CERTIFICATION REPORT

Subject: **Specific Absorption Rate (SAR) Experimental Analysis for the Bystander**

Product: Wireless Point of Sale Terminal with a Novatel NRM-6832 Expedite Wireless IP Modem

Model: Nurit 3010, CDPD

Client: Lipman USA Inc.

Address: 50 Gordon Dr.
Syosset, NY 11791 USA

Project #: LPMB-Nurit 3010 CDPD-3507B

Prepared by APREL Laboratories
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Engineering Technical Staff

Submitted by ______________________________ Date: _________________
Dr. Paul G. Cardinal
Director, Laboratories

Approved by ______________________________ Date: _________________
Dr. Jacek J. Wojcik, P. Eng.

FCC ID:	O2SNURIT3010C
Applicant:	Lipman USA Inc.
Equipment:	Wireless Point of Sale Terminal with a Novatel NRM-6832 Expedite Wireless IP Modem
Model:	Nurit 3010, CDPD
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 a Lipman Nurit 3010 wireless point of sale terminal (POS) which incorporates a Novatel NRM-6832 Expedite Wireless IP Modem. This report is supplementary to the engineering evaluation for user's hand exposure, report LPMB-Nurit 3010 CDPD-3507U. The measurements were carried out in accordance with FCC 96-326. The POS was evaluated at its nominal maximum power level (power level 2) with 100% duty factor.

For the SAR Analysis for the Bystander, the Lipman Nurit 3010 wireless point of sale terminal (POS) was tested at low, middle and high channels with the antenna oriented in two positions (at the antenna side of the terminal, 0^o, and pointing straight out, 180^o) as well as the keyboard, battery, antenna, right and top sides. The maximum SAR (6.18 W/kg) was found to coincide with the peak performance RF output power of channel 400 (middle, 837 MHz), with the antenna side of the DUI facing up against the bottom of the phantom and the antenna pointing straight out. Test data and graphs are presented in this report.

Based on the test results and on how the device will be used, with the duty factor of the POS intrinsically limited to less than 7% (see Appendix F), it is certified that the product meets the requirements as set forth in the above specifications, for an uncontrolled RF partial body 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) of a sample of a Lipman Nurit 3010 wireless point of sale terminal (POS), which incorporates a Novatel NRM-6832 Expedite Wireless IP Modem. 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 C95.1-1992, 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 97-01), "Evaluating Compliance with FCC Guidelines for Human Exposure to Radio Frequency Electromagnetic Fields".

3. EQUIPMENT UNDER INVESTIGATION

- Lipman Nurit 3010 wireless point of sale terminal (POS), s/n 86U04 5907107, received on 24 July 2000.

The POS will be called DUI (Device Under Investigation) in the following.

The DUI is intended to be used in the hand and may be carried in a case that hooks onto a belt. The antenna is a 5in centre-fed half-wavelengh dipole with a gain of 1 dB.

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A photograph of the DUI can be found in Appendix B. See the manufacturer's submission documentation for drawings and more design details.

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
- APREL F-1, flat manikin, s/n 001
- Tissue Recipe and Calibration Requirements, APREL procedure SSI/DRB-TP-D01-033
- HP 438A power meter, s/n 2502A01684, Asset # 301417
- HP 8482A power sensor, s/n 2652A1512B, Asset # 301418
- Toshiba Laptop computer Satellite ProTM 400S (to setup device via RS232 port)

5. TEST METHODOLOGY

1. The test methodology utilised 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 D contains information about the recipe and properties of the simulated tissue used for these measurements.
5. The liquid is contained in a manikin simulating a portion of the human body.

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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.

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 of the transmitter is sampled before and after each SAR run. In the case of this DUI, with does not have an externally accessible feedpoint, the radiated power was sampled. A power meter was connected to an antenna adjacent to a fixture to hold the transmitter in a reproducible position. The following table shows the radiated RF power sampled before and after each of the six sets of data used for the worst case SAR in this report.

Table 1. Sampled Radiated RF Power

Scan		**Relative Power Reading**	**Battery #**
Type	**Height (mm)**	**(dB)**	
Area	2.5	-0.3	10
Area	12.5	-0.2	-
Zoom	2.5	-	-
Zoom	7.5	-	-
Zoom	12.5	-0.5	-
Depth	2.5 – 12.5	-0.5	-

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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 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 via communications software supplied by the radio manufacturer running on a PC to control the channel and operating power (nominally power level 2).

3) Figure 3 in Appendix A shows a contour plot of the SAR measurements for the DUI (channel 400, middle, 837 MHz, antenna side, antenna pointing straight out, power level 2). The presented values were taken 2.5mm into the simulated tissue from the flat phantom's solid inner surface. Figures 1 and 2 show the flat phantom used in the measurements. A grid is shown inside the phantom indicating the orientation of the x-y grid used, with the co-ordinates (0,0) on the top left (orange dot). The x-axis is positive towards the bottom and the y-axis is positive towards the right.For this side of the DUI, the bottom was aligned with y = 1, and the antenna, with x = 2.

   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 visualisation aid.

   Similar data was obtained 12.5 mm into the simulated tissue. These measurements are presented as a contour plot in Appendix A Figure 5 and surface plot in Figure 6.

   Figure 10 in Appendix A shows an overlay of the DUI’s outlines, superimposed onto the contour plot previously shown as Figure 3.

   Figures 3 through 6 in Appendix A show that there is a dominant peak, in the contour plots, that diminishes in magnitude with depth into the tissue simulation.

