Certification Report on

Specific Absorption Rate (SAR) Experimental Analysis

Handspring

PDA with Phone Capability Manhattan

Test Date: July 2001

HANB-Manhattan PDA w.Phone Capability-3757

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INVESTIGATIVE SAR REPORT

Subject:	**Specific Absorption Rate (SAR) Hand and Body Report**
Product:	PDA with Phone Capability
Model:	Manhattan (Internal Product Name)
Client:	Handspring
Address:	189 Bernardo Avenue Mountain View, Ca 94043-5203
Project #:	HANB-Manhattan PDA w. Phone Capability-3757

Telecommunications Approval Board - Spectrum Sciences Institute
SAR Certified
APREL Laboratories
A141-Manhattan

Prepared by APREL Laboratories
51 Spectrum Way
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Approved by ______________ Date: 30th July 2001
Stuart Nicol
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Submitted by ______________ Date: July 30, 2001
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Released by ______________ Date: July 30/01
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FCC ID: O8FNYNY
Applicant: Handspring
Equipment: PDA with Phone Capability
Model: Manhattan (Internal Product Name)
Standard: FCC 96 –326, Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation

ENGINEERING SUMMARY

This report contains the results of the engineering evaluation performed onto a Manhattan PDA with phone capability in support of a FCC grant application. The measurements were carried out in accordance with FCC 96-326. The Device Under Investigation (DUI) was evaluated for its maximum power level 30 dBm (nominally). The client will supply a letter of confirmation as to the true power level for product tested. The duty cycle for the radio is set by the PCS standard at a value of one in eight and is restricted by the operational characteristics of the DUI. The end user will not be able to change the duty cycle.

The DUI was tested at low, middle and high channels for the PCS frequency range. The maximum 10g SAR (1.97 W/kg) was found to coincide with the peak performance RF output power of channel 661 middle (1880 MHz) for the keyboard down side of the device. The maximum 1g SAR while the device is in the pouch (0.31 W/Kg) was found to coincide with the peak performance RF output power of channel 512 low (1850.2 MHz) for the keyboard down side of the device (The hot spot is located on the antenna). The device was tested with the flip open and with the flip closed. With the flip closed the device will only transmit when the headset is attached. It was found that the conservative higher SAR was measured when the flip was closed and the headset attached. All subsequent conservative measured values contained in this report relate to the measured SAR while the device is connected to the headset and the flip closed.

At a separation distance of 12.1 mm from the back of the device, the 1g SAR is 1.33 W/Kg. In the operational manual will be a warning stating that bystanders and parts of the user's body other than extremities, must be at least 12.1 mm away from the back side of the device. Test data and graphs are presented in this report.

The device will be supplied with a pouch for use while the head set is connected.

Based on the test results and on how the device will be marketed and used, it is certified that the product meets the requirements as set forth in the above specifications, for RF exposure environment.

(The results presented in this report relate only to the sample tested.)

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1. INTRODUCTION

Tests were conducted to determine the Specific Absorption Rate (SAR) for a sample Manhattan PDA with phone capability. These tests were conducted at APREL Laboratories' facility located at 51 Spectrum Way, Nepean, Ontario, Canada. A view of the SAR measurement setup can be seen in Appendix A Figure 2. This report describes the results obtained.

2. APPLICABLE DOCUMENTS

The following documents are applicable to the work performed:

1) FCC 96-326, Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation

2) ANSI/IEEE C95.1-1999, IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

3) ANSI/IEEE C95.3-1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave.

4) OET Bulletin 65 (Edition 01-01) Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".

3. DEVICE UNDER INVESTIGATION

- Manhattan PDA, s/n DAAEDDVT1106Z, received on July 5, 2001.

The Manhattan PDA will be called DUI (Device Under Investigation) in the following test report.

The manufacturer's original submission documentation contains all the necessary drawings and applicable design details.

