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-3760

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INVESTIGATIVE SAR REPOR

Subject: **Specific Absorption Rate (SAR) Head 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-3760

Telecommunications Approval Board - Spectrum Sciences Institute
SAR Certified
APREL Laboratories
A174-Manhattan

Prepared by APREL Laboratories
51 Spectrum Way
Nepean, Ontario
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Approved by ____________ Date: 30th July 2001
Stuart Nicol
Director Product Development, Dosimetric R&D

Submitted by ____________ Date: July 30, 2001
Jay Sarkar
Technical Director of Standards & Certification

Released by ____________ Date: July 30/01.
Dr. Jacek J. Wojcik, P. Eng.

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FCC ID: O8FNYNY
Applicant: Handspring
Equipment: PDA with Phone Capability
Model: Manhattan
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 on the Handspring 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 the 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 1g SAR (0.76 W/kg) was found to coincide with the peak performance RF output power of channel 512 low (1850.2 MHz) for the keyboard up side of the device. (The hot spot is located near the antenna).

Test data and graphs are presented in this report.

Figures 3 and 4 provide graphical details of the area and depth scans for this unit. Due to the cut off nature of the graphs it was decided that the DUI would be reassessed by moving the microphone towards the ear so as to scan a larger area of the keyboard for the DUI. These tests were not in line with the general use position, and would constitute a more unnatural way of using the unit. This test proved that the general use position was providing a more conservative measurement. Due to the construction of the chassis the distance from the radiating source to the phantom actually increased when it was reassessed in the unnatural position.

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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TABLES AND FIGURES

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1. INTRODUCTION

Tests were conducted to determine the Specific Absorption Rate (SAR) on a sample Handspring 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 1. 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 97-01) Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".

3. DEVICE UNDER INVESTIGATION

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

The Handspring 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
- Universal Head and Arm Simulator (phantom 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 tissue. Appendix A contains information about the properties of the simulated tissue used for these measurements.
5. The liquid is contained in a manikin simulating a portion of the human head with an overall shell thickness of 3 mm.

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6. The DUI is positioned with the surface under investigation against the phantom touching the spacer at the receiver end of the DUI giving a total maximum distance (which includes the phantom thickness and spacer) of 6 mm.

7. All tests were performed with the highest power available from the sample DUI under transmit conditions.

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

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.

Note

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 form 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	24.4	24.2	0.2	1
Zoom	2.5	24.4	24.2	0.2	1
Zoom	7.5	24.4	24.2	0.2	1
Zoom	12.5	24.4	24.2	0.2	1
Depth	2.5 – 22.5	24.6	24.5	0.1	1

Table 1. Sampled RF Power

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6.2. SAR MEASUREMENTS

1) RF exposure is expressed as Specific Absorption Rate (SAR). SAR is calculated from the E-field, measured in a grid of test points as shown in Appendix A Figure 2. 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 at full power at the specified frequency.

3) Figure 3 in Appendix A shows a contour plot of the SAR measurements for the DUI (channel 512, 1850.2 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 next to the phantom in the generic touch position. The maximum distance was 6 mm at the spacer (including the phantom shell thickness) decreasing to 3 mm at the microphone.

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TYPE OF EXPOSURE	DUI side	Device distance to phantom (mm)	Channel L/M/H	#	Freq (MHz)	Peak Local SAR (W/kg)
Head	keyboard up side	3	Middle	661	1880	0.52
	Keyboard up side	3	Low	512	1850.2	0.96
	Keyboard up side	3	High	810	1909.8	0.31

Table 2. SAR Measurements

7. USER'S HEAD EXPOSURE

1) Due to the above data all subsequent testing for user's Head exposure was performed on channel 512 (1850.2 MHz), with the keyboard of the DUI facing up at a maximum distance of 6 mm at the spacer and minimum distance of 3 mm at the lower end of the DUI. This relates to the position and frequency found to provide the maximum measured SAR value.

2) 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 0.43 W/kg.

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3) 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 (-0.116 ± 0.007) mm.

