Specific Absorption Rate (SAR) Test Report
for
Advantra (UK) Limited
on the
4 Line Alphanumeric ReFlex Pager
Model: AR1800

Job # J99030958
Test Report: 99030958B
Date of Report: May 23, 2000

NVLAP Laboratory Code 200201-0
Accredited for testing to FCC Parts 15

Tested by:	Xi-Ming Yang	Xi-Ming Yang
Reviewed by:	David Chernomordik	David Chernomordik

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1 JOB DESCRIPTION

1.1 Client Information

The EUT has been tested at the request of

Company: Advantra (UK) Limited
St. Andrews Road
Cambridge, England CB4 1ZS

Name of contact: Steve Ritchie
US Telephone: 44-0-1223-442000
US Fax: 44-0-1223-442059

1.2 Equipment under test (EUT)

Product Descriptions:

Equipment	4 Line Alphanumeric ReFlex Pager		
Trade Name	Advantra	Model No.	AR1800
FCC ID	XXXAR1800	S/N No.	Not Labeled
Category	Portable	RF Exposure	Uncontrolled Environment
Frequency Band (uplink)	896 to 902 MHz	System	4 Line Alphanumeric ReFlex Pager

EUT Antenna Description			
Type	U-Shape	Configuration	Fixed
Dimensions	38 mm x 9 mm	Gain	-10 dB
Location	Internal at top		

Use of Product : Voice communications

Manufacturer: SAME as above.

Production is planned: [X] Yes, [ ] No

EUT receive date: 4/30/00

EUT received condition: Good condition prototype

Test start date: 4/30/00

Test end date: 5/20/00

1.3 Test plan reference

FCC rule part 2.1093, FCC Docket 96-326 & Supplement C to OET Bulletin 65

1.4 System test configuration

1.4.1 System block diagram & Support equipment

The diagram shown below details test configuration of the equipment under test .

S:	Shielded	**U:**	Unshielded	**F:**	With Ferrite Core

Support equipment					
Equp. #	**Equipment**	**Manufacturer**	**Model #**	**S/N #**	**FCC ID**
-	-	-	-	-	-

1.4.2 Test Position

The EUT was configured for testing in a typical fashion (as a customer would normally use it), and in the confines as outlined in C95.1 (1992) and Supplement C of OET 65 (1998). The EUT was placed in the intended use position, i.e. touching the human body or hand. Please refer to figure 1 below for the position details:

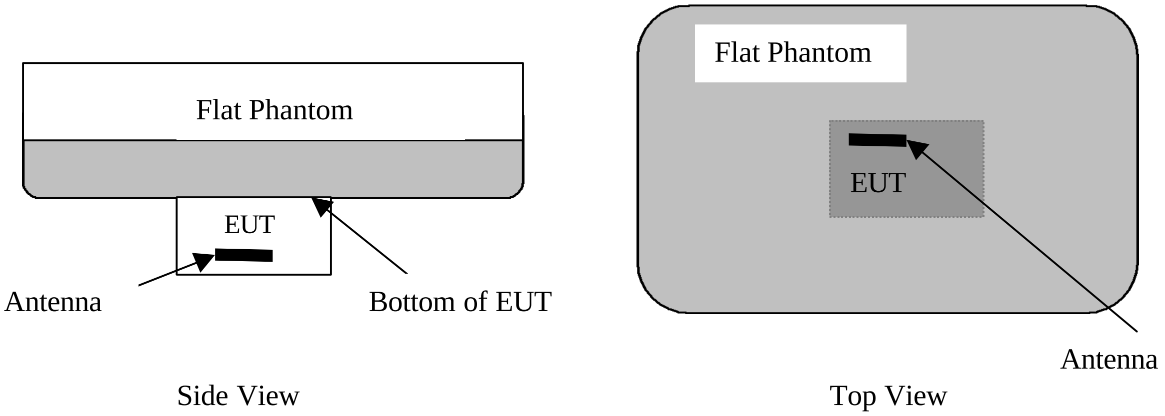


Figure 1: Intended use position

Figure 2 shows the location of antenna inside the EUT:

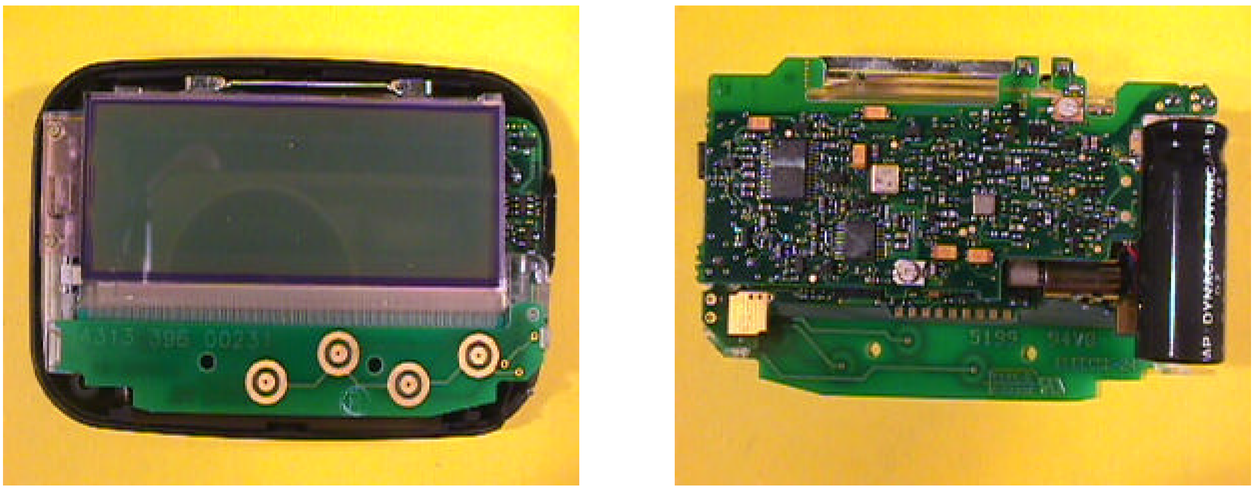


Figure 2: Antenna Location

1.4.3 Test Condition

During tests, the worst case data (max. RF coupling) was determined with following conditions:

EUT Antenna	Fixed	Orientation	N/A
Usage	Body-worn and hand-held	Distance between antenna axis at the joint and the liquid surface:	
Simulating human hand	Not Used	EUT Battery	DC 2.5V Supply, 1.5V Battery
Power output	1W to antenna 0.13 W (ERP)		

The spatial peak SAR values were accessed for lowestand highest operating channels defined by the manufacturer. Tests were performed at maximum duty cycle 15%C 194ms on, 1060 ms off).

Radiated emission measurement was performed, before and after SAR tests to ensure that the EUT operated at the highest power level.

1.5 Modifications required for compliance

No modifications were implemented by Intertek Testing Services.

1.6 Additions, deviations and exclusions from standards

No additions, deviations or exclusions have been made from standard.