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4. TEST EQUIPMENT

- APREL Triangular Dosimetric Probe Model E-009, s/n 115, Asset # 301420
- CRS Robotics A255 articulated robot arm, s/n RA2750, Asset # 301335
- CRS Robotics C500 robotic system controller, s/n RC584, Asset # 301334
- Rohde & Schwarz CMD 55 Radio Communications Tester Asset # WT996010
- Tissue Recipe and Calibration Requirements, APREL procedure SSI/DRB-TP-D01-033
- APREL flat Phantom F1 (overall shell thickness 3mm)

5. TEST METHODOLOGY

1. The test methodology utilized in the certification of the DUI complies with the requirements of FCC 96-326 and ANSI/IEEE C95.3-1992.
2. The E-field is measured with a small isotropic probe (output voltage proportional to E^2).
3. The probe is moved precisely from one point to the next using the robot (10 mm increments for wide area scanning, 5 mm increments for zoom scanning, and 2.5 mm increments for the final depth profile measurement).
4. The probe travels in the homogeneous liquid simulating human muscle tissue. Appendix A contains information about the properties of the simulated tissue used during the measurement process.
5. The liquid is contained in a manikin simulating a portion of the human body with an overall shell thickness of 3 mm.
6. The DUI is positioned with the surface under investigation against the phantom.
7. All tests were performed with the highest power available from the sample DUI under transmit conditions.

More detailed descriptions of the test method is given in Section 6 when appropriate.

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6. TEST RESULTS

6.1. TRANSMITTER CHARACTERISTICS

The battery-powered DUI will consume energy from its batteries, which may affect the DUI's transmission power characteristics. In order to gage this effect the output of the transmitter is sampled before and after each SAR test. In the case of this DUI, the Tx power was sampled through out the test process. The following table shows the RF power sampled before and after each of the seven sets of data used for the worst case SAR in this report.

<u>Note</u>

The power measurement is not conducted and only relative to a true pin on pin conducted measurement. The R&S communications tester provides the technician with the functionality of viewing the expected power and the actual received power from the DUI. This allows the technician to monitor the possible drift in power during the test process, and as a result assess the delta if any.

Scan		**Power Readings (dBm)**		**D**	**Battery #**
Type	**Height (mm)**	**Before**	**After**	**(dB)**	
Area	2.5	21.8	21.5	0.3	1
Zoom	2.5	21.8	21.5	0.3	1
Zoom	7.5	21.8	21.5	0.3	1
Zoom	12.5	21.8	21.5	0.3	1
Zoom	17.5	21.8	21.5	0.3	1
Zoom	22.5	21.8	21.5	0.3	1
Depth	2.5 – 22.5	21.7	21.4	0.3	1

Table 1. Sampled RF Power

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6.2. SAR MEASUREMENTS

1) RF exposure is expressed as a Specific Absorption Rate (SAR). SAR is calculated from the E-field, measured in a grid of test points. SAR is expressed as RF power per kilogram of mass, averaged in 10 grams of tissue for the extremities and 1 gram of tissue elsewhere.

2) The DUI was put into test mode for the SAR measurements by enabling a call via the R&S communications tester. A SIMM card was located in the DUI to enable the interaction between the R&S communications tester and the DUI. The R&S communications tester then sent out a command for the DUI to transmit on full power at the specified frequency.

3) Figure 3 in Appendix A shows a contour plot of the SAR measurements for the DUI (channel 661, 1880 MHz). It also shows an overlay of the DUI's outlines, superimposed onto the contour plot

   A different presentation of the same data is shown in Appendix A Figure 4. This is a surface plot, where the measured SAR values provide the vertical dimension, which is useful as a visualization aid.

4) Wide area scans were performed for the low, middle and high channels of the DUI. The DUI was operating at maximum output power (30 dBm) with the duty cycle set at one in eight as per the PCS specification. The DUI was placed in close proximity of the phantom for the keyboard up and keyboard down permutations. The phantom shell thickness is 3 mm overall.

