Certification Report on

Specific Absorption Rate (SAR)
Experimental Analysis

Research In Motion

Blackberry Wireless Handheld
Model: R1900G-1-4

Test Date: September 2001

RIMB-BlackBerry R1900G-1-4-3789

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EXPERIMENTAL ANALYSIS SAR REPORT

Subject: **Specific Absorption Rate (SAR) Hand and Body Report**

Product: BlackBerry Wireless Handheld

Model: R1900G-1-4

Client: Research In Motion Limited

Address: 295 Phillip St.
Waterloo, Ontario
Canada N2L 3W8

Project #: RIMB-BlackBerry R1900G-1-4-3789

Prepared by APREL Laboratories
51 Spectrum Way
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Approved by _____ Date: 21st. September 2001
Stuart Nicol
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Submitted by _____ Date: Sept 21, 2001
Jay Sarkar
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Released by _____ Date Sept 25/01.
Dr. Jacek J. Wojcik, P. Eng.

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FCC ID: L6AR1900G-1-4
Applicant: Research In Motion LTD.
Equipment: BlackBerry Wireless Handheld
Model: R1900G-1-4
Standard: FCC 96 –326, Guidelines for Evaluating the Environmental Effects of Radio-Frequency Radiation, Supplement C (Edition 01-01) to OET Bulletin 65

ENGINEERING SUMMARY

This report contains the results of the engineering evaluation performed on the RIM BlackBerry Wireless Handheld operating in PCS mode. The measurements were carried out in accordance with FCC 96-326. The RIM BlackBerry Wireless Handheld was evaluated for its maximum power level 30 dBm with a 12.5 % duty cycle (1/8). The end user can not change the duty cycle for this device.

The RIM BlackBerry Wireless Handheld is intended to be used as a handheld device and also in the supplied holster with belt clip during body worn voice/data operation.

The RIM BlackBerry Wireless Handheld was tested in PCS (1/8) mode at low, middle and high channels for hand exposure on the keyboard up, keyboard down, and left sides. The maximum 10g SAR (3.31 W/kg) was found to coincide with the peak performance RF output power of channel 810 (1909.8 MHz) for the left side of the device. (The hot spot is located on the antenna).

The RIM BlackBerry Wireless Handheld was also tested at low, middle and high channels in PCS mode for body exposure on the keyboard up side while attached to the holster. The maximum 1g SAR for the device while attached to the holster (0.25 W/kg) was found to coincide with the peak performance RF output power of channel 810 (1909.8 MHz) for the keyboard up side of the device while connected to the HDW03458-01 headset. (The hot spot is located on the antenna).

At a separation distance of 5.9 mm from the back of the device, the 1g SAR is 1.24 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 5.9 mm away from the back side of the device. Test data and graphs are presented in this report.

The RIM BlackBerry Wireless Handheld was tested with and without headsets, HDW-03458-00 and HDW-03458-01.

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 the RF exposure environment.

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

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Table of Contents

TABLES AND FIGURES

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1. INTRODUCTION

Tests were conducted to determine the Specific Absorption Rate (SAR) for a sample RIM BlackBerry Wireless Handheld transceiver. 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 & 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 97-01) Supplement C (Edition 01-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".

3. DEVICE UNDER INVESTIGATION

- RIM BlackBerry Wireless Handheld s/n 005SB-318, received on Sept 12, 2001.

The RIM BlackBerry Wireless Handheld will be called DUI (Device Under Investigation) in the following.

Refer to the manufacturer's submission documentation for drawings and further 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
- Wavetek communication test instrument 4400M, s/n 1011020511057
- Tissue Recipe and Calibration Requirements, APREL procedure SSI/DRB-TP-D01-033
- APREL flat phantom F2 (overall shell thickness 2mm)

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 body with an overall shell thickness of 2 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 are given in Section 6 where 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 characteristics. In order to gage this effect the output Tx power of the transmitter is sampled before and after each SAR run. In the case of this DUI, the conducted power was sampled. The following table shows the conducted RF power sampled before and after each of the four sets of data used for the worst case SAR in this report.