4) For the SAR Analysis for the Bystander (Table 2), wide area scans were performed for the low (991, 824 MHz), middle (400, 837 MHz) and high (799, 849 MHz) channels. The antenna was also oriented in two positions: stowed (0^o) and pointing straight out (180^o), with the keyboard, battery, antenna, right and

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top sides of the DUI facing up against the bottom of the phantom. The DUI was operating at maximum output power (power level 2) and 100% duty factor. The peak single point SAR for the scans were:

Table 2. SAR Measurements for the Bystander

DUI side	Antenna position	Channel			Peak SAR (W/kg)
		L/M/H	#	Freq (MHz)	
keyboard	extended (180^o)	low	991	824	0.31
battery side	extended (180^o)	low	991	824	0.28
antenna side	extended (180^o)	low	991	824	5.09
right side	extended (180^o)	low	991	824	0.63
antenna	**extended (180^o)**	**middle**	**400**	**837**	**5.89**
antenna side	extended (180^o)	high	799	849	5.83
antenna side	stowed (0^o)	low	991	824	5.47
antenna	**stowed (0^o)**	**middle**	**400**	**837**	**6.70**
antenna side	stowed (0^o)	high	799	849	5.43
top side	stowed (0^o)	middle	400	837	0.12
battery side with carrier	stowed (0^o)	middle	400	837	0.26

All subsequent testing for bystander exposure (or parts of the user other than extremities) was performed on channel 400 (middle, 837 MHz), with the antenna pointing straight out (180^o) and the antenna side of the DUI against the phantom.

5) Wide area scans were then performed on channel 400 (middle, 837 MHz) versus separation at 100% duty factor. The peak single point SAR for the scans were:

Table 3. SAR versus DUI Separation

Channel			DUI to phantom's inner surface separation (mm)	Peak SAR (W/kg)
L/M/H	#	Freq (MHz)		
middle	400	837	13	2.33
			23	0.95
			33	0.45

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6) Channel 400 (middle, 837 MHz) was then explored on a refined 5 mm grid in three dimensions. Figures 7, 8 and 9 show the measurements made at 2.5, 7.5 and 12.5 mm, respectively. 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 4.54 W/kg.

7) 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 few (x,y) co-ordinates within the refined grid as a function of depth, with 2.5 mm spacing. Figure 11 in Appendix A shows the data gathered and the exponential curves fit to them. The average exponential coefficient was determined to be (-0.064 ± 0.007) / mm.

8) 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**, 6.18 W/kg.

7. SEPARATION AT 100% DF

The measurements of highest local SAR versus separation of the DUI from the bottom of the phantom (Section 6.2.5) will enable the maximum 1g SAR measured for a separation of 3 mm (previous section) to be interpolated for other separations.

If the data for Figure 11 is fitted to an exponential equation we get:

$$\text{Peak Local SAR} = 7.874\, e^{-0.0888 * (\text{separation})}$$

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

$$\text{Maximum 1g SAR} = k\, e^{-0.0888 * (\text{separation})}$$

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Using this equation with the previous section's data:

Maximum 1g SAR at the surface = 6.18 W/kg
Tissue to DUI separation = 3 mm,

results in a k = 8.064 W/kg, which corresponds to the maximum 1g SAR when the separation is 0 mm. A conservative maximum 1g SAR of 1.18 W/kg (1.6 W/kg reduced by our measurement uncertainty) would occur for a separation of 21.6 mm.

At a standard separation distance of 4 cm the maximum 1g SAR would be 0.23 W/kg.

8. DUTY FACTORS

The manufacturer's software limits the operation further to 6.9% (see Appendix F).

The test software supplied by Novatel Wireless permitted the SAR testing to be performed with a duty factor of 100%. However, testing with a duty factor of 6.9% was not possible.

Consequently, the maximum 1g SAR for the end product, with a maximum 6.9% duty factor, has to be estimated using proportional scaling with respect to the duty factor. The **maximum 1g SAR value at the surface averaged over 1 gram is** 0.43 W/kg.

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9. CONCLUSIONS

The maximum Specific Absorption Rate (SAR) averaged over 1 gram, determined at 837 MHz (channel 400, middle, antenna side, antenna pointing straight out, power level 2) of the Lipman Nurit 3010 wireless point of sale terminal (POS), which incorporates a Novatel NRM-6832 Expedite Wireless IP Modem operating with a 100% duty factor, is 6.18 W/kg. The overall margin of uncertainty for this measurement is ±26.1 % (Appendix C). The SAR limit given in the FCC 96-326 safety guideline for uncontrolled RF partial body exposure (1.6 W/kg reduced by the measurement uncertainty) is 1.18 W/kg.

Since the POS duty factor is limited to 6.9% by the manufacture's (Lipman, see Appendix F) software, the maximum SAR averaged over 1 gram at this duty factor would be 0.43 W/kg.

Considering the above, this unit as tested, and as it will be marketed, with a duty factor of less than 7%, is found to be compliant with this requirement.

Telecommunications Approval Board - Spectrum Sciences Institute - SAR Certified APREL Laboratories A084 - Nurit 3010C

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APPENDIX A. Measurement Setup and SAR Graphs

