 7% (k=2)	Boundary effect:	
ConvF Y	4.99 ± 7% (k=2)	Alpha	0.75
ConvF Z	4.99 ± 7% (k=2)	Depth	1.99

Sensor Offset

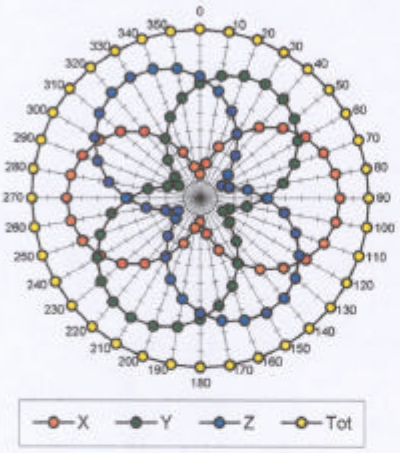
Probe Tip to Sensor Center	2.7	mm
Optical Surface Detection	1.6 ± 0.2	mm

Page 2 of 7

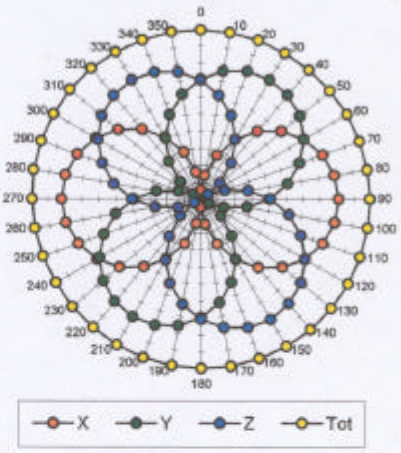
ET3DV5 SN:1333

Receiving Pattern (ϕ), θ = 0°

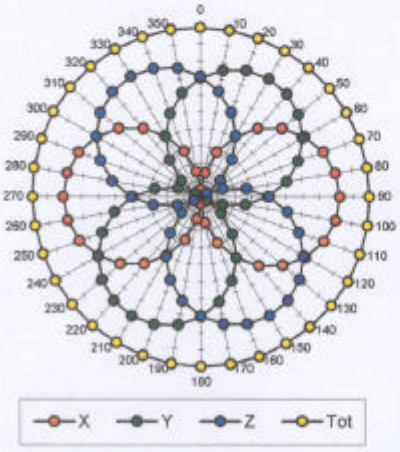
f = 30 MHz, TEM cell ifi110



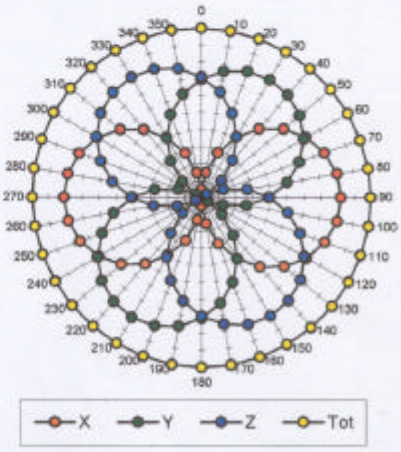
