Celltech
Testing and Engineering Services Lab

January 29, 2004

Federal Communications Commission
Equipment Approval Services
7435 Oakland Mills Road
Columbia, MD 21046
Attn: Stan Lyles

SUBJECT: Vertex Standard Co., Ltd.
FCC ID: K6610503220
731 Confirmation No.: EA654860
Correspondence Ref. No.: 26241

Dear Stan:

On behalf of Vertex Standard Co., Ltd. is our response to item 5 of your e-mail dated January 21, 2004 requesting additional information for the subject application.

1. Motorola released a study in December 2003 for the accuracy of the Agilent 85070C dielectric probe kit versus the slotted line method for frequencies from 75 MHz to 3 GHz (please see attachment). The conclusion from Motorola states "Good agreement has been demonstrated between the two methods with deviations within 10% from 75 MHz to 3 GHz". Table 4 on page 4 of the study specifically shows the comparison between the Agilent 85070C and the slotted line technique at 150 MHz with brain fluid using DGBE based solution. Subsequently, we performed our own evaluation of the Agilent 85070C dielectric probe kit with DGBE based solution at 150 MHz with the same simulated brain tissue mixture used during the Motorola study (Section III, page 3). The 150MHz dielectric parameters of the DGBE based solution were measured using the Agilent 85070C dielectric probe kit, and resulted in less than a 5% difference in conductivity and permittivity over several measurements at 23 ± 1 ºC (please see attached measured fluid dielectric parameters), compared to the measurements shown in Table 4 on page 4 of the Motorola report. We subsequently retested the Vertex Standard radio at the worst-case face-held test position (please see attached test data) with the same DGBE simulated brain tissue mixture as was used for the Motorola study, which resulted in a SAR value that was -6.7% of the previous SAR value using the sugar/salt solution. Therefore, it is our conclusion that the interlab comparisons verify the accuracy of the Agilent 85070C dielectric probe kit at 150 MHz.

If you have any further questions regarding the above, please do not hesitate to contact us.

Sincerely,

Jonathan Hughes
General Manager
Celltech Labs Inc.

cc: Vertex Standard Co., Ltd.
M. Flom Associates, Inc.

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Dielectric Parameter Measurement of Lossy Liquids using the Agilent 85070C Dielectric Probe Kit

Maurice Ballen, Michael Kanda, Mark Douglas, C-K. Chou
Motorola Florida Research Laboratories
Fort Lauderdale, Florida

December 12, 2003

Introduction

This report documents the useful frequency range of the Agilent 85070C dielectric probe kit. Measurements of various lossy liquids were performed from 30 – 3000 MHz and compared with measurements using a slotted line during 2001 to early 2003. Good agreement has been demonstrated between the two methods, with deviations within 10% from 75 MHz to 3 GHz. Below 75 MHz, the results show good agreement for the conductivity, but significant deviation between the two methods for permittivity.

Method

The Agilent 850702C is an open-ended coaxial probe (see [1] for a description of open-ended coaxial probes). This probe is easy to use, widely available and requires minimal handling. Swept frequency measurements can be quickly performed using a network analyzer. A single measurement uncertainty value for this probe is not available, given that the uncertainty is dependent on the dielectric parameters being measured. Agilent reports an accuracy of ±5% for permittivity and ±0.05 for loss tangent over a frequency range of 200 MHz to 20 GHz [2]. However, it also offers the disclaimer that these performance parameters are typical and non-warranted. The frequency range is specified as 'nominal', suggesting that frequencies outside this range may be useable under certain conditions. Therefore, to estimate the measurement uncertainty and accuracy, measurements should be made and compared with other methods, using media having dielectric parameters similar to those of the media under test (tissue-equivalent liquids of [1]). The measurement repeatability of the Agilent 85070C (based on 5 repeat measurements of ethanediol from 300 to 3000 MHz) was found to be 0.7% or less across the frequency range.

A slotted line was also used for the study (see [1] for a description of slotted lines). The length of the slotted line (CG-266 / U) is approximately 0.9 m, which is sufficient to minimize reflections from the back wall that would otherwise affect the accuracy of the measurements. For the diacetin-based and DGBE-based reference liquids studied here, the 0.9 m length corresponds to at least 7.9 penetration depths at 30 MHz, giving a reflected wave that is at least 34 dB below the incident wave (reflections are even smaller at the higher frequencies). The inner and outer diameters of the slotted line are 16 mm and 38.8 mm, respectively. The same setup was used in a study reported by Chou et al. [3] over a frequency range of 13.56 to 2450 MHz.

Results

To demonstrate the accuracy of the two methods in the 30 – 3000 MHz range, measurements are shown below for a 0.1 M saline solution, a diacetin-based solution, and a DGBE-based solution. The saline solution was chosen because published reference data are available. The other two solutions were chosen because they have dielectric parameters similar to those of tissue-equivalent liquids.

I. Saline solution

The accuracy of the Agilent 85070C for 0.1 M saline solution is shown in Tables 1 and 2. Measurement data at 23 ± 1 ^{o}C are compared with data from Chris Davis (at 23.2 ^{o}C using a coaxial probe) and Arthur Von Hippel (at 25 ^{o}C using a capacitive technique, as reported in [4]). The results are in close agreement across the frequency range of 75 – 3000 MHz, considering the differences in methods, solutions and environmental conditions.