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DUI Side	In Pouch	Headset	Flip (open/closed)	L/M/H	Channel #	Freq (MHz)	Peak Local SAR (W/Kg
Keyboard down side	No	Yes	Closed	Middle	661	1880	4.73
Keyboard down side	No	Yes	Closed	Low	512	1850.2	4.30
Keyboard down side	No	Yes	Closed	High	810	1909.8	4.00
Keyboard down side	No	No	Open	Middle	661	1880	2.57
Keyboard down side	No	No	Open	Low	512	1850.2	2.46
Keyboard down side	No	No	Open	High	810	1909.8	2.49
Keyboard down side	No	Yes	Open	Middle	661	1880	2.70
Keyboard down side	Yes	Yes	Closed	Middle	661	1880	0.30
Keyboard down side	Yes	Yes	Closed	Low	512	1850.2	0.32
Keyboard down side	Yes	Yes	Closed	High	810	1909.8	0.25
Keyboard up side	No	Yes	Closed	Middle	661	1880	0.67
Keyboard up side	No	Yes	Closed	Low	512	1850.2	1.00
Keyboard up side	No	Yes	Closed	High	810	1909.8	0.54

Table 2. SAR Measurements

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7. USER'S HAND EXPOSURE

All subsequent testing for user's hand exposure was performed on channel 661 (1880 MHz), with the backside of the DUI facing up against the bottom of the phantom and the headset attached. This relates to the position and frequency found to provide the maximum measured SAR value.

1) Channel 661 (1880 MHz) was then explored on a refined 5 mm grid in three dimensions. The SAR value averaged over 10 grams was determined from these measurements by averaging the 125 points (5x5x5) comprising a 2 cm cube. The maximum SAR value measured averaged over 10 grams was determined from these measurements to be 1.01 W/kg.

2) To extrapolate the maximum SAR value averaged over 10 grams to the inner surface of the phantom a series of measurements were made at five (x,y) co-ordinates within the refined grid as a function of depth, with 2.5 mm spacing. The average exponential coefficient was determined to be (-0.140 ± 0.006) mm.

3) The distance from the probe tip to the inner surface of the phantom for the lowest point is 2.5 mm. The distance from the probe tip to the tip of the measuring dipole within the APREL Triangular Dosimetric Probe Model E-009 is 2.3 mm. The total extrapolation distance is 4.8 mm, the sum of these two.

Applying the exponential coefficient over the 4.8 mm to the maximum SAR value averaged over 10 grams that was determined previously, we obtain the **maximum SAR value at the surface averaged over 10 grams, 1.97 W/kg.**

8. BYSTANDER EXPOSURE

All subsequent testing for bystander exposure was performed on channel 661 (1880 MHz), with the backside of the DUI facing up against the bottom of the phantom and the headset attached. This relates to the position and frequency found to provide the maximum measured SAR value.

1) Channel 661 (1880 MHz) was also explored on a refined 5 mm grid in three dimensions. The SAR value averaged over 1 gram was determined from these measurements by averaging the 27 points (3x3x3) comprising a 1 cm cube. The maximum SAR value measured averaged over 1 gram was determined from these measurements to be 2.16 W/kg.

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2) To extrapolate the maximum SAR value averaged over 1 gram to the inner surface of the phantom a series of measurements were made at a five (x,y) co-ordinates within the refined grid as a function of depth, with 2.5 mm spacing. The average exponential coefficient was determined to be (-0.140 ± 0.006) mm.

3) The distance from the probe tip to the inner surface of the phantom for the lowest point is 2.5 mm. The distance from the probe tip to the tip of the measuring dipole within the APREL Triangular Dosimetric Probe Model E-009 is 2.3 mm. The total extrapolation distance is 4.8 mm, the sum of these two.

   Applying the exponential coefficient over the 4.8 mm to the maximum SAR value averaged over 1 gram that was determined previously, we obtain the **maximum SAR value at the surface averaged over 1 gram, 4.23 W/kg**.

4) Wide area scans were then performed for channel 661 (middle, 1880 MHz) versus DUI separation from the bottom of the phantom. The peak single point SAR for the scans were:

DUI to phantom separation (mm)	**Highest Local SAR (W/kg)**
10	0.82
20	0.22
30	0.14

Table 3. SAR versus DUI-Phantom Separation

The measurements of highest local SAR versus separation of the DUI from the bottom of the phantom can be used to determine the SAR exposure of the bystander during operation of the DUI.