2 SAR EVALUATION

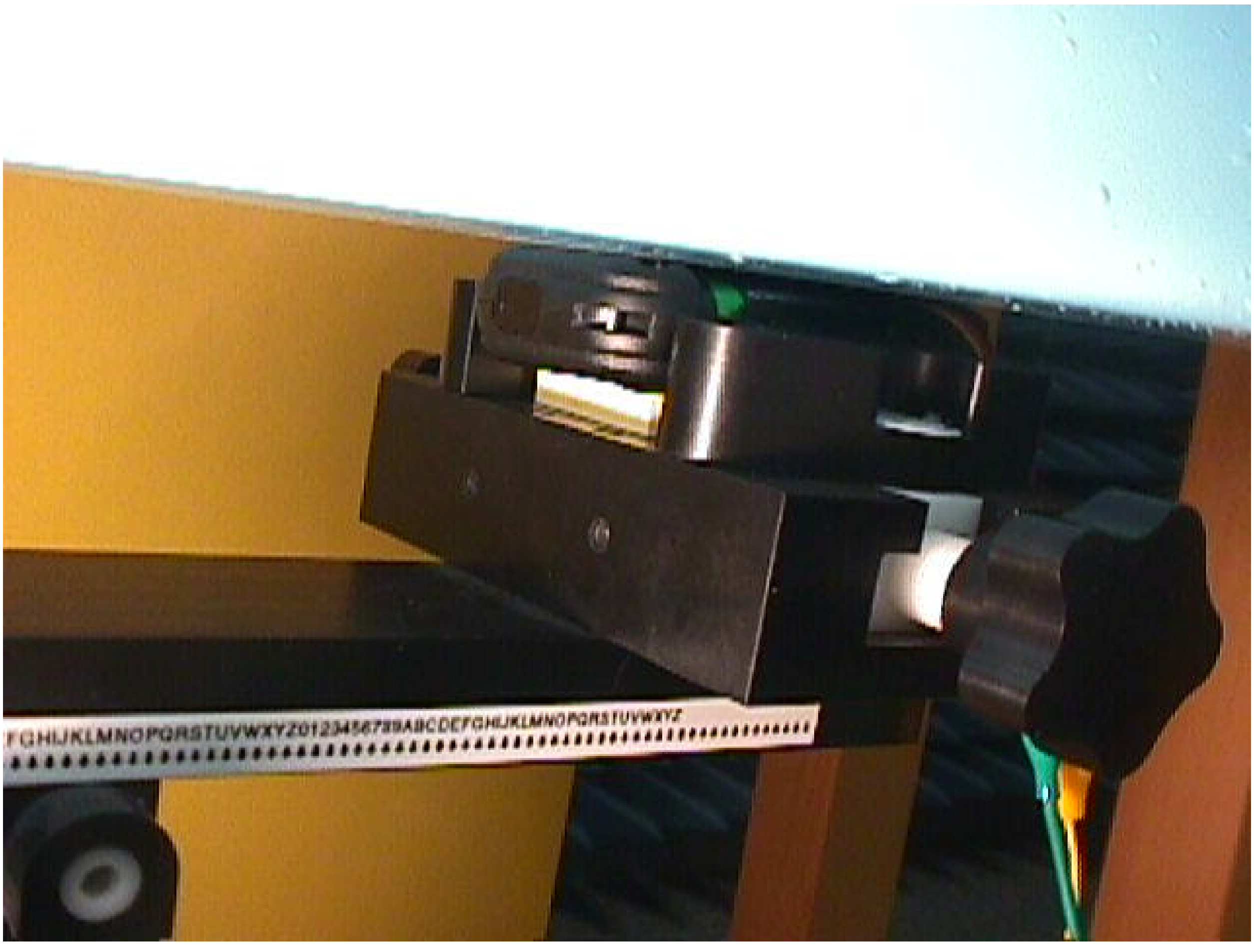
2.1 SAR Limits

The following FCC limits for SAR apply to devices operate in General Population/Uncontrolled Exposure environment:

EXPOSURE (General Population/Uncontrolled Exposure environment)	SAR (W/kg)
Average over the whole body	0.08
Spatial Peak (1g)	1.60
Spatial Peak for hands, wrists, feet and ankles (10g)	4.00