f = 100 MHz, TEM cell ifi110



f = 300 MHz, TEM cell ifi110



f = 900 MHz, TEM cell ifi110



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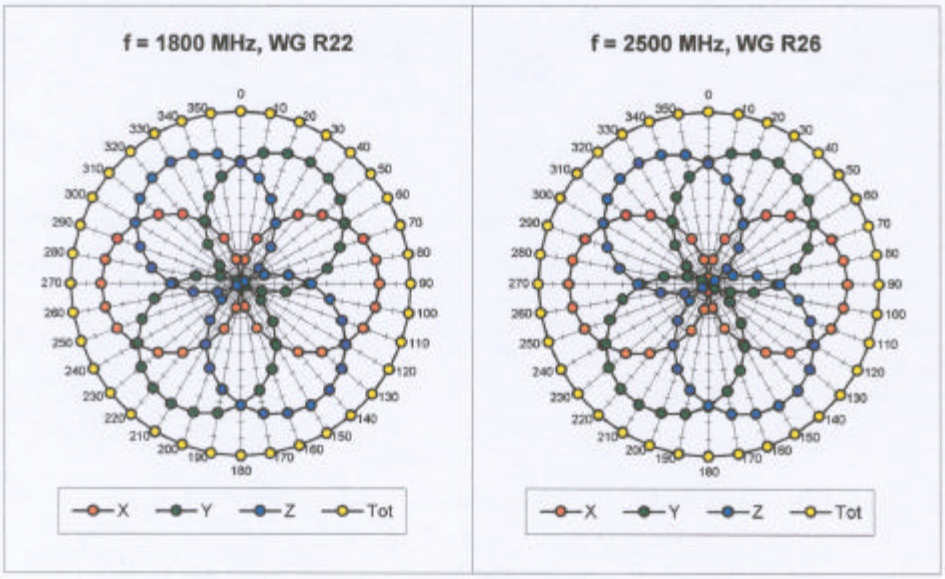
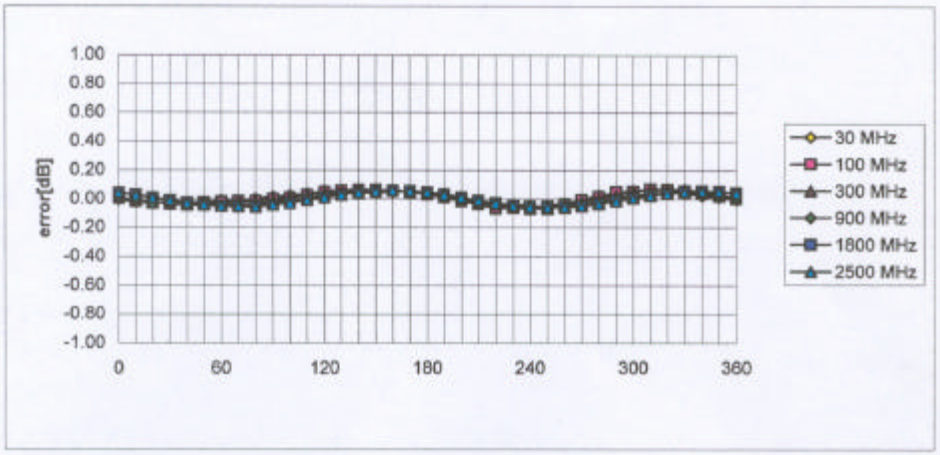
ET3DV5 SN:1333



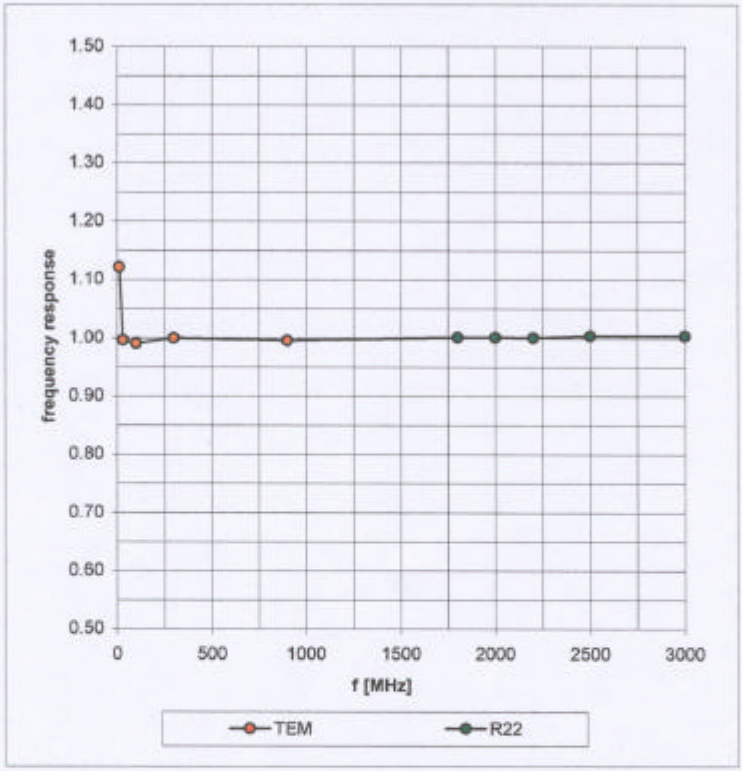
Isotropy Error (ϕ), θ = 0°



ET3DV5 SN:1333

Frequency Response of E-Field

(TEM-Cell:ifi110, Waveguide R22)