Table 1: Measured conductivity of 0.1 M saline solution using the Agilent 85070C and slotted line, as compared with reference data from Arthur von Hippel and Chris Davis.

f (MHz)	85070C	Slotted line	Von Hippel	Davis
75	0.97	1.02		0.98
300	0.99	1.04	0.99	0.998
837	1.15	1.18		1.129
1000	1.22	1.26		1.193
3000	3.133	2.95	3.02	2.86

Table 2: Measured permittivity of 0.1 M saline solution using the Agilent 85070C and slotted line, as compared with reference data from Arthur von Hippel and Chris Davis.

f (MHz)	85070C	Slotted line	von Hippel	Davis
75	80.8	77.9		76.95
300	78.48	79	76	76.93
837	77.6	77.76		76.81
1000	77.43	77.56		76.75
3000	75.15	76.5	75.5	75.15

II. Diacetin-based solution

A diacetin-based solution was measured over the 30 – 300 MHz frequency range. This solution comprises 55.7% water, 43% diacetin, 1.2% salt, and 0.1% Dowacil 75. The liquid temperature was 23 ± 1 ^{o}C. A comparison of the two methods is shown in Fig. 1 and Table 3. The conductivity values are in good agreement across the whole frequency range. However, the permittivity values differ by more than 10% below about 75 MHz.

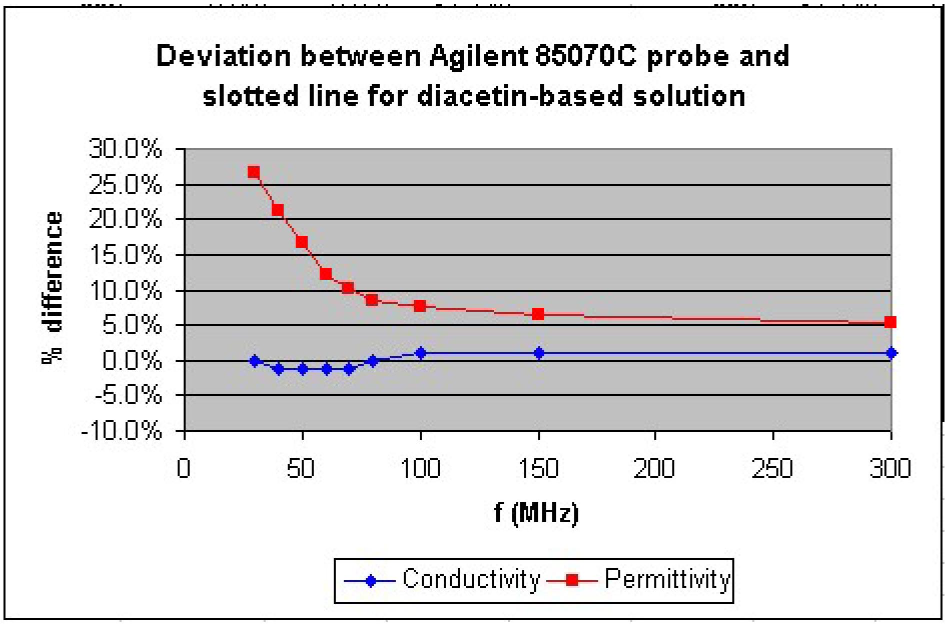


Fig. 1: Deviation between Agilent 85070C probe and slotted line for diacetin-based solution.

Table 3: Measured dielectric parameters using the two methods for diacetin-based solution.

	Conductivity (S/m)		Relative Permittivity	
F (MHz)	85070C	slotted line	85070C	slotted line
30	0.85	0.85	63.9	50.5
40	0.86	0.87	60.7	50.1
50	0.86	0.87	58.9	50.5
60	0.86	0.87	56.7	50.6
70	0.86	0.87	56	50.8
80	0.86	0.86	55.4	51.1
100	0.87	0.86	54.7	50.8
150	0.88	0.87	54	50.7
300	0.94	0.93	52.1	49.5

III. DGBE-based solution

A comparison of the two methods for a DGBE-based solution is shown in Fig. 2. The recipe comprises 56.6% water, 42% DGBE, and 1.4% salt. The liquid temperature was 23 ± 1 ^{o}C. The results are presented in Fig. 2 and Table 4. For this solution, both conductivity and permittivity are in agreement within 10% at all frequencies studied. Comparing these results with those for the diacetin-based solution and the saline solution, the correlation of the two methods at frequencies below 75 MHz appears to depend significantly on specific dielectric parameters.

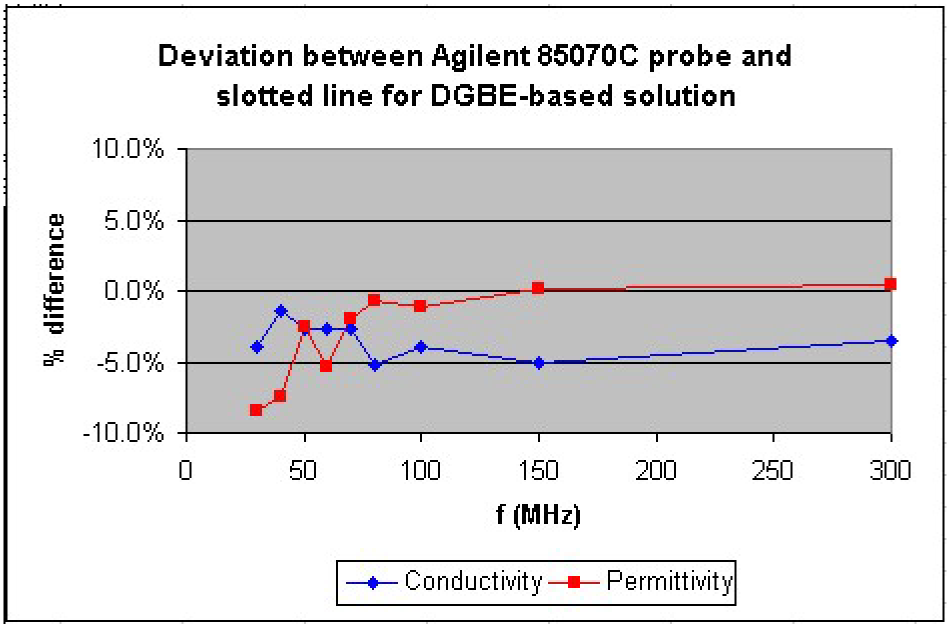


Fig. 2: Deviation between Agilent 85070C probe and slotted line for DGBE-based solution.