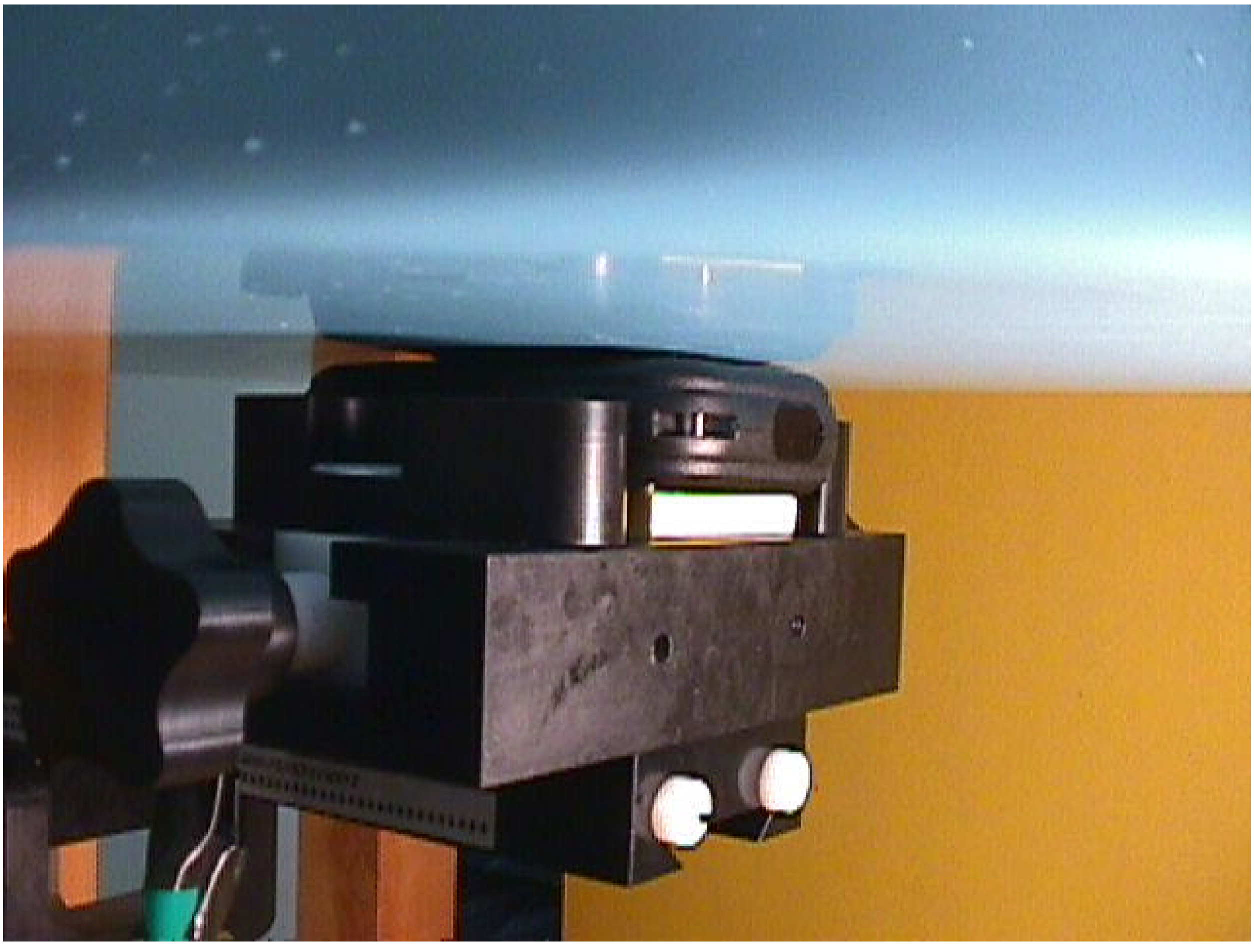
2.2 Configuration Photographs

Worst-Case SAR measurement



2.2 Configuration Photographs - Continued

Worst-Case SAR measurement



2.3 System Verification

Prior to the assessment, the system was verified to the ±5% of the specifications by using the system validation kit. The validation was performed at 900 MHz.

Validation kit	Targeted SAR_{1g} (mW/g)	Measured SAR_{1g} (mW/g)
D900V2, S/N #: 013	3.92	3.86

2.4 Evaluation Procedures

The SAR evaluation was performed with the following procedures:

a. SAR was measured at a fixed location above the ear point and used as a reference value for the assessing the power drop.

b. The SAR distribution at the exposed side of the head was measured at a distance of 4.0 mm from the inner surface of the shell. The area covered the entire dimension of the head and the horizontal grid spacing was 20 mm x 20 mm. Based on this data, the area of the maximum absorption was determined by spline interpolation.

c. Around this point, a volume of 32 mm x 32 mm x 34 mm was assessed by measuring 5 x 5 x 7 points. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure:

   I) The data at the surface were extrapolated, since the center of the dipoles is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measurement point is 1.6 mm. The extrapolation was based on a least square algorithm. A polynomial of the fourth order was calculated through the points in Z-axes. This polynomial was then used to evaluate the points between the surface and the probe tip.

   ii) The maximum interpolated value was searched with a straight-forward algorithm. Around this maximum the SAR values averaged over the spatial volumes (1g or 10g) were computed using the 3-D spline interpolation algorithm. The 3-D spline is composed of three one-dimensional splines with the "Not a knot" condition (in x, y and z directions). The volume was integrated with the trapezoidal algorithm. 1000 points (10 x 10 x 10) were interpolated to calculate the average.

   iii) All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.

d. Re-measurement of the SAR value at the same location as in step a. above. If the value changed by more than 5 %, the evaluation was repeated.