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If the data for Figure 4 is fitted to an exponential equation we get:

$$\text{Peak Local SAR} = 6.2134\, e^{*-0.1271\,(\text{separation})}$$

A similar equation will exist for the maximum 1g SAR versus separation:

$$\text{Maximum 1g SAR} = k\, e^{*-0.1271\,(\text{separation})}$$

Using this equation with the previous data:

Maximum 1g SAR at the surface	=	4.23 W/kg
Tissue to DUI separation	=	3 mm,

results in k = 6.19 which corresponds to the maximum 1g SAR when the separation is 0 mm. A conservative maximum 1g SAR of 1.33 W/kg (1.6 W/kg reduced by our measurement uncertainty, 16.8 %) would occur for a separation of 12.1 mm from the antenna of the DUI.

At a standard separation distance of 4 cm, the maximum 1g SAR would be 0.04 W/kg.

9. BODY EXPOSURE

All subsequent testing for body exposure was performed on channel 512 (1850.2 MHz), with the backside of the DUI facing up against the bottom of the phantom and the DUI inserted in the pouch with the headset attached. This relates to the position and frequency found to provide the maximum measured SAR value.

1) Channel 512 (1850.2 MHz) was also explored on a refined 5 mm grid in three dimensions. The SAR value averaged over 1 gram was determined from these measurements by averaging the 27 points (3x3x3) comprising a 1 cm cube. The maximum SAR value measured averaged over 1 gram was determined from these measurements to be 0.18 W/kg.

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2) To extrapolate the maximum SAR value averaged over 1 gram to the inner surface of the phantom a series of measurements were made at a five (x,y) co-ordinates within the refined grid as a function of depth, with 2.5 mm spacing. The average exponential coefficient was determined to be (-0.110 ± 0.006) mm.

3) The distance from the probe tip to the inner surface of the phantom for the lowest point is 2.5 mm. The distance from the probe tip to the tip of the measuring dipole within the APREL Triangular Dosimetric Probe Model E-009 is 2.3 mm. The total extrapolation distance is 4.8 mm, the sum of these two.

   Applying the exponential coefficient over the 4.8 mm to the maximum SAR value averaged over 1 gram that was determined previously, we obtain the **maximum SAR value at the surface averaged over 1 gram, <u>0.31 W/kg</u>**.

Figure 1 Manhattan PDA in Pouch Side View

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10. CONCLUSIONS

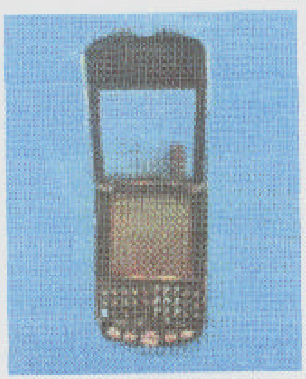
The maximum Specific Absorption Rate (SAR) for the hand averaged over 10 grams, determined at 1880 MHz (channel 661) of the Manhattan PDA, is **<u>1.97 W/kg</u>**. The overall margin of uncertainty for this measurement is ±12.15% (Appendix B). The SAR limit given in the FCC 96-326 Safety Guideline is 4 W/kg for hand exposure for the general population.

The maximum Specific Absorption Rate (SAR) for the body averaged over 1 gram, determined at 1850.2 MHz (channel 512) of the Manhattan PDA while inserted in the pouch, is **<u>0.31 W/kg</u>**. The overall margin of uncertainty for this measurement is ±13.7% (Appendix B). The SAR limit given in the FCC 96-326 Safety Guideline is 1.6 W/kg for body exposure for the general population.

For a user exposing a part of the body other than the extremities, at a separation distance of 4 cm from the device, **<u>the maximum Specific Absorption Rate (SAR) averaged over 1g is 0.04 W/kg.</u>** The SAR limit given in the FCC 96-326 Safety Guideline is 1.6 W/kg for uncontrolled partial body exposure of the general population. The minimum separation distance that will ensure that the limit is not exceeded is 12.1 mm.

Considering the above, this unit as tested, and as it will be marketed and used, is found to be compliant with the FCC 96-326 requirement.