Table 4: Measured dielectric parameters using the two methods for DGBE-based solution.

F (MHz)	Conductivity (S/m)		Relative Permittivity	
	85070C	slotted line	85070C	slotted line
30	0.72	0.75	57.7	63
40	0.73	0.74	56.2	60.7
50	0.73	0.75	56.6	58.1
60	0.73	0.75	53.7	56.7
70	0.73	0.75	54.6	55.7
80	0.73	0.77	54.1	54.5
100	0.74	0.77	53.3	53.9
150	0.75	0.79	52.8	52.7
300	0.83	0.86	50.5	50.3

Conclusion

In this study, measurements of lossy liquids were performed from 30 – 3000 MHz using the Agilent 85070C open ended coaxial probe and a slotted line. The results give confidence in the use of the Agilent 85070C for tissue-equivalent liquids over a broad frequency range. Good agreement has been demonstrated between the two methods, with deviations within 10% from 75 MHz to 3 GHz. Below 75 MHz, the results show good agreement for the conductivity, but substantial deviation between the two methods for permittivity.

References

[1] IEEE 1528, IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, IEEE, Piscataway, NJ. 2003

[2] Agilent, "Agilent 850702D Dielectric Probe Kit: Product Overview," available at http://cp.literature.agilent.com/litweb/pdf/5968-5330E.pdf.

[3] Chou, C.K., G.W. Chen, A.W. Guy, and K.H. Luk. "Formulas for preparing phantom muscle tissue at various radiofrequencies." *Bioelectromagnetics* 5(4):435-441, 1984.

[4] von Hippel, A. *Dielectric Materials and Applications,* MIT Press: Cambridge, MA, 1954.

DGBE Solution 150MHz Brain	Test #	Celltech's Measured Fluid Dielectric Parameters using Agilent 85070C Probe Kit		Motorola's Measured Fluid Dielectric Parameters using Agilent 85070C Probe Kit	
		Conductivity (S/m)	Relative Permittivity	Conductivity (S/m)	Relative Permittivity
56.6 % Water 42 % DGBE 1.4 % Salt	1	0.76	52.3	0.75	52.8
	2	0.76	52.2		
	3	0.76	52.1		
	4	0.76	52.1		

150MHz Fluid Dielectric Parameters

DGBE Solution (Brain)

January 29, 2004

Frequency	e'	e''
50.000000 MHz	59.1810	262.9960
60.000000 MHz	57.0040	219.4460
70.000000 MHz	56.2074	188.2871
80.000000 MHz	55.1892	165.9271
90.000000 MHz	54.4088	148.6073
100.000000 MHz	53.4980	134.5420
110.000000 MHz	53.1260	122.9283
120.000000 MHz	52.5533	113.3501
130.000000 MHz	52.2834	105.0323
140.000000 MHz	52.2785	97.7005
150.000000 MHz	52.2929	91.6044
160.000000 MHz	52.1555	86.2670
170.000000 MHz	52.1578	81.5375
180.000000 MHz	52.3401	76.9428
190.000000 MHz	52.1393	73.1508
200.000000 MHz	52.0867	70.0067
210.000000 MHz	51.7272	66.9050
220.000000 MHz	51.4627	64.3354
230.000000 MHz	51.3350	62.0081
240.000000 MHz	51.1928	59.7495
250.000000 MHz	50.9842	57.6892

150MHz Fluid Dielectric Parameters

DGBE Solution (Brain)

January 29, 2004

Frequency	e'	e''
50.000000 MHz	59.0028	262.3481
60.000000 MHz	56.7324	219.4532
70.000000 MHz	56.1437	188.1144
80.000000 MHz	55.0837	165.8288
90.000000 MHz	54.3529	148.3372
100.000000 MHz	53.4520	134.4213
110.000000 MHz	53.0837	122.8186
120.000000 MHz	52.5023	113.0114
130.000000 MHz	52.2104	104.8471
140.000000 MHz	52.3267	97.5220
150.000000 MHz	52.2350	91.5533
160.000000 MHz	52.0704	86.1443
170.000000 MHz	52.1476	81.3932
180.000000 MHz	52.2719	76.9479
190.000000 MHz	52.1127	73.0879
200.000000 MHz	51.9333	69.8957
210.000000 MHz	51.7272	66.9050
220.000000 MHz	51.4780	64.2965
230.000000 MHz	51.3072	61.9029
240.000000 MHz	51.1062	59.5682
250.000000 MHz	50.8922	57.5991

150MHz Fluid Dielectric Parameters

DGBE Solution (Brain)

January 29, 2004

Frequency	e'	e''
50.000000 MHz	57.2294	263.2041
60.000000 MHz	55.7029	219.0734
70.000000 MHz	55.4086	188.8361
80.000000 MHz	54.2227	166.0118
90.000000 MHz	53.7463	147.9068
100.000000 MHz	53.0267	134.0305
110.000000 MHz	52.5606	122.7683
120.000000 MHz	52.5958	112.8361
130.000000 MHz	52.4567	104.7392
140.000000 MHz	52.2358	97.4687
150.000000 MHz	52.0852	91.3437
160.000000 MHz	52.1147	86.0387
170.000000 MHz	52.0670	81.2779
180.000000 MHz	52.1760	76.8865
190.000000 MHz	51.9570	73.0351
200.000000 MHz	51.9283	69.8343
210.000000 MHz	51.7484	66.9228
220.000000 MHz	51.4288	64.3760
230.000000 MHz	51.3088	61.9207
240.000000 MHz	51.1570	59.7357
250.000000 MHz	50.9662	57.6745