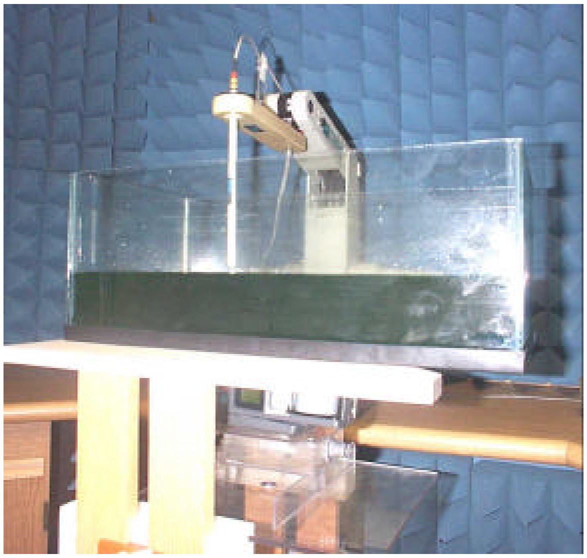

Figure 1. Setup and Close up of the Setup

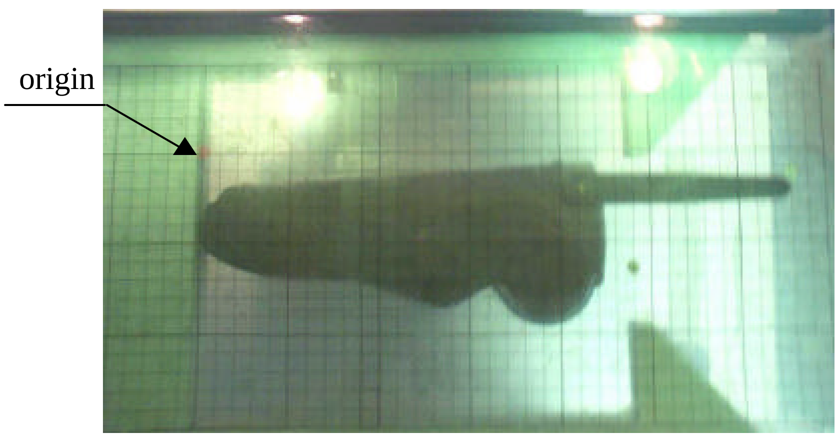

Figure 2. Grid inside the Phantom

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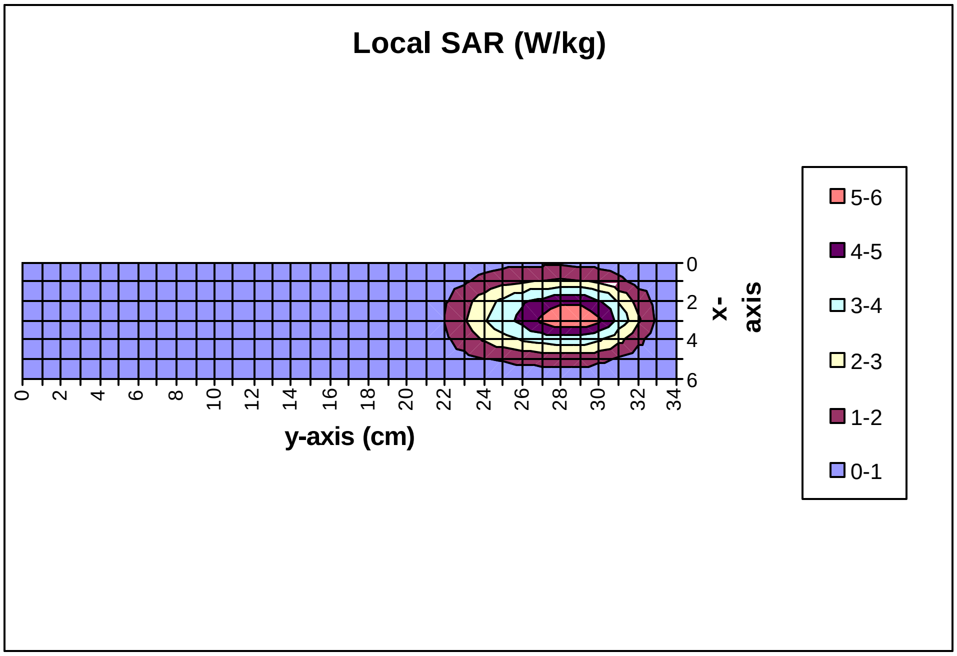