Scan		Power Readings (dBm)		D	Battery #
Type	Height (mm)	Before	After	(dB)	
Zoom	2.5	30.05	29.78	0.27	3
Zoom	7.5	30.05	29.78	0.27	3
Zoom	12.5	30.05	29.78	0.27	3
Depth	2.5 – 22.5	29.91	29.92	0.01	4

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. SAR is expressed as RF power per kilogram of mass, averaged within 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 Wavetek communications test instrument. A SIMM card was located in the DUI to enable the interaction between the Wavetek communications test instrument and the DUI. The Wavetek communications test instrument then sent out a command for the DUI to transmit at full power at the specified frequency.

3) Figures 3, 5, and 7 in Appendix A show contour plots of the SAR measurements for the DUI (channel 810, 1909.8 MHz for body, hand, and bystander exposure) It also shows an overlay of the DUI's outlines, superimposed onto the contour plots.

   A different presentation of the same data is shown in Appendix A Figures 4, 6, and 8. These are surface plots, 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 on the keyboard up, keyboard down, and left sides of the DUI. The DUI was operating at maximum output power 30 dBm at a 12.5 % duty factor. The peak single point SAR for the scans were:

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	DUI side	Holster	Headset	Channel			Peak Local SAR (W/kg)
				L/M/H	#	Freq (MHz)	
TYPE OF EXPOSURE	Keyboard up side	Yes	No	Middle	661	1880	0.21
	Keyboard up side	Yes	No	Low	512	1850.2	0.21
	Keyboard up side	Yes	No	High	810	1909.8	0.25
	Keyboard up side	Yes	HDW-03458-00	High	810	1909.8	0.23
	Keyboard up side	Yes	HDW-03458-01	High	810	1909.8	0.25
	Keyboard down side	NO	No	Middle	661	1880	2.01
	Keyboard down side	NO	No	Low	512	1850.2	1.47
	Keyboard down side	NO	No	High	810	1909.8	2.22
	Keyboard down side	NO	HDW-03458-00	High	810	1909.8	2.29
	Keyboard down side	NO	HDW-03458-01	High	810	1909.8	2.36
	Left side	NO	No	Middle	661	1880	5.28
	Left side	NO	No	Low	512	1850.2	3.79
	Left side	NO	No	High	810	1909.8	5.79
	Left side	NO	HDW-03458-00	High	810	1909.8	5.50
	Left side	NO	HDW-03458-01	High	810	1909.8	5.36

Table 2. SAR Measurements

7. USER'S HAND EXPOSURE

All subsequent testing for user's hand exposure was performed on channel 810 (1909.8 MHz), with the left side of the DUI facing up against the bottom of the phantom. This relates to the position and frequency found to provide the maximum measured SAR value.

1) Channel 810 (1909.8 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 1.84 W/kg.

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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 (-0.122± 0.004) 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, 3.31 W/kg.**

8. BODY EXPOSURE

All subsequent testing for body exposure was performed on channel 810 (1909.8 MHz), with the keyboard up side of the DUI facing up against the bottom of the phantom and the DUI inserted into the holster with the HDW03458-01 headset attached. This relates to the position and frequency found to provide the maximum measured SAR value.

1) Channel 810 (1909.8 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 0.16 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 (-0.094 ±0.001) 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, 0.25 W/kg**.

9. BYSTANDER EXPOSURE

All subsequent testing for bystander exposure was performed on channel 810 (1909.8 MHz), with the backside of the DUI facing up against the bottom of the phantom and the HDW03458-01 headset attached. This relates to the position and frequency found to provide the maximum measured SAR value.

1) Channel 810 (1909.8 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 1.25 W/kg.

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, 2.11 W/kg**.

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4) Wide area scans were then performed for channel 810 (high, 1909.8 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)**
0	2.37
10	0.39
20	0.14
30	0.04

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.