150MHz Fluid Dielectric Parameters

DGBE Solution (Brain)

January 29, 2004

Frequency	e'	e''
50.000000 MHz	59.0200	263.0812
60.000000 MHz	56.8829	219.9928
70.000000 MHz	56.2237	188.8110
80.000000 MHz	55.1945	166.0800
90.000000 MHz	54.2936	147.9765
100.000000 MHz	53.2681	133.9386
110.000000 MHz	53.0475	122.0394
120.000000 MHz	52.2931	112.2373
130.000000 MHz	51.9880	104.2288
140.000000 MHz	52.0353	97.0411
150.000000 MHz	52.0512	91.2364
160.000000 MHz	51.9903	86.0982
170.000000 MHz	52.0425	81.6182
180.000000 MHz	52.1837	77.2973
190.000000 MHz	52.0536	73.4392
200.000000 MHz	51.9076	70.0833
210.000000 MHz	51.5762	66.9769
220.000000 MHz	51.3596	64.2321
230.000000 MHz	51.1753	61.6456
240.000000 MHz	51.0334	59.3512
250.000000 MHz	50.7477	57.3154

300 MHz System Performance Check - Jan 29, 2004

DUT: Dipole 300 MHz; Model: D300V2; Type: System Performance Check; Serial: 135

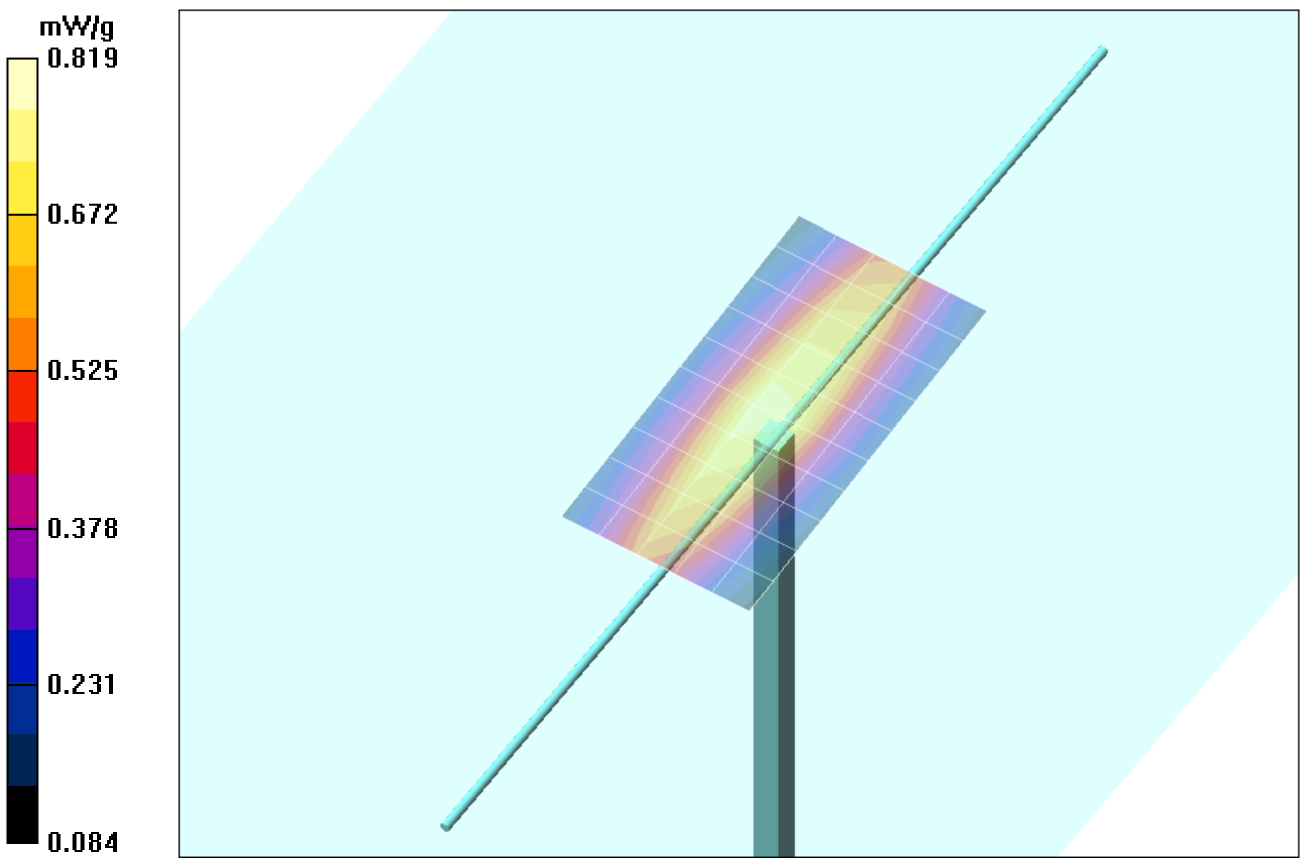
Ambient Temp: 24.1°C; Fluid Temp: 22.5°C; Barometric Pressure: 102.8 kPa; Humidity: 32%