4) 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>0.76 W/kg</u>**.

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8. CONCLUSIONS

The maximum Specific Absorption Rate (SAR) averaged over 1 gram, determined at 1850.2 MHz (channel 512) of the Manhattan PDA, is 0.76 W/kg. The overall margin of uncertainty for this measurement is ±11.55 % (Appendix B). The SAR limit given in the FCC 96-326 Safety Guideline is 1.6 W/kg for head exposure for the general population.

Tested by ____________ Date July 11, 2001

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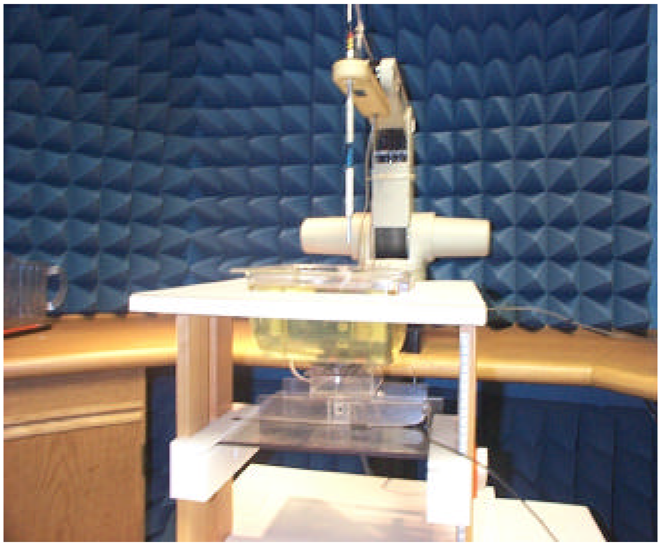
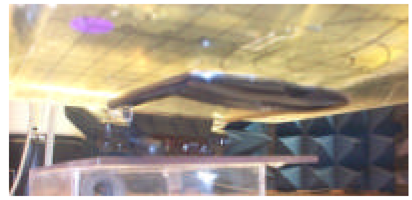
APPENDIX A. Measurement Setup, Tissue Properties and SAR Graphs





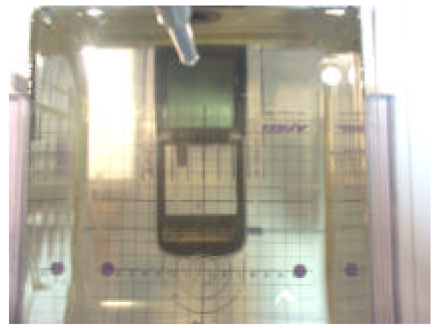


Figure 1&2. Setup & Measurement Grid

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	41.02	41.00	2 %
Conductivity, σ [S/m]	1.46	1.40	5 %
Tissue Conversion Factor, γ	5.2	-	-

Table 3. Dielectric Properties of the Simulated Brain Tissue at 1900 MHz

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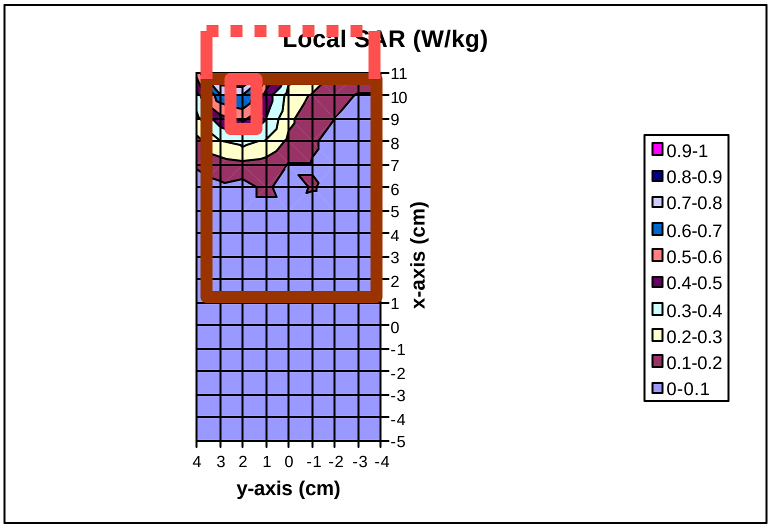