2.5 Test Results

The results on the following page(s) were obtained when the device was tested in the condition described in this report. Detail measurement data and plots which reveal information about the location of the maximum SAR with respect to the device, are reported in Appendix A.

The maximum spatial peak SAR values average over 1g assessed in "touch" position was 0.915 mW/g when tested in test mode.

The maximum spatial peak SAR values average over 10g assessed in "touch" position was 0.153 mW/g when tested in test mode. The unit is in compliance with the requirements of the FCC for body, hands and feet requirements.

Please note that in test mode, the duty cycle is much higher than in real operation.

In normal operation, the 1.5V battery charges up the super cap before the transmitter can transmit. For test purposes, 2.5 DC supply was used to boost charge rate and to transmit more often (up to 15%), therefore the duty cycle is less than 15%.

In the real operation, the duty cycle of ReFlex could be a maximum of 8.5%. The transmitting time is a maximum of 1 block which is 160ms within a minimum of 1.875 seconds interval. In practice there are a maximum of 10 to 20 calls with auto response transmissions per day average.

Trade Name:	Advantra	Model No.:	AR1800
Serial No.:	Not Labeled	Test Engineer:	XM Yang

TEST CONDITIONS			
Ambient Temperature	23 °C	Relative Humidity	48 %
Test Signal Source	Test Mode	Signal Modulation	15% Duty Cycle
Output Power Before SAR Test	1W to antenna	Output Power After SAR Test	1W to antenna
Test Duration	30 Min.	Number of Battery Change	DC Power Supply 2.5V DC to Power Amplifier

Usage (Touch Position, Face)							
Channel MHz	Operating Mode	Duty Cycle ratio	Measured ERP Power (mW	Measured SAR_{1g} (mW/g)	Measured SAR_{10g} (mW/g)	Plot Number	Position
896	Unmodulated	15%	130	0.915	0.153	1	Face down
902	Unmodulated	15%	98.2	0.504	0.082	2	Face up
896	Unmodulated	15%	130	0.362	0.061	3	Face down
902	Unmodulated	15%	98.2	0.463	0.104	4	Face up

Note: a) Worst case data were reported
b) Duty cycle factor included in the measured SAR data (see Plots 5, 6)
c) Uncertainty of the system is not included

3.0 EQUIPMENT

3.1 Equipment List

The Specific Absorption Rate (SAR) tests were performed with the SPEAG model DASY 3 automated near-field scanning system which is package optimized for dosimetric evaluation of mobile radios [3].

The following major equipment/components were used for the SAR evaluations:

SAR Measurement System			
EQUIPMENT	SPECIFICATIONS	S/N #	CAL. DATE
Robot	**Stäubi RX60L**	597412-01	N/A
	Repeatability: ± 0.025mm Accuracy: 0.806×10^{-3} degree Number of Axes: 6		
E-Field Probe	**ET3DV5**	1333	04/10/00
	Frequency Range: 10 MHZ to 6 GHz Linearity: ± 0.2 dB Directivity: ± 0.1 dB in brain tissue		
Data Acquisition	**DAE3**	317	N/A
	Measurement Range: 1μV to >200mV Input offset Voltage: < 1μV (with auto zero) Input Resistance: 200 M		
Phantom	**Generic Twin V3.0**	N/A	N/A
	Type: Generic Twin, Homogenous Shell Material: Fiberglass Thickness: 2 ± 0.1 mm Capacity: 20 liter Ear spacer: 4 mm (between EUT ear piece and tissue simulating liquid)		
Simulated Tissue	**Mixture**	N/A	11/06/99
	Please see section 6.2 for details		
Power Meter	**HP 435A w/ 8481H sensor**	1312A01255	02/16/00
	Frequency Range: 100kHz to 18 GHz Power Range: 300μW to 3W		