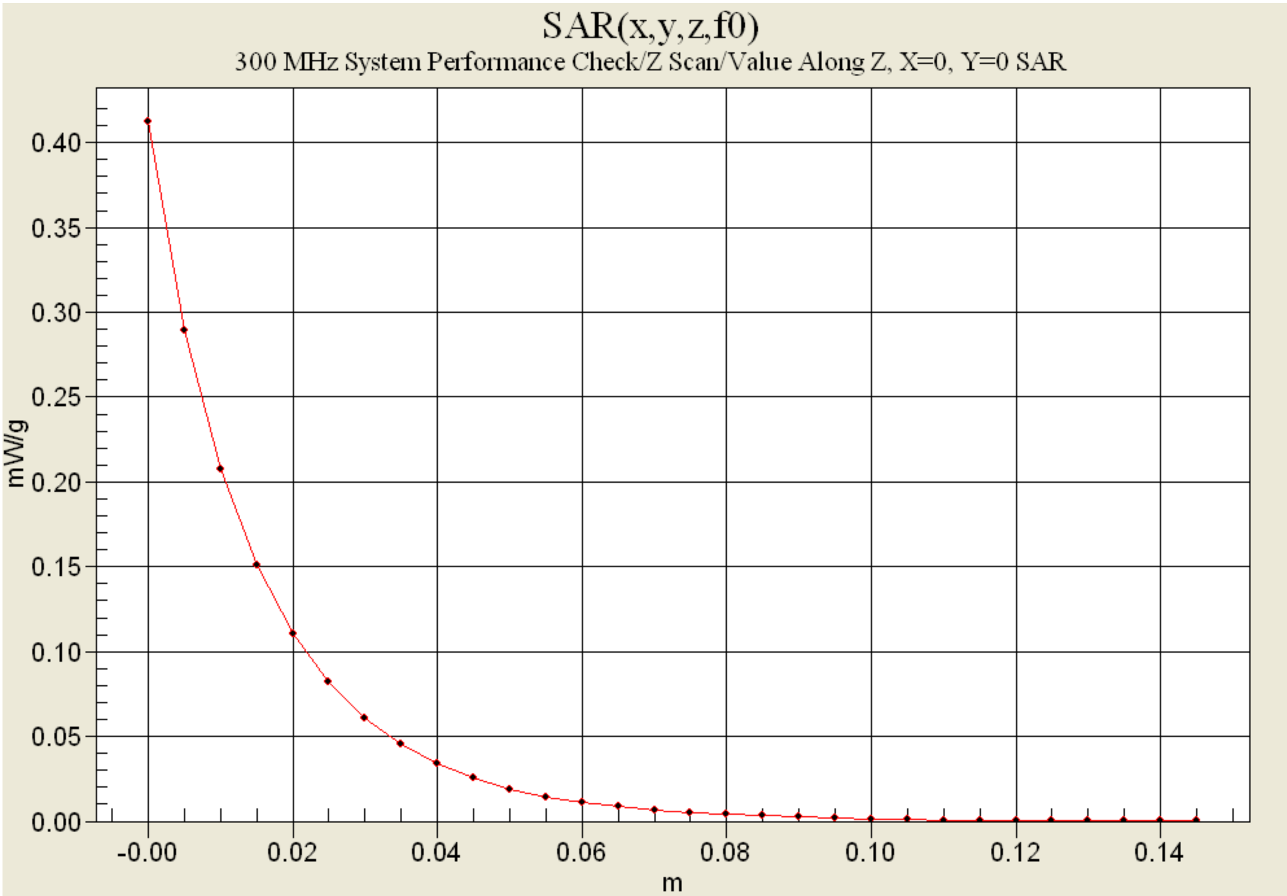
Communication System: CW
Forward Conducted Power: 250 mW
Frequency: 300 MHz; Duty Cycle: 1:1
Medium: 300 HSL (σ = 0.9 mho/m; ε_r = 46.6; ρ = 1000 kg/m^3)

- Probe: ET3DV6 - SN1590; ConvF(8.3, 8.3, 8.3); Calibrated: 15/05/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn353; Calibrated: 19/12/2003
- Phantom: Validation Planar; Type: Plexiglas; Serial: 137
- Measurement SW: DASY4, V4.2 Build 12; Postprocessing SW: SEMCAD, V1.8 Build 94

300 MHz System Performance Check/Area Scan (6x11x1):
Measurement grid: dx=15mm, dy=15mm

300 MHz System Performance Check/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 1.36 W/kg
SAR(1 g) = 0.776 mW/g; SAR(10 g) = 0.501 mW/g
Reference Value = 30.2 V/m
Power Drift = -0.1 dB





SAR(x,y,z,f0)
300 MHz System Performance Check/Z Scan/Value Along Z, X=0, Y=0 SAR
mW/g
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
-0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
m

300MHz System Performance Check

Measured Fluid Dielectric Parameters (Brain)

January 29, 2004

Frequency	e'	e''
200.000000 MHz	51.0997	73.6001
210.000000 MHz	50.2661	71.0487
220.000000 MHz	49.4929	68.7096
230.000000 MHz	48.8929	66.4901
240.000000 MHz	48.1967	64.5183
250.000000 MHz	47.8025	62.6125
260.000000 MHz	47.3881	60.9518
270.000000 MHz	47.1456	59.2265
280.000000 MHz	46.9443	57.5283
290.000000 MHz	46.7771	55.9702
300.000000 MHz	46.5546	54.2666
310.000000 MHz	46.3080	52.9181
320.000000 MHz	45.8814	51.7660
330.000000 MHz	45.4848	50.6945
340.000000 MHz	45.0753	49.7762
350.000000 MHz	44.7293	48.9165
360.000000 MHz	44.3211	48.0902
370.000000 MHz	44.0463	47.2589
380.000000 MHz	43.8217	46.4653
390.000000 MHz	43.6110	45.5460
400.000000 MHz	43.3522	44.7001