Figure 3. Contour Plot of Area Scan 2.5mm Above Phantom Surface

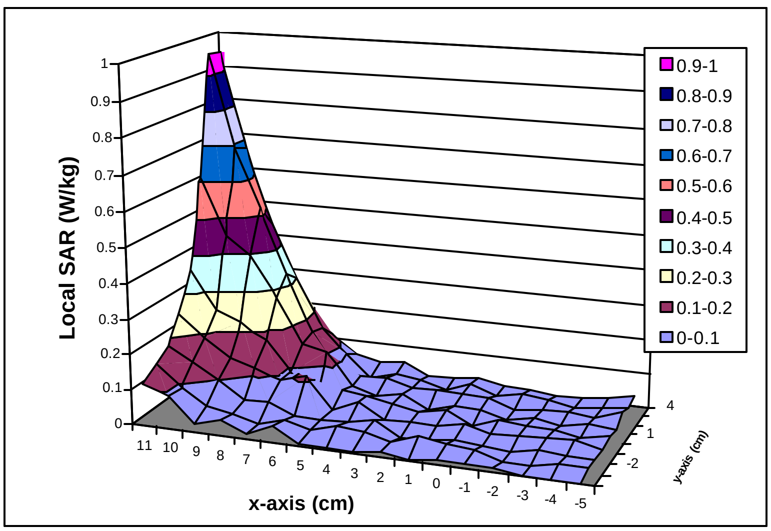

Figure 4. Surface Plot of Area Scan 2.5mm Above Phantom Surface

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APPENDIX B. Uncertainty Budget

Calculated Uncertainties		
Type of Uncertainty	**Specific to**	**Uncertainty**
Power variation due to battery condition	DUI	2.3%
Extrapolation due to curve fit of SAR vs depth	Setup	3.0%
Extrapolation due to depth measurement	Setup	4.8%
Conductivity	Setup	5.0%
Permitivity	Setup	2.0%
Probe Calibration	Setup	6.5%
Probe Positioning	Setup	2.0%
Probe Isotropicity	Setup	3.5%
Other Setup Uncertainty (Ambient,,,)	Setup	3.0%
	23.1%	**Expanded Uncertainty K^2**

Table 4. Uncertainty Budget

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APPENDIX C. Dipole Validation Scan on a Flat Phantom

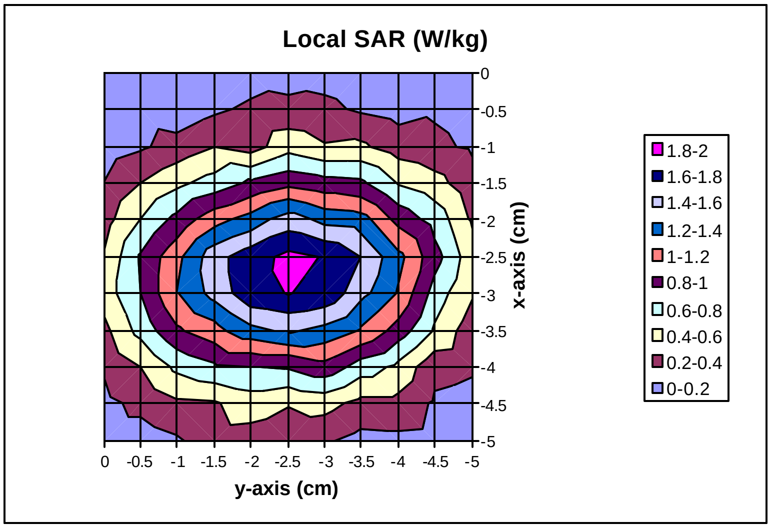

Figure 5. Surface Plot for Validation Dipole (Area Scan 2.5mm Above Phantom)

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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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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