3.2 Muscle Tissue Simulating Liquid

Ingredient	Frequency 900 MHz)
Water	54.05 %
Sugar	45.05 %
Salt	0.1 %
Bactericide	0.8 %

The dielectric parameters were verified prior to assessment using the HP 85070A dielectric probe kit and the HP 8753C network Analyzer. The dielectric parameters were:

Frequency (MHZ)	ε*	σ*(mho/m)	ρ**(kg/m³)
900	55.7 ± 5%	0.99 ± 10%	1000

* *worst case uncertainty of the HP 85070A dielectric probe kit*

** worst case assumption

3.3 Field Probe Calibration

Probes were calibrated by the manufacturer in the TEM cell ifi 110. To ensure consistency, a strict protocol was followed. The conversion factor (ConF) between this calibration and the measurement in the tissue simulation solution was performed by comparison with temperature measurement and computer simulations. Probe calibration factors are included in Appendix C.

3.4 Measurement Uncertainty

The uncertainty budget has been determined for the DASY3 measurement system according to the NIS81 [5] and the NIST 1297 [6] documents and is given in the following table. The extended uncertainty (K=2) was assessed to be 23.5 %

UNCERTAINTY BUDGET				
Uncertainty Description	Error	Distrib.	**Weight**	**Std.Dev.**
Probe Uncertainty				
Axial isotropy	±0.2 dB	U-shape	0.5	±2.4 %
Spherical isotropy	±0.4 dB	U-shape	0.5	±4.8 %
Isotropy from gradient	±0.5 dB	U-shape	0	
Spatial resolution	±0.5 %	Normal	1	±0.5 %
Linearity error	±0.2 dB	Rectang.	1	±2.7 %
Calibration error	±3.3 %	Normal	1	±3.3 %
SAR Evaluation Uncertainty				
Data acquisition error	±1 %	Rectang.	1	±0.6 %
ELF and RF disturbances	±0.25 %	Normal	1	±0.25 %
Conductivity assessment	±10 %	Rectang.	1	±5.8 %
Spatial Peak SAR Evaluation Uncertainty				
Extrapol boundary effect	±3 %	Normal	1	±3 %
Probe positioning error	±0.1 mm	Normal	1	±1 %
Integrat. And cube orient	±3 %	Normal	1	±3 %
Cube shape inaccuracies	±2 %	Rectang.	1	±1.2 %
Device positioning	±6 %	Normal	1	±6 %
Combined Uncertainties				**±11.7 %**

3.5 Measurement Tractability

All measurements described in this report are traceable to National Institute of Standards and Technology (NIST) standards or appropriate national standards.

4 WARNING LABEL INFORMATION - USA

Not applicable.

5 REFERENCES

[1] ANSI, *ANSI/IEEE C95.1-1991: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 Ghz*, The Institute of electrical and Electronics Engineers, Inc., New York, NY 10017, 1992

[2] Federal Communications Commission, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", OET Bulletin 65, FCC, Washington, D.C. 20554, 1997

[3] Thomas Schmid, Oliver Egger, and Niels Kuster, "Automated E-field scanning system for dosimetric assessments", *IEEE Transaction on Microwave Theory and Techniques*, vol. 44, pp. 105-113, Jan. 1996.

[4] Niels Kuster, Ralph Kastle, and Thomas Schmid, "Dosimetic evaluation of mobile communications equipment with know precision", IEICE Transactions on Communications, vol. E80-B, no. 5, pp.645-652, May 1997.

[5] NIS81, NAMAS, "The treatment of uncertainty in EMC measurement", Tech. Rep., NAMAS Executive, National Physical Laboratory, Teddinton, Middlesex, England, 1994.

[6] Barry N. Tayor and Chris E. Kuyatt, "Guidelines for evaluating and expressing the uncertainty of NIST measurement results", Tech. Rep., National Institute of Standards and Technology, 1994.