Figure 3. Contour Plot of the Area Scan 2.5mm Above Phantom Surface

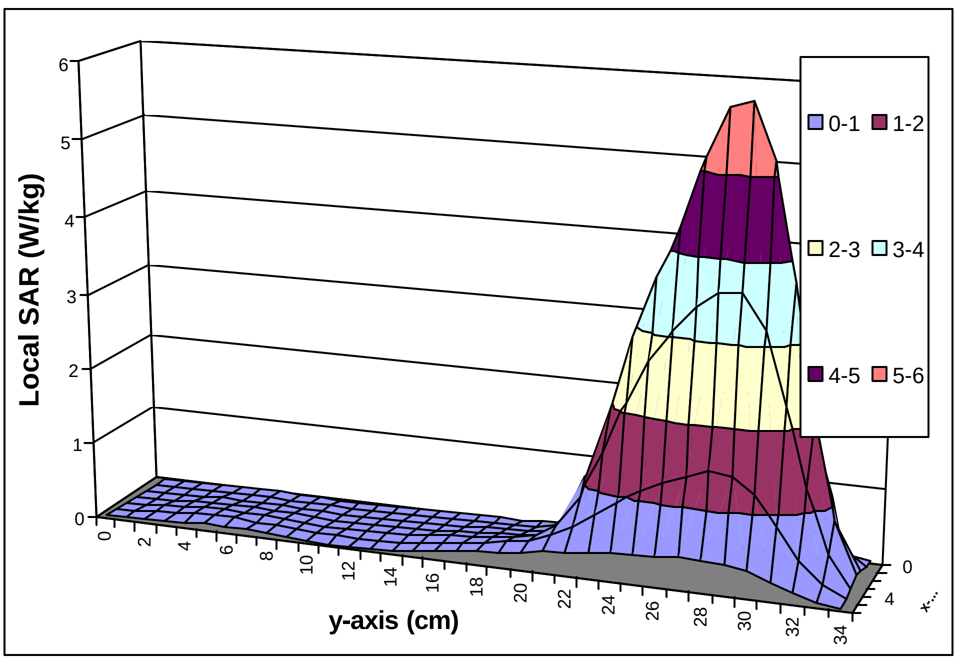

Figure 4. Surface Plot of the Area Scan 2.5mm Above Phantom Surface

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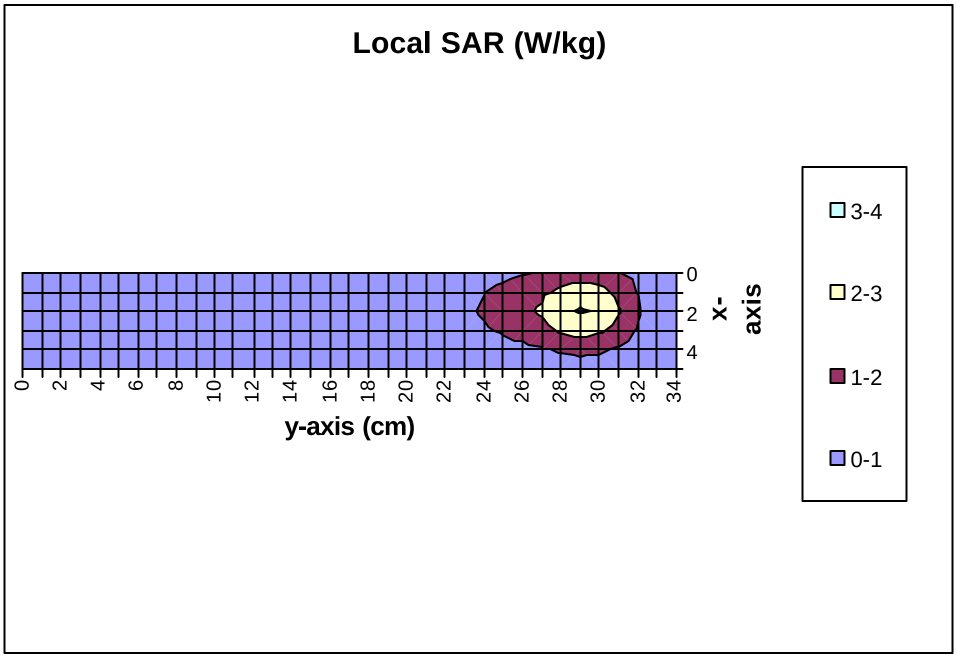

Figure 5. Contour Plot of the Area Scan 12.5mm Above Phantom Surface

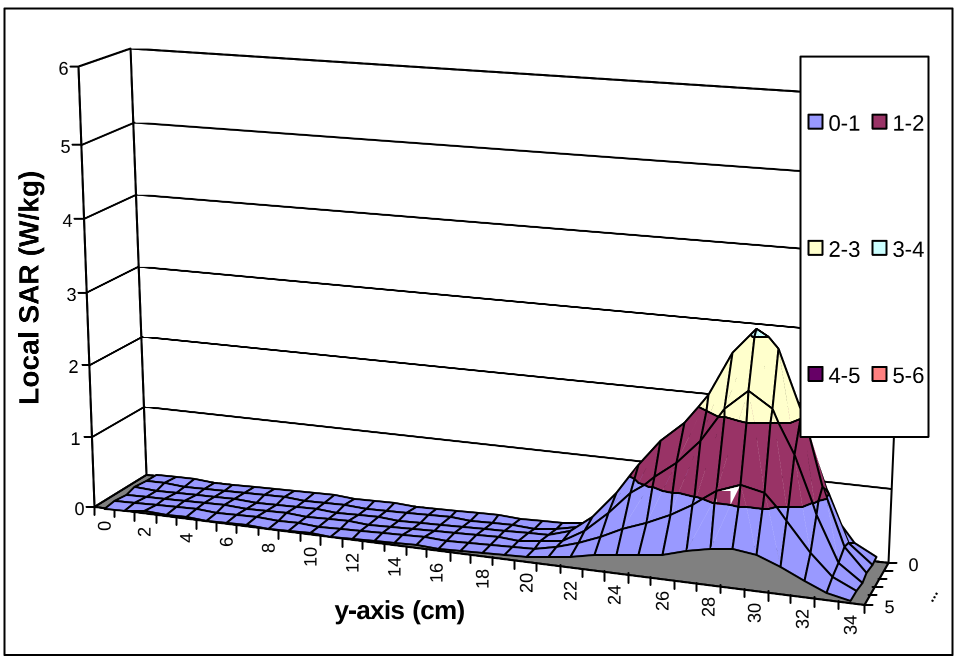

Figure 6. Surface Plot of the Area Scan 12.5mm Above Phantom Surface

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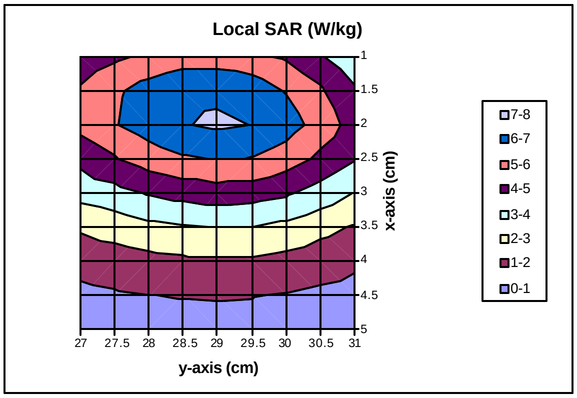