Tested by ____________ Date July 12, 2001



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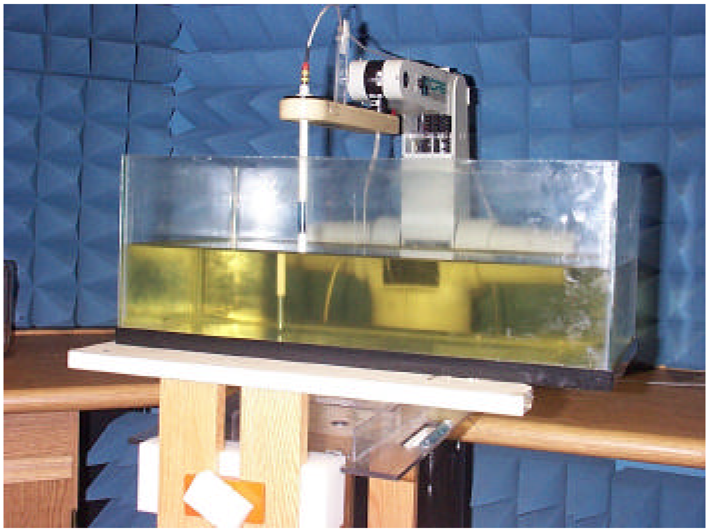
APPENDIX A. Measurement Setup, Tissue Properties and SAR Graphs



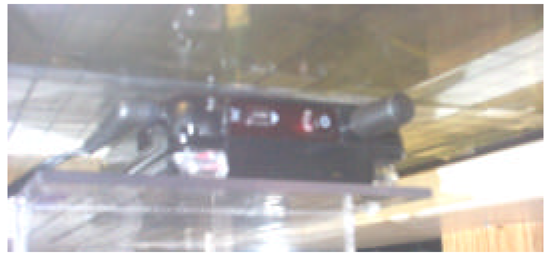


Figure 2. Setup

Simulated Tissue Material and Calibration Technique

The mixture used was based on that presented SSI/DRB-TP-D01-033, "Tissue Recipe and Calibration Requirements". The density used to determine SAR from the measurements was the recommended 1000 kg/m^3 found in Appendix C of Supplement C to OET Bulletin 65, Edition 01-01).

Dielectric parameters of the simulated tissue material were determined using a Hewlett Packard 8510 Network Analyzer, a Hewlett Packard 809B Slotted Line Carriage, and an APREL SLP-001 Slotted Line Probe.

	APREL	Target values	Δ (%)
Dielectric constant, ε_r	53.2	53.3	0 %
Conductivity, σ [S/m]	1.6	1.52	6%
Tissue Conversion Factor, γ	9.2	-	-

Table 4. Dielectric Properties of the Simulated Muscle Tissue at 1900 MHz

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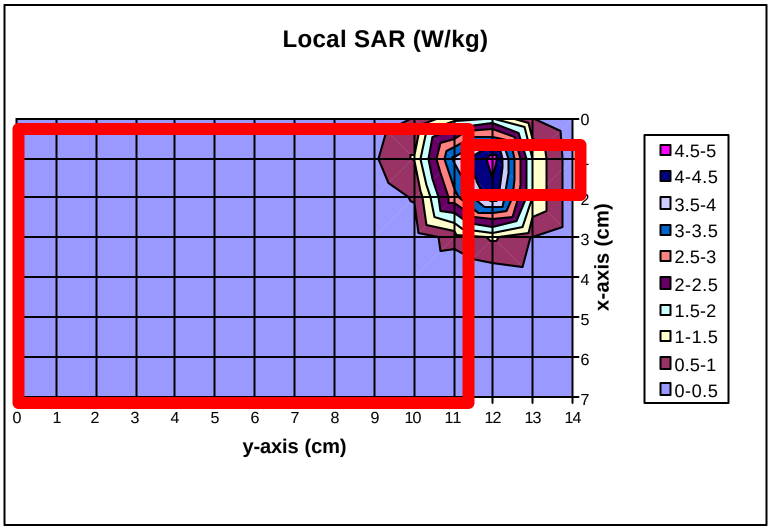