Face SAR - Jan 29, 2004

DUT: Vertex Standard FCC ID: K6610503220; Type: VHF FM PTT Radio Transceiver; Serial: 3K000002

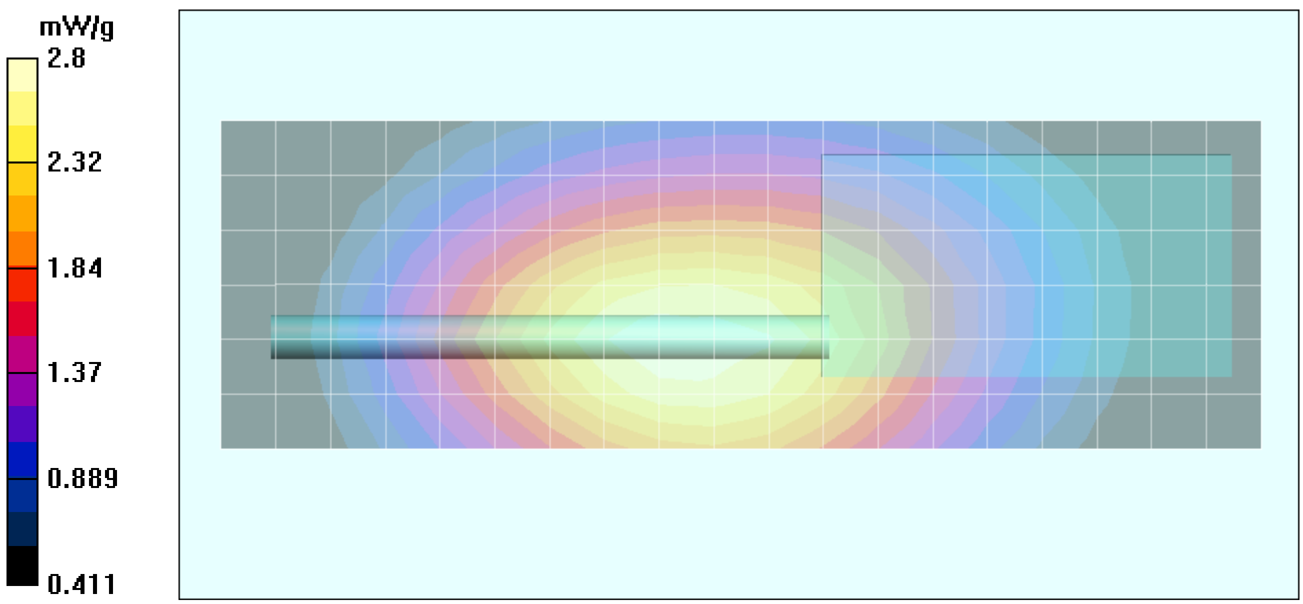
Ambient Temp: 24.5°C; Fluid Temp: 23.2°C; Barometric Pressure: 102.8 kPa; Humidity: 32%

Conducted Power: 5.17 Watts
Communication System: VHF FM
Frequency: 146 MHz; Duty Cycle: 1:1
Medium: HSL150 (σ = 0.76 mho/m; ε_r = 52.3; ρ = 1000 kg/m^3)

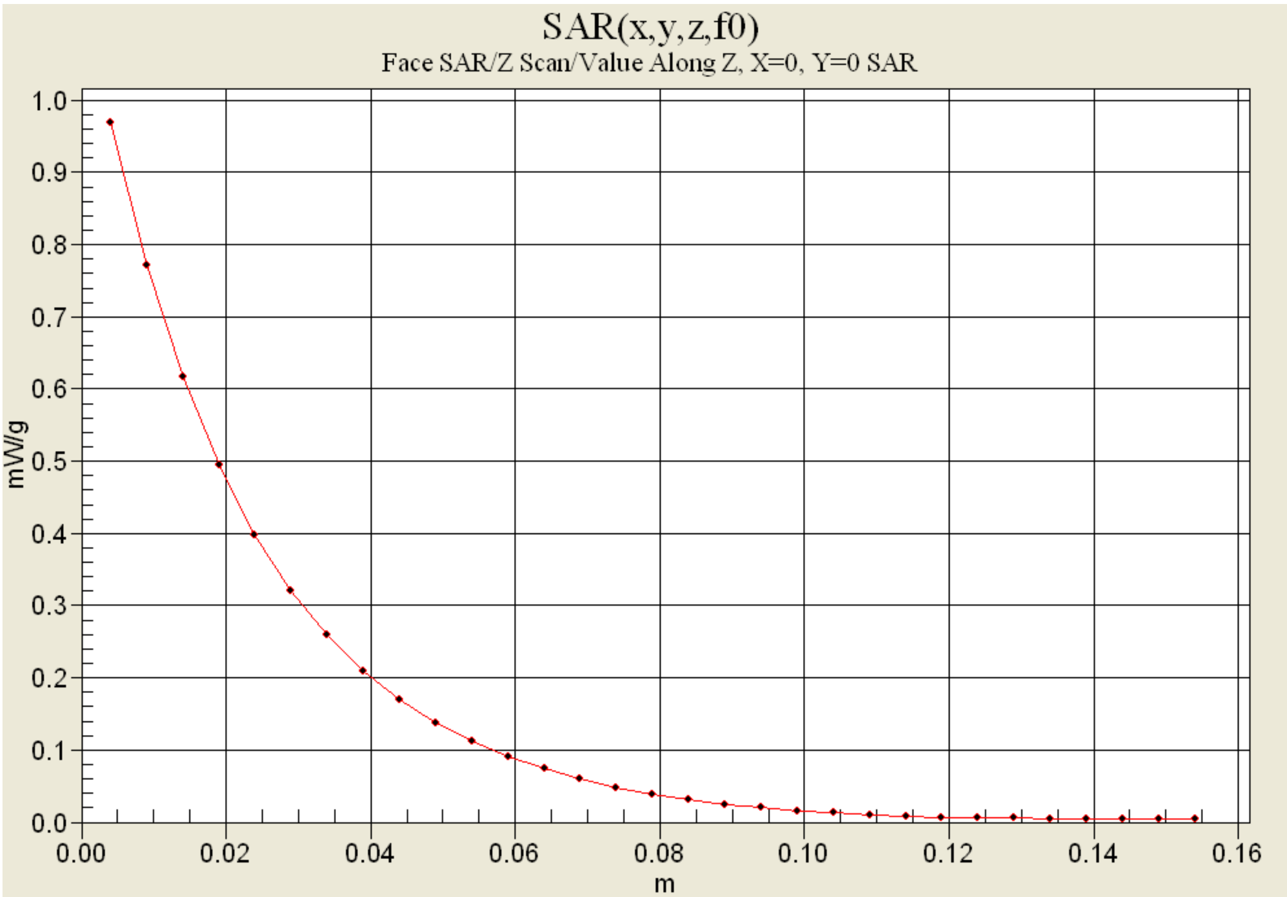
- Probe: ET3DV6 - SN1387; ConvF(9.1, 9.1, 9.1); Calibrated: 26/02/2003
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn370; Calibrated: 19/05/2003
- Phantom: Planar back; Type: Barski Industries; Serial: 03-01
- Measurement SW: DASY4, V4.2 Build 12; Postprocessing SW: SEMCAD, V1.8 Build 94