If the data from table 3 is fitted to an exponential equation we get:

$$\text{Peak Local SAR} = 2.8648\, e^{*-0.1371\,(\text{separation})}$$

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

$$\text{Maximum 1g SAR} = k\, e^{*-0.1371\,(\text{separation})}$$

Using this equation with the previous data:

Maximum 1g SAR at the surface = 2.11 W/kg
Tissue to DUI separation = 2 mm,

Results in k = 2.78 which corresponds to the maximum 1g SAR when the separation is 0 mm. A conservative maximum 1g SAR of 1.24 W/kg (1.6 W/kg reduced by our measurement uncertainty, 22 % K=2) would occur for a separation of 5.9 mm from the antenna of the DUI.

At a standard separation distance of 4 cm, the maximum 1g SAR would be 0.01W/kg.

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10. CONCLUSIONS

The maximum Specific Absorption Rate (SAR) for the hand averaged over 10 grams, determined at 1909.8 MHz (channel 810) of the RIM BlackBerry Wireless Handheld, is **3.31W/kg**. The overall margin of uncertainty for this measurement is ± 22 % K=2 (Appendix B). The SAR limit given in the FCC 96-326 Safety Guideline is 4 W/kg for hand exposure to the general population.

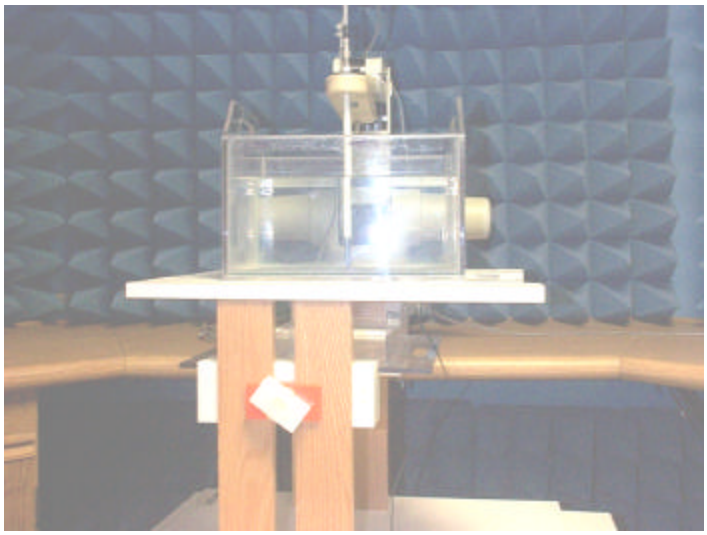
For a user exposing a part of the body other than the extremities (body), the maximum Specific Absorption Rate (SAR) averaged over 1gram is **0.25 W/kg** while the DUI is attached to the holster. The SAR limit given in the FCC 96-326 Safety Guideline is 1.6 W/kg for uncontrolled partial body exposure of the general population. The overall margin of uncertainty for this measurement is 22% K=2 (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 bystander exposing a part of the body other than the extremities, at a separation distance of 4 cm from the device, the maximum Specific Absorption Rate (SAR) averaged over 1g is **0.01 W/kg**. 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 minus the measurement uncertainty (1.6 - 22% (K=2) = **1.24 W/kg**) is not exceeded is 5.9 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 SEPT 13, 2001

APPENDIX A. Measurement Setup, Tissue Properties and SAR Graphs



Figure's 1&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.

The recipe used for the Liquid tissue was taken from OET Bulletin 65, Edition 01-01, presented on page 38 for body.