Figure 7. Zoom Scan 2.5mm Above Phantom Surface

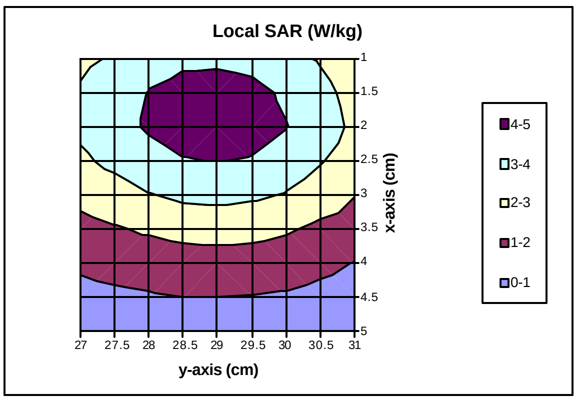

Figure 8. Zoom Scan 7.5mm Above Phantom Surface

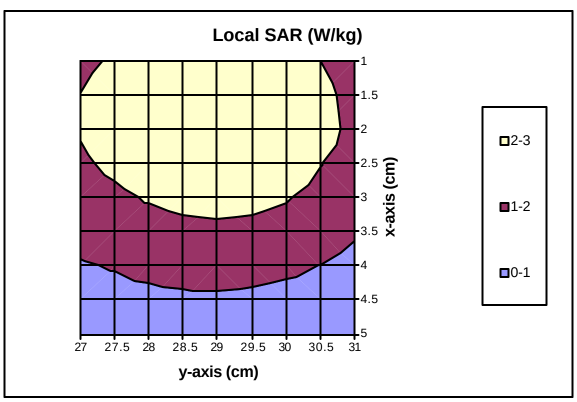

Figure 9. Zoom Scan 12.5mm Above Phantom Surface

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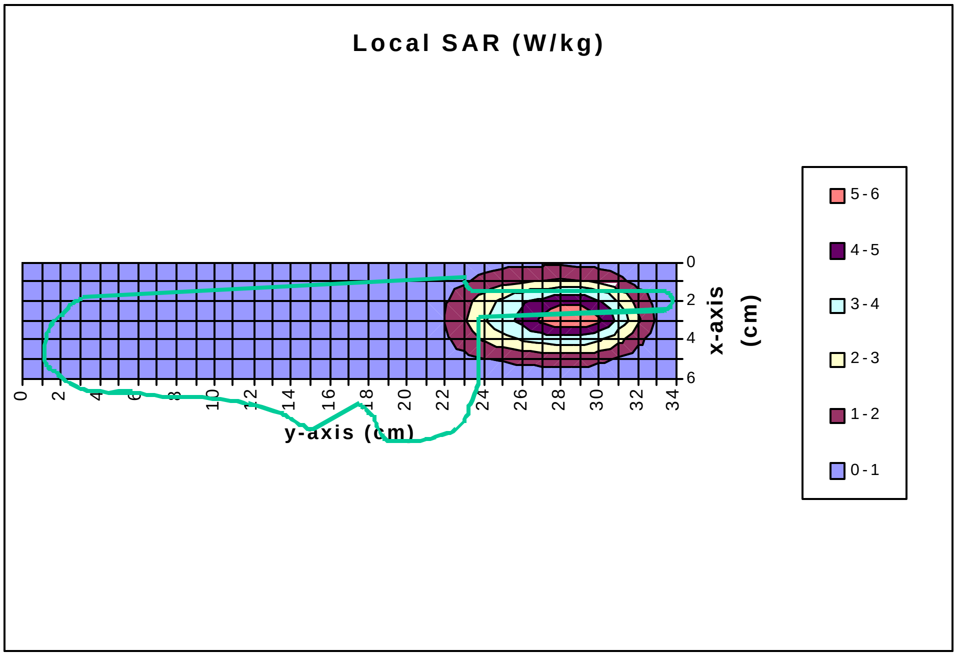

Figure 10. Overlay of the DUI's Outlines Superimposed onto the Area Scan

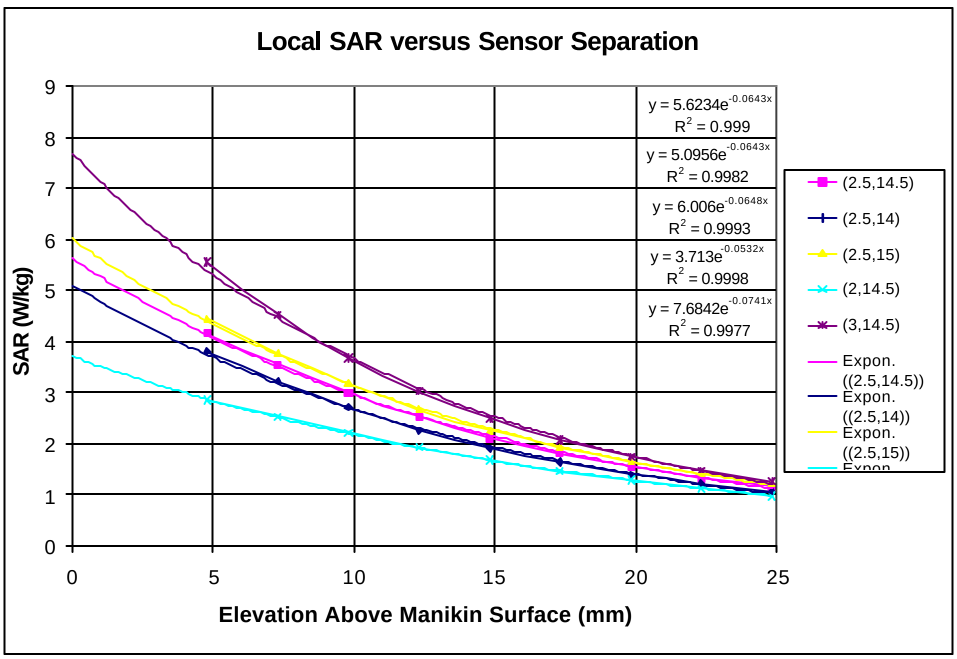

Figure 11. Local SAR versus Sensor Separation

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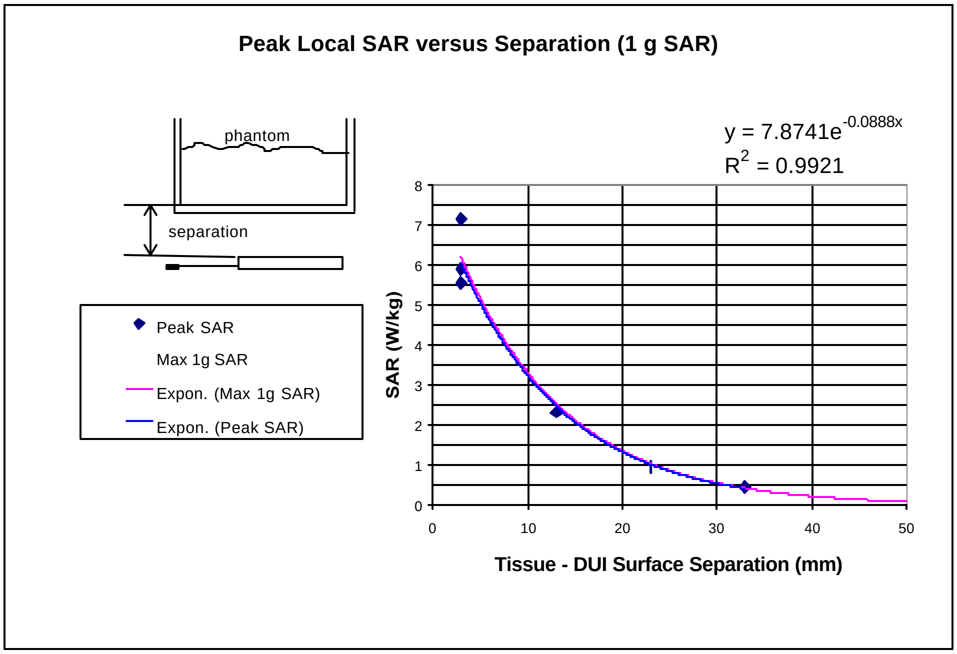