Face-Held - 146 MHz Antenna - Low Channel/Area Scan (7x20x1):
Measurement grid: dx=15mm, dy=15mm

Face-Held - 146 MHz Antenna - Low Channel/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Peak SAR (extrapolated) = 4.16 W/kg
SAR(1 g) = 2.7 mW/g; SAR(10 g) = 1.99 mW/g
Reference Value = 55.1 V/m
Power Drift: -0.11 dB

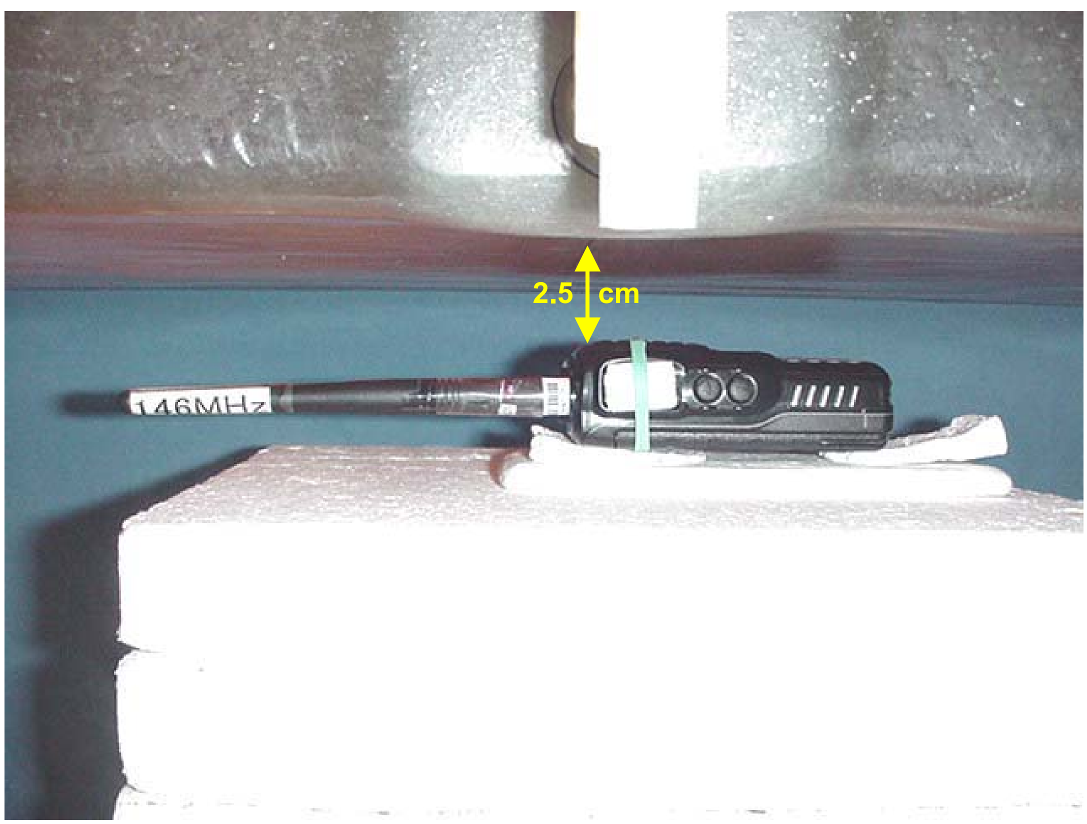


Z-AXIS SCAN - Jan 29, 2004



SAR TEST SETUP PHOTOS
Jan 29, 2004

Note: The SAR measurement was performed using a Fiberglas planar phantom, which is resistant to the Glycol solution. The Plexiglas phantom used during the previous SAR evaluations with sugar/salt solution is not resistant to the Glycol solution.



2378 Westlake Road
Kelowna, B.C. Canada
V1Z-2V2

BARSKI INDUSTRIES (1985) LTD.

