Certification Report on

Specific Absorption Rate (SAR)
Experimental Analysis

UNIDEN AMERICA Corporation

Cordless Phone (Handset)
UC789BH

Test Date: June 2002

UESB-TRU5885-CORDLESS PHONE-3916

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Experimental Analysis SAR Report

Subject: **Specific Absorption Rate (SAR) Head Report**

FCC ID: AMWUC789

Product: Cordless Phone (Handset)

Model: UC789BH

Client: UNIDEN AMERICA Corporation

Address: Engineering Services Office
216 John Street, PO Box 580
Lake city, SC 29560, USA

Project #: UESB-TRU5885-cordless phone-3916

Prepared by: APREL Laboratories
51 Spectrum Way
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Telecommunications Approval Board - Spectrum Sciences Institute
SAR Certified
APREL Laboratories
UC789BH

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CERTIFICATE OF COMPLIANCE

Applicant name and address	**Date and Location of Testing**
Uniden America Corp. 216 John St., PO Box: 580 Lake City, SC 29560 USA.	Date of Test: June 2002 Project No. : UESB-TRU5885-cordless phone-3907 Test Location: APREL Laboratories, Nepean, ON CANADA

FCC ID: **AMWUC789**

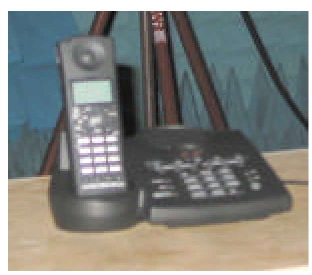
APPLICANT: Uniden America Corp.

Product:	**Cordless Phone**
Model:	**TRU5885(xx)/UC789BH**
Classification:	**Spread Spectrum Transceiver (DSS)**
Method/System:	**Direct Sequence System (DSS)**
Max. RF Power:	**Base 0.132 W(EIRP); Handset 0.118 W(EIRP)**
RF Band:	**5.8 GHz**
Max. SAR Value:	**0.25 W/kg Head SAR, Handset**
	1.05 W/kg Base
FCC Rule Parts:	**2.1093, FCC/OET Bulletin 65 Supplement C(2001)**
Application Type:	**Certification**

This application has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1-1992 and has been tested in accordance with the measurement procedures specified in FCC/OET Bulletin 65 Supplement C (2001) and IEEE Std. 1528-200X (May, 2002).

I attest to the accuracy of the data. All measurements reported were carried out under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the compliance of these measurements and vouch for the qualifications of the persons taking them. This relates only to the sample tested.

Jayanta (Jay) Sarkar
Technical Director, Standards & Certification



FCC ID: AMWUC789
Applicant: UNIDEN America Corporation
Equipment: Cordless Phone (Handset)
Model: UC789BH
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 Uniden UC789BH Cordless Phone (Handset), operating in Direct Sequence Spread Spectrum mode. The measurements were carried out in accordance with FCC 96-326. Scientific and technical details as presented in IEEE P-1528 were also used for the assessment of the device tested. The Device Under Investigation (DUI) was evaluated for its **maximum power level** of 20.7dBm (0.118W) EIRP while operating with a 50% duty cycle. The end user will not be able to change the duty circle.

The UC789BH Cordless Phone (Handset) is a Handheld unit with an internal antenna. The UC789BH Cordless Phone (Handset) also has a belt-clip and a headset for body-worn application.

The UC789BH Cordless Phone (Handset) was tested at low(ch#1), middle(ch#18) and high(ch#35) channels for the right and left sides of the head in both the touch and tilt positions. Body-worn exposure was also tested.

For head exposure, the maximum 1g SAR was found to be 0.25 W/kg for the peak RF output power of low channel (ch#1, 5742.980MHz) for the right head side in the tilt position.

For body-worn application, the maximum 1g SAR was found to be 1.23 W/kg for the peak RF output power of low channel (ch#1, 5742.980MHz) with the belt-clip and headset connected.

Test data and graphs are presented in this report.

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 evaluated

.

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1. INTRODUCTION

Tests were conducted to determine the Specific Absorption Rate (SAR) for a sample UC789BH Cordless Phone (Handset). 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".

5) IEEE P-1528 Draft "Recommended Practice for Determining the Peak Spatial Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communication Devices: Experimental Techniques."

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3. DEVICE UNDER INVESTIGATION

- Uniden Cordless Phone (Handset), model no: UC789BH, received in June 2002.

The Uniden UC789BH Cordless Phone (Handset) shall be called DUI (**D**evice **U**nder **I**nvestigation) in the following test report.