Figure 12. Peak Local SAR versus Separation (1g SAR)

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APPENDIX B. Manufacturer's Specifications

Antenna stowed (0^o position)

Antenna extended (180^o position)

The antenna is a 5in centre-fed half-wavelengh dipole with a gain of 1 dB

(See manufacturer's submission documentation for drawings and more design details)

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APPENDIX C. Uncertainty Budget

Uncertainties Contributing to the Overall Uncertainty

Type of Uncertainty	Specific to	Uncertainty	
Power variation due to battery condition	phone	5.9%	
Extrapolation due to curve fit of SAR vs depth	phone	23.0%	
Extrapolation due to depth measurement	setup	3.2%	
Conductivity	setup	6.0%	
Density	setup	2.6%	
Tissue enhancement factor	setup	7.0%	
Voltage measurement	setup	1.5%	
Probe sensitivity factor	setup	3.5%	
		26.1%	**RSS**

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APPENDIX D. Simulated Muscle Tissue Material and Calibration Technique

The mixture used was based on that presented SSI/DRB-TP-D01-033, “Tissue Recipe and Calibration Requirements”.

De-ionised water	52.8%
Sugar	45.3%
Salt	1.5%
HEC	0.3 %
Bactericide	0.1 %

Mass density, ρ 1.30 g/ml
(The density used to determine SAR from the measurements was the recommended 1040 kg/m^3 found in Appendix C of Supplement C to OET Bulletin 65, Edition 97-01).

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

The dielectric properties at 835 MHz are:

	APREL	OET 65 Supplement	Δ (%) (OET)
Dielectric constant, ε_r	58.6	56.11	4.4%
Conductivity, σ [S/m]	1.09	0.946	15.3%
Tissue Conversion Factor, γ	7.8	-	-

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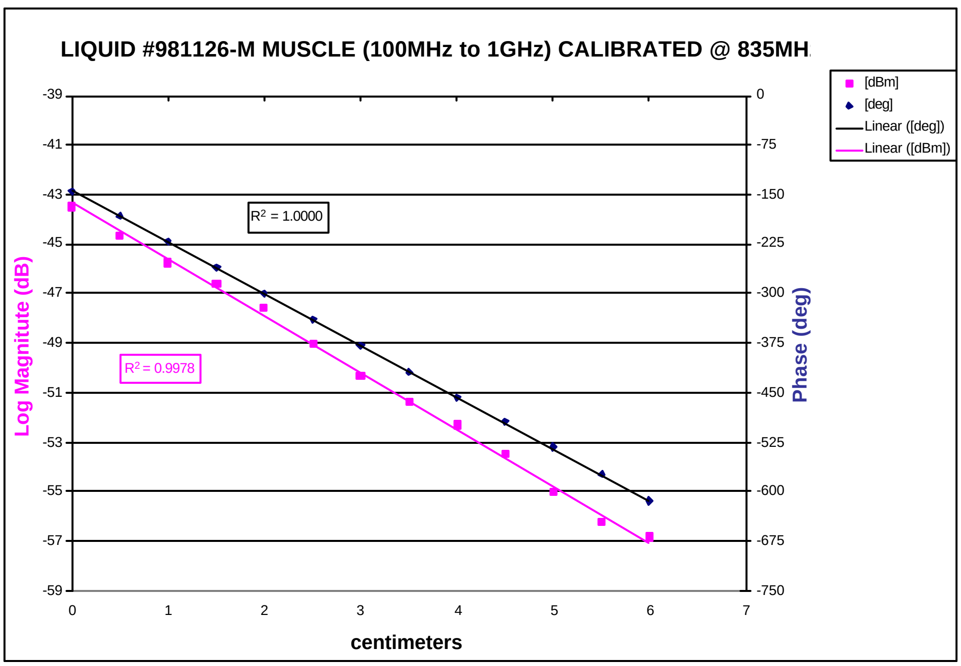
SIMULATION FLUID #	981126-M
CALIBRATION DATE	31-Jul-00
CALIBRATED BY	Ken O'Donnell
Frequency Range	100MHz-1GHz
Frequency Calibrated	835 MHz
Tissue Type	Muscle