Figure 3. Contour Plot of Area Scan 2.5mm Above Phantom Surface

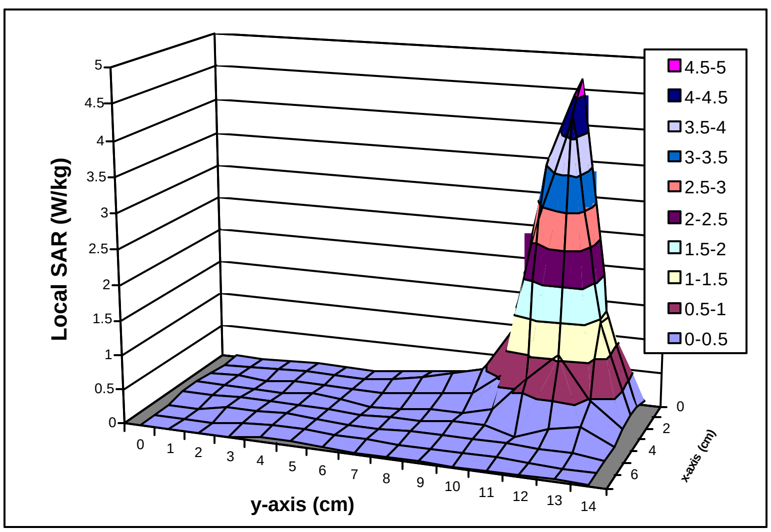

Figure 4. Surface Plot of Area Scan 2.5mm Above Phantom Surface

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APPENDIX B. Uncertainty Budget

Calculated Uncertainties		
Type of Uncertainty	**Specific to**	**Uncertainty**
Power variation due to battery condition	DUI	3.5%
Extrapolation due to curve fit of SAR vs depth	Setup	3.0%
Extrapolation due to depth measurement	Setup	4.8%
Conductivity	Setup	6.0%
Permitivity	Setup	0.0%
Probe Calibration	Setup	6.5%
Probe Positioning	Setup	2.0%
Probe Isotropicity	Setup	3.5%
Other Setup Uncertainty (Ambient,,,)	Setup	3.0%
	24.3%	**Expanded Uncertainty K^2**

Table 5. Uncertainty Budget (Hand & Bystander)

Calculated Uncertainties		
Type of Uncertainty	**Specific to**	**Uncertainty**
Power variation due to battery condition	DUI	7.2%
Extrapolation due to curve fit of SAR vs depth	Setup	3.0%
Extrapolation due to depth measurement	Setup	4.8%
Conductivity	Setup	6.0%
Permitivity	Setup	0.0%
Probe Calibration	Setup	6.5%
Probe Positioning	Setup	2.0%
Probe Isotropicity	Setup	3.5%
Other Setup Uncertainty (Ambient,,,)	Setup	3.0%
	27.4%	**Expanded Uncertainty K^2**

Table 6. Uncertainty Budget (Body)

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APPENDIX C. Dipole Validation Scan on a Flat Phantom

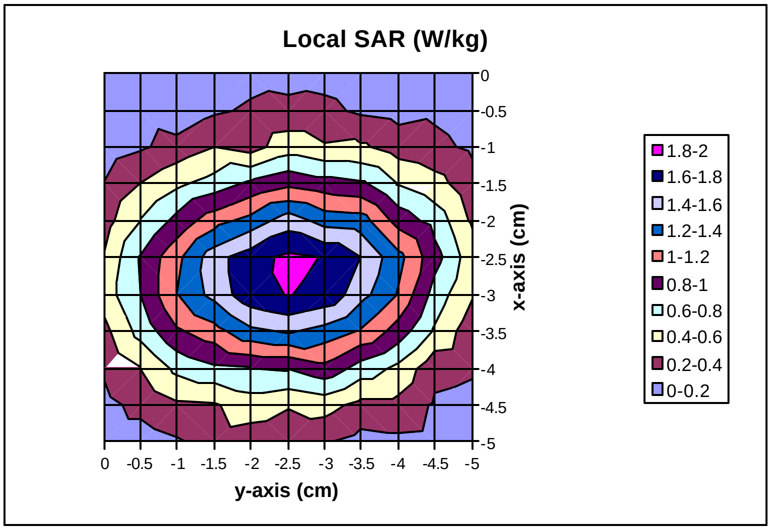

Figure 5. Surface Plot for Validation Dipole (Area Scan 2.5mm Above Phantom)

Frequency (MHz)	1 Gram SAR (W/Kg)	Target Value (W/Kg)	Delta (%)	Input Power to Dipole (dBm)	Distance from Dipole to Tissue (mm)
1900	1.77	1.74	1.7%	16.8	10