	APREL	Target Values	Δ (%)
Dielectric constant, ε_r	50.83	53.3	-4.6 %
Conductivity, σ [S/m]	1.51	1.52	-0.4 %
Tissue Conversion Factor, γ	4.5	-	-

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

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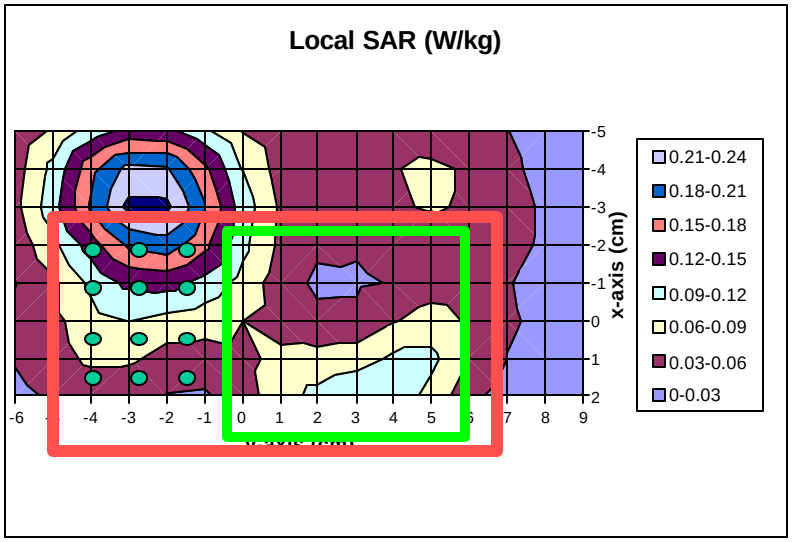

Figure 3. Contour Plot of the Area Scan 2.5mm Above Phantom Surface (Body Exposure)

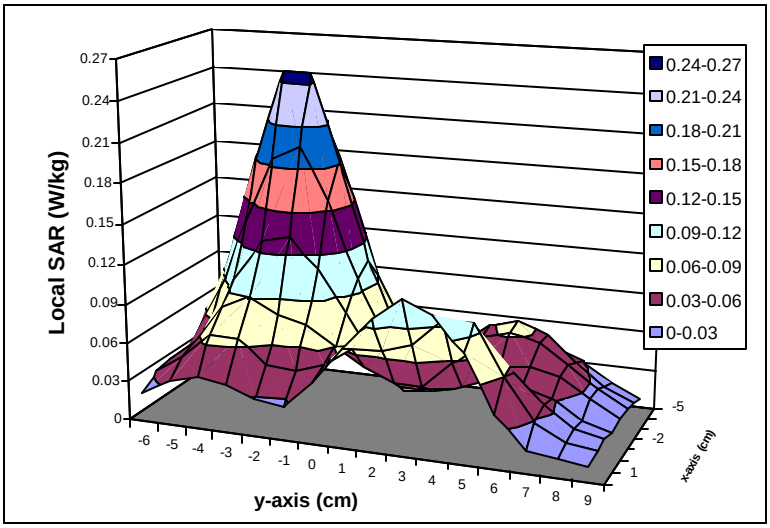

Figure 4. Surface Plot of the Area Scan 2.5mm Above Phantom Surface (Body Exposure)

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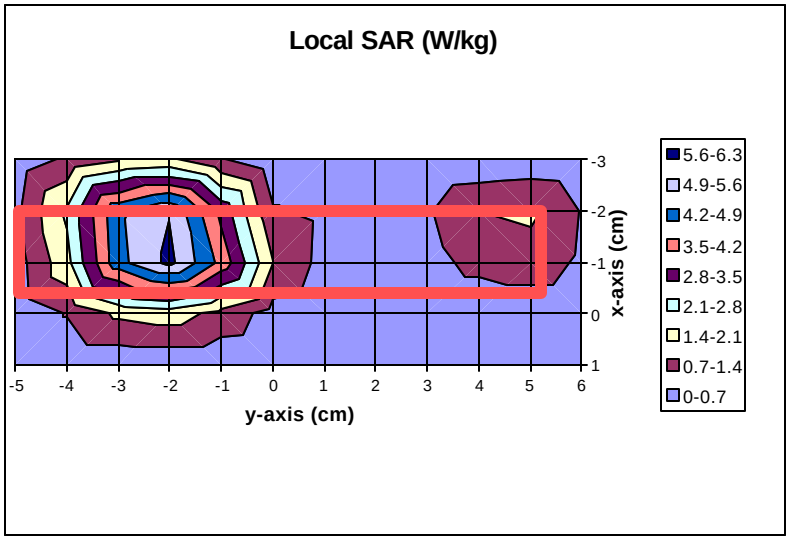