Position	Amplitude	Phase	
[cm]	[dBm]	[deg]	[deg]
0	-43.48	-143.7	-143.7
0.5	-44.66	177.8	-182.2
1	-45.77	138.3	-221.7
1.5	-46.58	99.6	-260.4
2	-47.61	61.03	-298.97
2.5	-48.99	21.06	-338.94
3	-50.3	-18.14	-378.14
3.5	-51.34	-58.06	-418.06
4	-52.27	-96.03	-456.03
4.5	-53.47	-134.13	-494.13
5	-55.04	-171.99	-531.99
5.5	-56.22	145.77	-574.23
6	-56.8	105.82	-614.18
ΔdB_1	-6.82	Δdeg_1	-234.44
ΔdB_2	-6.68	Δdeg_2	-235.86
ΔdB_3	-6.5	Δdeg_3	-234.33
ΔdB_4	-6.89	Δdeg_4	-233.73
ΔdB_5	-7.43	Δdeg_5	-233.02
ΔdB_6	-7.23	Δdeg_6	-235.29
ΔdB_7	-6.5	Δdeg_7	-236.04
ΔdB_{AVG} [dB]	-6.86	Δdeg_{AVG} [deg]	-234.6728571
dB_{AVG} (α_{AVG}) [dB/cm]	-2.29	deg_{AVG} (β_{AVG}) [deg/cm]	-78.22428571
(α_{AVG}) [NP/cm]	-0.263426699	(β_{AVG}) [rad/cm]	-1.365271341
f [Hz]	8.35E+08		
μ [H/cm]	1.25664E-08		
ε_0 [F/cm]	8.854E-14		
ε_r	**58.6**		
σ effective	**1.09**		



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835 MHz Data (Heike & Tony) Muscle with E-115

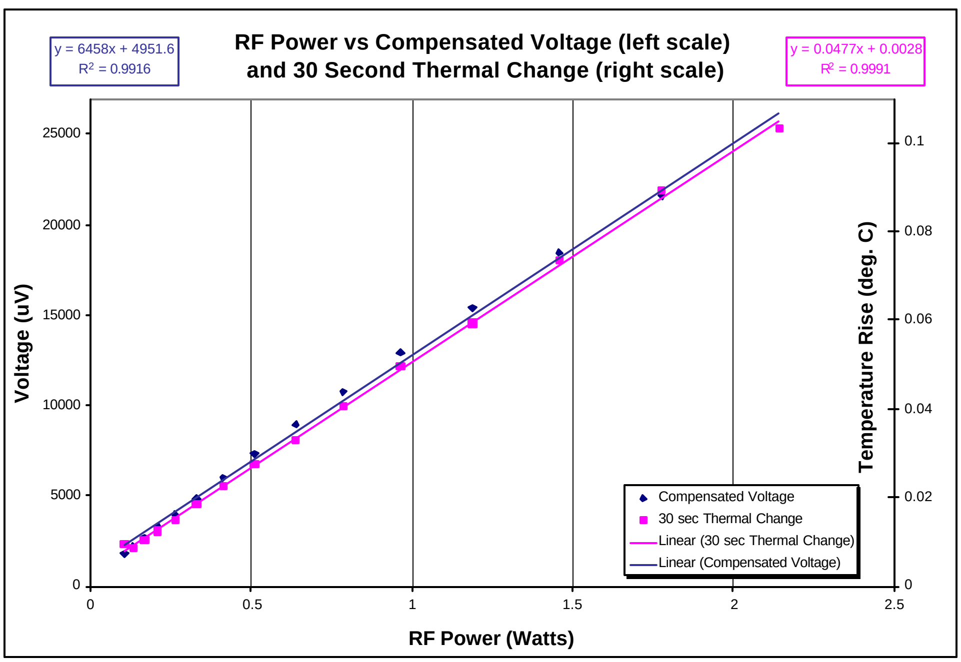
						delta T	Sum		Thermal
RF Power			Ch0	Ch1	Ch2	(30 sec)	Vi/Ei		SAR
W	dBm	R&S	uV	uV	uV	deg. C			W/kg
0.10666	20.28	-25.61	391	1196	2954	0.0093	1792.736		0.86
0.133352	21.25	-24.64	439	1440	3638	0.0086	2177.984		0.80
0.169044	22.28	-23.61	513	1782	4517	0.0102	2689.029		0.94
0.210863	23.24	-22.65	586	2173	5542	0.0125	3276.59		1.16
0.263027	24.2	-21.69	684	2661	6787	0.0147	3999.08		1.36
0.328095	25.16	-20.73	830	3247	8276	0.0185	4875.658		1.71
0.412098	26.15	-19.74	1001	4028	10205	0.0227	6012.429		2.10
0.509331	27.07	-18.82	1196	4932	12402	0.0273	7312.846		2.53
0.639735	28.06	-17.83	1440	6079	15137	0.0331	8940.589		3.06
0.787046	28.96	-16.93	1733	7397	18188	0.0405	10779.67		3.75
0.966051	29.85	-16.04	2100	8960	21680	0.0495	12918.42		4.58
1.188502	30.75	-15.14	2515	10815	25806	0.0592	15441.16		5.48
1.458814	31.64	-14.25	3052	13086	30640	0.0736	18455.06		6.81
1.778279	32.5	-13.39	3662	15503	35718	0.0893	21651.69		8.26
2.142891	33.31	-12.58	4395	18335	41528	0.1031	25349.01		9.54

Directional Coupler factor	25.89	dB (Asset 100251 cal file data)
Additional inline attenuation	20	dB

Sensitivity (e)	1.658	1.721	1.68	- Sensor Sensitivity in mV/ (mW/cm^2): 835 MHz cal
η = 1.50 e	2.487	2.5815	2.52	

Density	1.3	g/cm^3	1300	kg/m^3	
Conductivity	10.8	mS/cm	1.08	S/m	
Heat Capacity (c)	2.775	J/C/g	2775	J/C/kg	
Exposure Time	30	seconds	30	seconds	
Slope of Measure Voltage (m_V)	11722.36	uV/W	0.011722	V/W	
- standard error or m_V	182.1283	uV/W	0.000182	V/W	1.6%
Slope of Measure Temp Change (m_T)	0.047724	C/W	0.047724	C/W	
- standard error or m_T	0.000398	C/W	0.000398	C/W	0.8%