Figure 6. Validation Dipole Under Phantom

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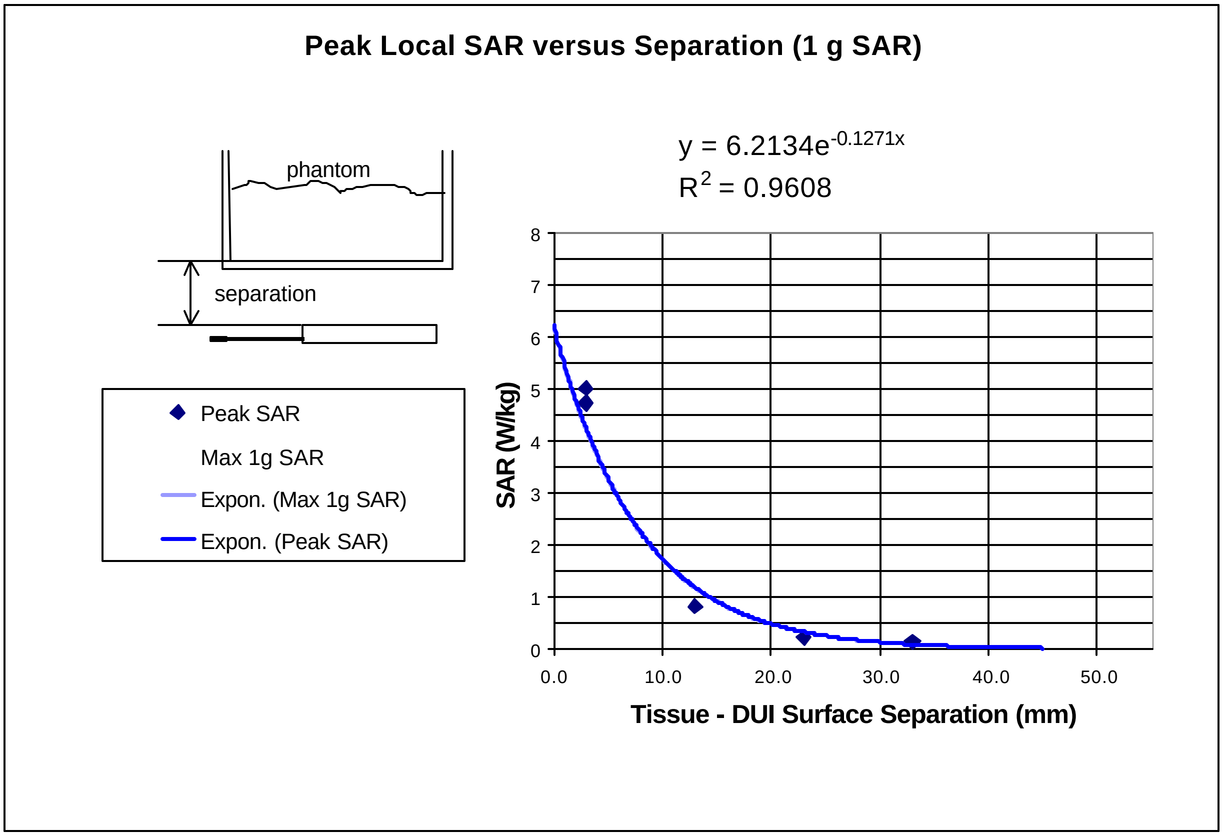

Figure 7. Peak Local SAR versus DUI Separation

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APPENDIX D. Probe Calibration

NCL CALIBRATION LABORATORIES

Calibration File No.: 301420

CERTIFICATE OF CALIBRATION

It is certified that the equipment identified below has been calibrated in the **NCL CALIBRATION LABORATORIES** by qualified personnel following recognized procedures and using transfer standards traceable to NRC/NIST.

Equipment: Miniature Isotropic RF Probe

Manufacturer: APREL Laboratories/IDX Robotics Inc
Model No.: E-009
Serial No.: 115

Customer: APREL
Asset No.:301420

Calibration Procedure: SSI/DRB-TP-D01-032

Cal. Date: 9 November, 2000 Cal. Due Date: 8 November, 2001
Remarks: None

Calibrated By: ______________________

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