Figure 5. Contour Plot of the Area Scan 2.5mm Above Phantom Surface Hand Exposure (View screen is facing down on right side)

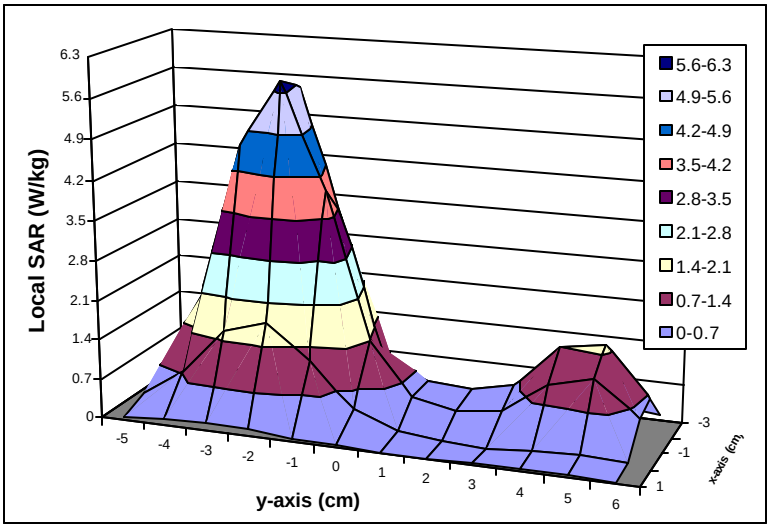

Figure 6. Surface Plot of the Area Scan 2.5mm Above Phantom Surface (Hand Exposure)

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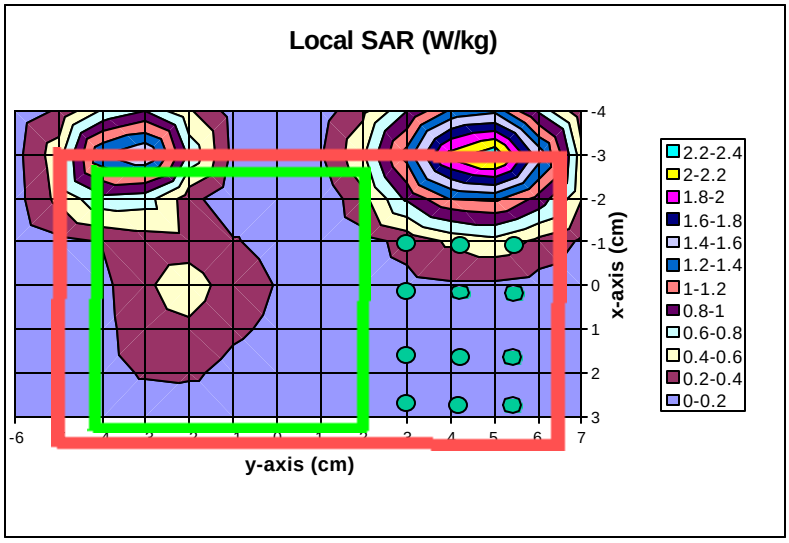

Figure 7. Contour Plot of the Area Scan 2.5mm Above Phantom Surface (Bystander Exposure)