Table 1: Measured Transmitted Power

Frequency	Channel #	L/M/H	E.I.R.P.
5742.98	1	Low	0.118W

DUI: Uniden UC789BH Cordless Phone (Handset)

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4. TEST EQUIPMENT

- APREL Triangular Dosimetric Probe Model E-010, s/n 163
- ALIDX-500 Dosimetric SAR Measurement System
- APREL flat Phantom F1, Part # P-V-G8 (overall shell thickness 2mm)
- APREL 5800MHz Dipole
- APREL RF Amplifier
- Hewlett Packard Signal Generator Asset
- R&S Power Meter
- Hewlett Packard Dual Directional Coupler

Table 2: Instrumentation

Instrument	Calibration Due	Asset Number/Serial Number
E-010 Probe	May 2003	163
ALIDX-500	March 2003	N/A
APREL Flat Phantom	N/A	APL-001
APREL UniPhantom	N/A	APL-085
APREL 5800MHz Dipole	December 2003	N/A
APREL RF Amplifier	October, 2003	301467
HP-Signal Generator	November 2002	301463
R&S Power Meter	September 2002	301451
R&S Power Sensor	September 2002	301461
HP Directional Coupler	October 2002	100251

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5. SET UP

5.1 ALIDX-500 Measurement System

The image below shows the laboratory along with the ALIDX-500 Measurement system.

The ALIDX-500 Dosimetric SAR Measurement System was developed jointly with APREL Laboratories and IDX Robotics for use within wireless development and the compliance environment. The system consists of a six axis articulated arm, and controller for precise probe positioning (0.05 mm repeatability). Custom software has been developed to enable communications between the robot controller software and the host operating system.

An amplifier is located on the articulated arm, which is isolated from the custom designed end effector and robot arm. The end effector provides the mechanical touch detection functionality and probe connection interface. The amplifier is functionally validated within the manufacturers site and calibrated at NCL Calibration Laboratories. A Data Acquisition Card (DAC) is used to collect the signal as detected by the isotropic e-field probe. The DAC manufacturer calibrates the DAC to NIST standards. A formal validation is executed using all mechanical and electronic components to prove conformity of the measurement platform as a whole.

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The ALIDX-500 has been designed to measure devices within the compliance environment to meet all recognized standards. The system also conforms to standards, which are currently being developed by the scientific and manufacturing community.

The course scan resolution is defined by the operator and reflects the requirements of the standard to which the device is being tested. Precise measurements are made within the predefined course scan area and the values are logged.

The user predefines the sample rate for which the measurements are made so as to ensure that the full duty-cycle of a pulse modulation device is covered during the sample. The following algorithm is an example of the function used by the system for linearisation of the output for the probe.

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

The APREL E-Field probe is evaluated to establish the diode compression point.

A complex algorithm is then used to calculate the values within the measured points down to a resolution of 1mm. The data from this process is then used to provide the co-ordinates from which the cube scan is created for the determination of the 1 g and 10 g averages.

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Cube scan averaging consists of a number of complex algorithms, which are used to calculate the one, and ten gram averages. The basis for the cube scan process is centered on the location where the maximum measured SAR value was found. When a secondary peak value is found which is within 60% of the initial peak value, the system will report this back to the operator who can then asses the need for further analysis of both the peak values prior to the one and ten-gram cube scan averaging process. The algorithm consists of 3D cubic Spline, and Lagrange extrapolation to the surface, which form the matrix for calculating the measurement output for the one and ten gram average values. The resolution for the physical scan integral is user defined with a final calculated resolution down to 1mm.

In-depth analysis for the differential of the physical scanning resolution for the cube scan analysis has been carried out, to identify the optimum setting for the probe positioning steps, and this has been determined at 8mm increments on the X, & Y planes. The reduction of the physical step increment increased the time taken for analysis but did not provide a better uncertainty or return on measured values.

Prior to the measurement process the operator can insert the parameters for which the physical measurements are made, defining the X, Y, and Z probe movement integrals. For the FCC compliance process both OET 65 “Supplement C” and the IEEE draft standard “P-1528” were used to define the measurement parameters used during the assessment of the device.

The final output from the system provides data for the area scan measurements, physical and splined (1mm resolution) cube scan with physical and calculated values (1mm resolution).