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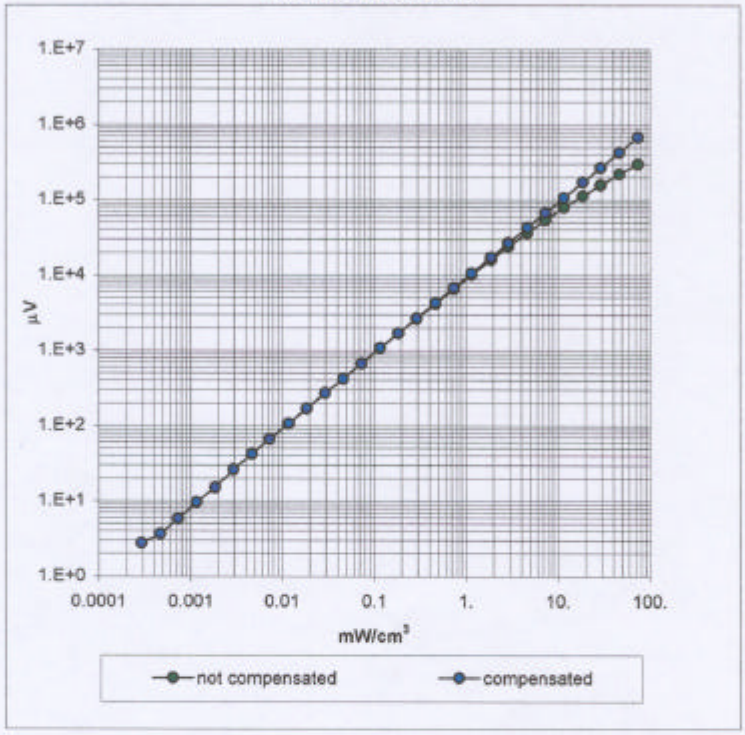
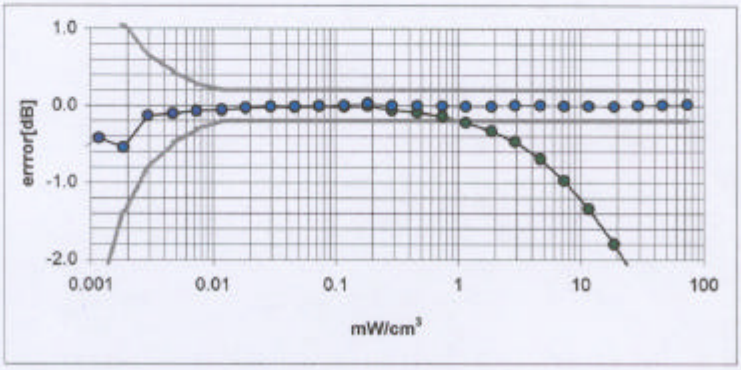
Dynamic Range f(SAR_{brain})

(TEM-Cell:ifi110)





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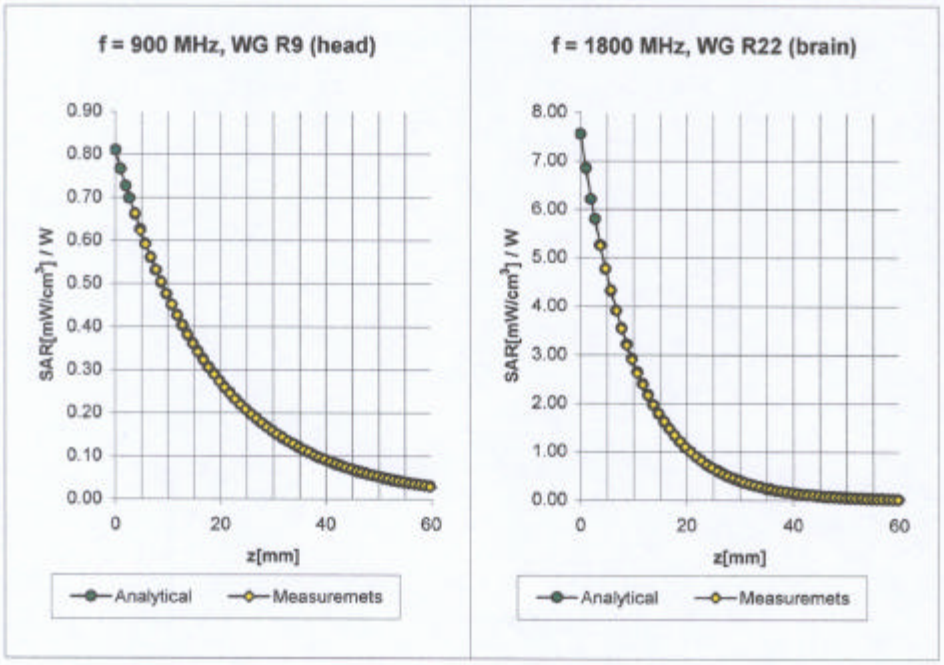
Conversion Factor Assessment



Head **900 MHz** $\varepsilon_r = 42 \pm 5\%$ $\sigma = 0.97 \pm 10\%$ mho/m

ConvF X	**5.83** ± 7% (k=2)	Boundary effect:	
ConvF Y	**5.83** ± 7% (k=2)	Alpha	**0.38**
ConvF Z	**5.83** ± 7% (k=2)	Depth	**2.70**

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

ConvF X	**4.99** ± 7% (k=2)	Boundary effect:	
ConvF Y	**4.99** ± 7% (k=2)	Alpha	**0.75**
ConvF Z	**4.99** ± 7% (k=2)	Depth	**1.99**

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7.0 DOCUMENT HISTORY

Revision/ Job Number	Writer Initials	Date	Change
1.0 / J20037843	SS	February 21, 2001	Original document