Ph. # 250-769-6848
Fax # 250-769-6334
E-mail: barskiind@shaw.ca
Web: www.bcfiberglass.com

FIBERGLASS FABRICATORS

Certificate of Conformity

Item : Flat Planar Phantom Unit # 03-01
Date: June 16, 2003
Manufacturer: Barski Industries (1985 Ltd)

Test	Requirement	Details
Shape	Compliance to geometry according to drawing	Supplied CAD drawing
Material Thickness	Compliant with the requirements	2mm +/- 0.2mm in measurement area
Material Parameters	Dielectric parameters for required frequencies Based on Dow Chemical technical data	100 MHz-5 GHz Relative permittivity<5 Loss Tangent<0.05

Conformity

Based on the above information, we certify this product to be compliant to the requirements specified.

Signature: ____________

Daniel Chailler

Fiberglass Planar Phantom - Top View

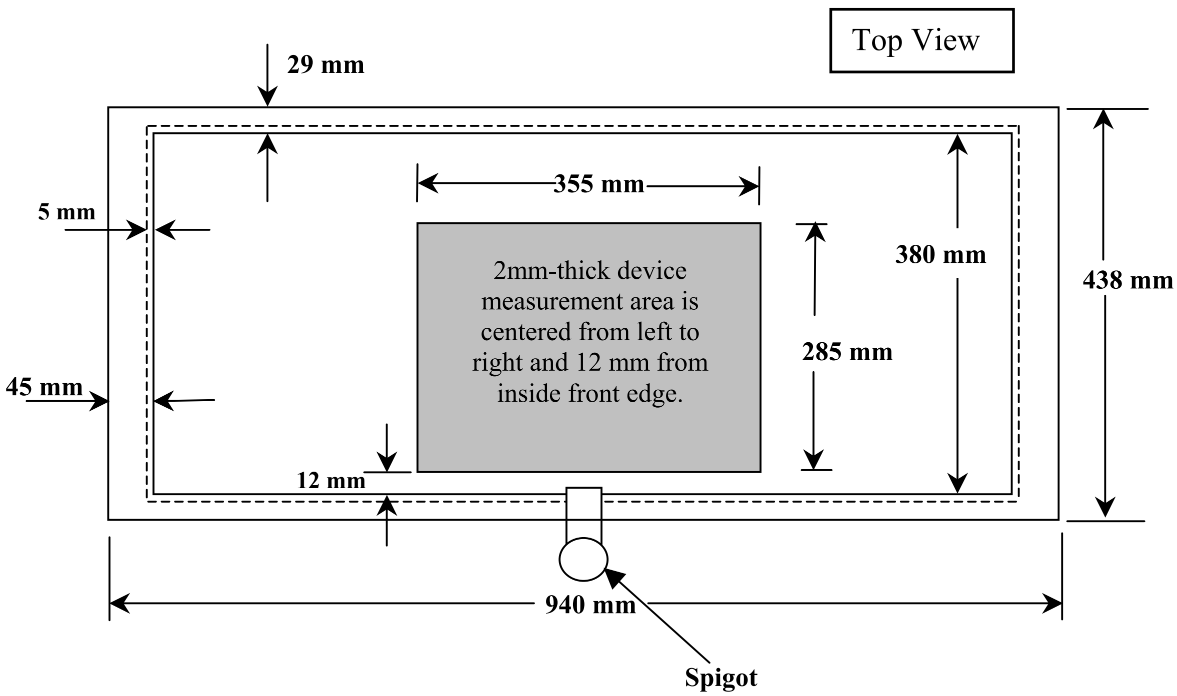
Fiberglass Planar Phantom - Front View

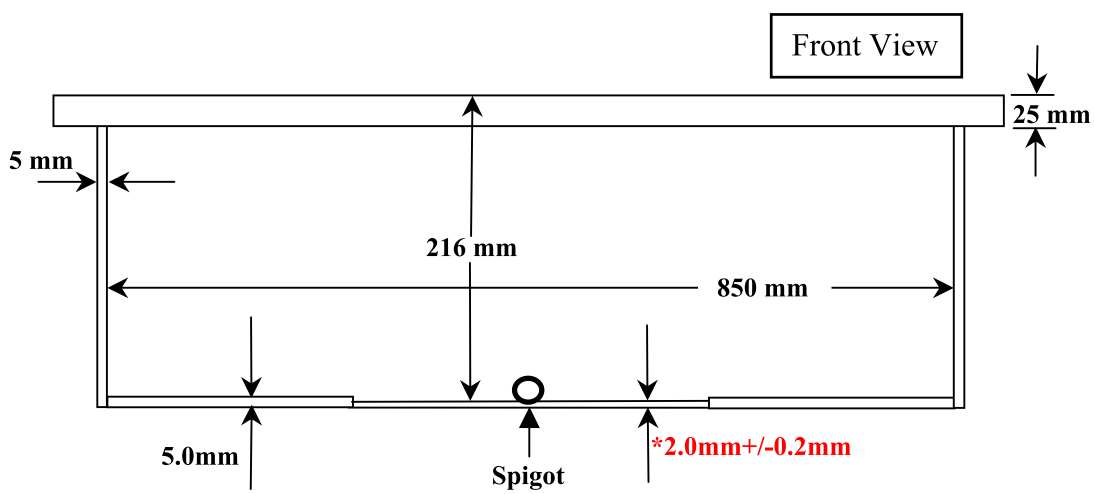
Fiberglass Planar Phantom - Back View

Fiberglass Planar Phantom - Bottom View

Dimensions of Fiberglass Planar Phantom

(Manufactured by Barski Industries Ltd. - Unit# 03-01)





Note: Measurements that aren't repeated for the opposite sides are the same as the side measured. This drawing is not to scale.