Tissue Conversion Factor (γ)	**7.8**



51 Spectrum Way
Nepean, Ontario, K2R 1E6
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e-mail: info@aprel.com

APPENDIX E. Validation Scans on a Flat Phantom

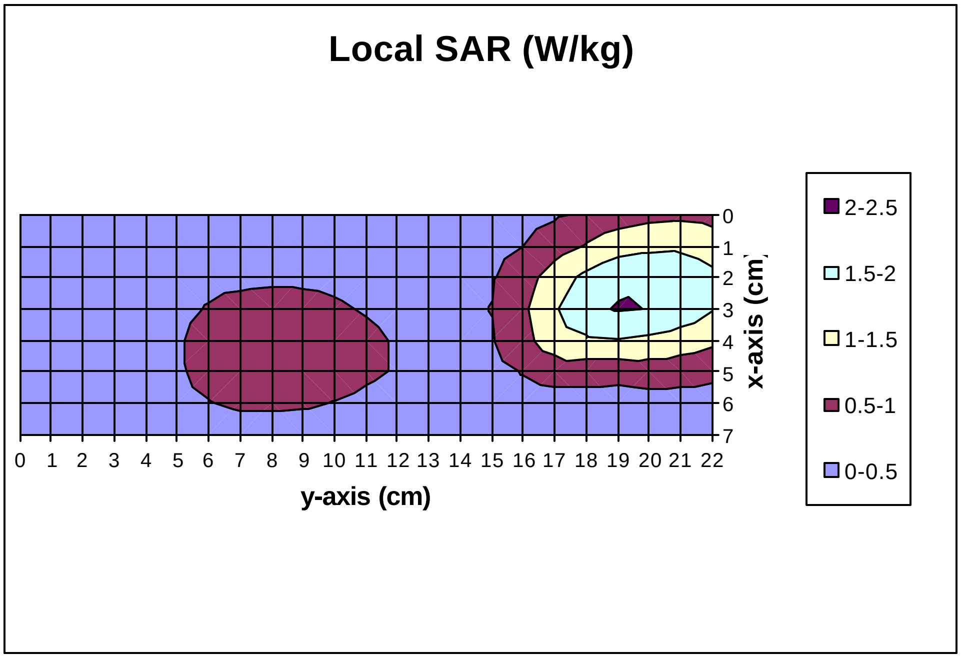

Figure 13. Contour Plot of the Reference Area Scan 2.5mm Above Phantom

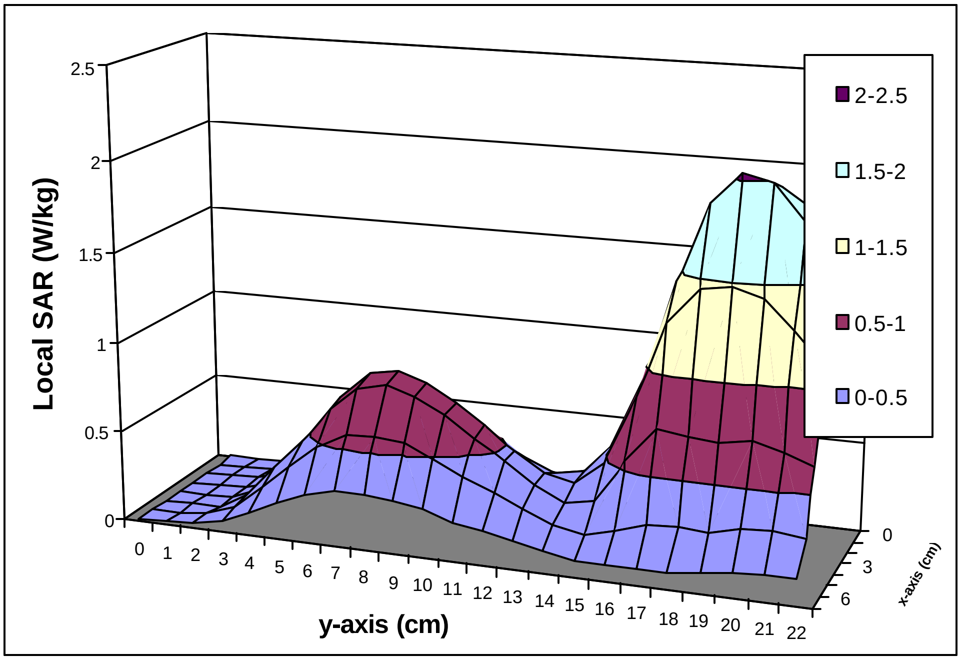

Figure 14. Surface Plot of the Reference Area Scan 2.5mm Above Phantom

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APPENDIX F. Duty Factor Limitation of Lipman Nurit 3010 POS

Lip LIPMAN U.S.A. Inc. *The Ideal Solution®*

50 Gordon Drive
Syosset, New York 11791

September 14, 2000

Federal Communications Commision
Equipment Authorization Branch
7435 Oakland Mills Road
Columbia, MD 21406

To Whom It May Concern:
A typical authorization financial transaction in the POS industry consists of approximately 100 bytes of request that is transmitted by the POS device and 50 bytes of response received by the POS device. The fastest transaction time that has been achieved on the CDPD network was 3 seconds. A regular transaction time is about 6 seconds and it takes another 10 seconds before the next transaction can be run after swiping the next card and entering the amount.

To be conservative, we will still assume that we can transmit one transaction per 3 sec continuously. According to Novatel Wireless, CDPD transmits at a maximum of 19200 bits per second, which would be 57600 bits in 3 seconds. The maximum duty factor is therefore 100 bytes * 8 bits/byte / 57600 = 0.0139 or 1.4%.

Some of the financial institutions may require the terminal to submit all transactions as a batch at the end of each day. During this batch upload terminal uploads all necessary transactions to the host computer.

The current maximum byte stream transmitted for a transaction in a batch upload is 250.

Assuming the worst condition situation, the terminal will submit one transaction (500-byte stream, double the size of current numbers) per 3 seconds. According to Novatel Wireless, CDPD transmits at a maximum of 19200 bits per second, which would be 57600 bits in 3 seconds. The maximum duty factor is therefore 500 (bytes per transaction) * 8 bits/byte / 57600 bits (per 3 seconds shortest transaction interval) = 0.0694 or 6.9%.

Sincerely,
Bulent Ozayaz
Chief Engineer

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