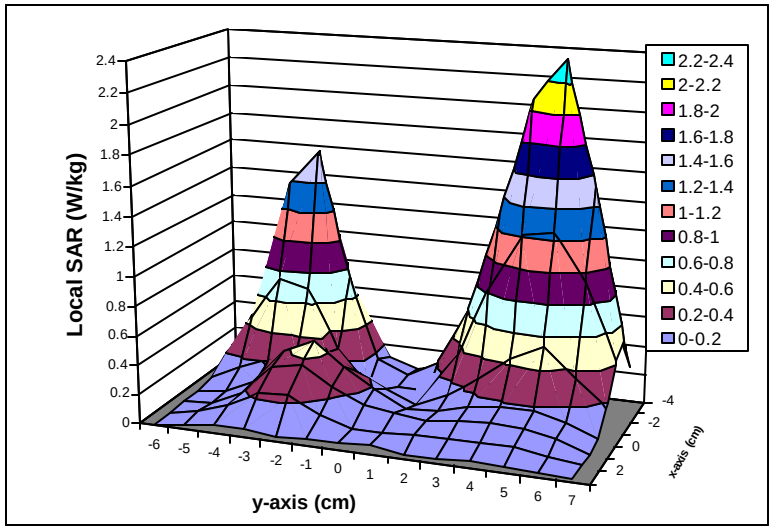

Figure 8. Surface Plot of the Area Scan 2.5mm Above Phantom Surface (Bystander Exposure)

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APPENDIX B. Uncertainty Budget

Calculated Uncertainties			
Type of Uncertainty		**Specific to**	**Uncertainty**
Power variation due to battery condition		DUI	0.8%
Extrapolation due to curve fit of SAR vs depth		Setup	3.0%
Extrapolation due to depth measurement		Setup	4.8%
Conductivity		Setup	0.4%
Permitivity		Setup	4.6%
Probe Calibration		Setup	7.0%
Probe Positioning		Setup	2.0%
Probe Isotropicity		Setup	3.5%
Other Setup Uncertainty (Ambient,,,)		Setup	3.0%
	22%	**Expanded Uncertainty K=2**	

Table 5. Uncertainty Budget

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APPENDIX C. Dipole Validation Scan on a Flat Phantom

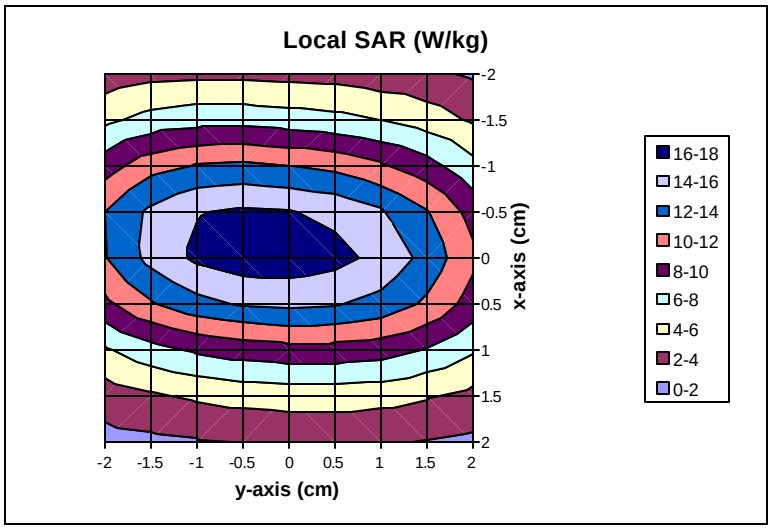

Figure 9. Surface Plot for Validation Dipole (Zoom Scan 2.5mm Above Phantom)

Frequency (MHz)	1 Gram SAR (W/Kg)	Target Value (W/Kg)	Delta (%)	Input Power to Dipole (dBm)	Distance from Dipole to Tissue (mm)
1900	16.38	15.02	8.30%	25.78	10

Figure 10. Validation Dipole Under Phantom

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APPENDIX D. Probe Calibration

NCL CALIBRATION LABORATORIES

Calibration File No.: 301485

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.: 154

Customer: APREL
Asset No.:301485

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

Cal. Date: 12 September, 2001 Cal. Due Date: 11 September, 2002
Remarks: None

Calibrated By: _____

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