The overall uncertainty for the methodology and algorithms the ALIDX500 used during the SAR calculation was evaluated using the data from IEEE P-1528 f3 algorithm:

$$f_3(x, y, z) = A \frac{a^2}{\frac{a^2}{4} + x'^2 + y'^2} \cdot \left(e^{-\frac{2z}{a}} + \frac{a^2}{2(a + 2z)^2} \right)$$

The probe used during the measurement process has been assessed to provide values for diode compression. These values are calculated during the probe calibration exercise and are used in the mathematical calculations for the assessment of SAR.

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5.2 Validation

A full system validation was run prior to the SAR testing. The methodology used for the system validation was taken from IEEE P-1528 section 7 (where applicable). Further details of the tissue used during the system validation is provided in section 6.3 Simulated Tissue. The results from the system validation are provided in Annex A Measurement Results.

The image below shows the setup used for the system validation.

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5.3 Simulated Tissue

The recipes used to make the simulated tissue were developed by APREL Laboratories using the epsilon and sigma as presented in OET Supplement C. Upon request further information shall be presented.

The density used to determine SAR from the measurements was the recommended 1.0 kg/m^3 found in Appendix C of "Supplement C OET Bulletin 65, Edition 01-01".

Dielectric parameters of the simulated tissue material were determined using an Anritsu 37347A Vector Network Analyzer, a Hewlett Packard 809B Slotted Line Carriage, and an APREL SLP-001 Slotted Line Probe.

Table 3: Properties of the Tissue

Brain Tissue	APREL	Target Value	D (%)
Dielectric constant, ε_r	35.2	35.3	-0.3
Conductivity, σ [S/m]	6.5	5.27	+23.3
Tissue Conversion Factor,	2.4	-	-

Table 4: Tissue Calibration Instrumentation

Instrument	Calibration Due	Asset Number/Serial Number
Anritsu VNA	7 August 2002	Z0107643 TEMP
HP Slotted Line	NA	100195
APREL Slotted Line Probe	December 2002	APL-SLP-001

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5.4 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).

$$SAR = \frac{\sigma |\mathbf{E}|^2}{\rho}$$

3. The probe is moved precisely from one point to the next using the robot (10 mm increments for wide area scanning and 8 mm increments for zoom scanning in the X, Y directions) and (5.0 mm increments for the final depth profile measurement in the Z direction).

4. The probe travels in the homogeneous liquid simulating human tissue (head).

   Section 5.3 contains information about the properties of the simulated tissue used for these measurements.

5. The liquid is contained in SAM phantoms simulating a portion of the human head one for the left side and another for the right side. The overall shell thickness of the phantoms is 2-6 mm.

6. For the touch position the DUI is positioned with the surface under investigation against the phantom with no separation distance. To achieve this the intersection of the MB/ERP line and the acoustic output of the DUI is used to line up device prior to testing. The device is then positioned using views from above and to the sides of the DUI. At this point the DUI is raised and brought into contact with the SAM Phantom where a minimum of three points of the DUI are in contact with the phantom. The angle of this position is then noted and referenced for repeatability.

7. For tilt position the recorded angle used during the touch assessment is then used to provide the details in which the +15° position can be achieved. The device is placed into the touch position and then lowered so that the +15° position can be achieved. Once the change in angle has been made the device is then raised and compensation made for the displacement of the acoustic output in respect to the intersection of the

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MB/NF line in for the “X” axis is executed. (For details, IEEE Std 1528-200X 4.5.2).

8. 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 power characteristics. In order to gage this effect the output of the transmitter is sampled before and after each SAR test. The following table shows the RF power sampled before and after each scan.

Note

The power measurement is not conducted and only relative to a true pin on pin conducted measurement. The spectrum analyzer provides the technician with the functionality of viewing the actual received Tx Signal from the DUI. This allows the engineer to monitor any drift in power during the test process, and as a result assess the delta if any.

Table 5: Relative power measurement before and after the scanning

Type of Exposure	Scan Type	Power Readings (dBm)		ΔP_{TX} (dB)	Battery #
		Before scanning	After scanning		
Hand Exposure	Coarse	-40.2	-40.2	0	1
	Fine	-40.2	-40.2	0	1

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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. The equation below is a representation of how SAR can theoretically equate.

$$SAR = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dV}\right)$$

2) The DUI was put into test mode for the SAR measurements via testing software supplied by the manufacturer running on the DUI to control the channel and operating TX mode.

3) Table 6 provides the details in tabular form of the full measurement analysis, which was performed on the DUI. Appendix A provides contour plots of the SAR measurements on the DUI. The actual device is presented as an overlay superimposed onto the contour plot of the DUI.

4) Wide area scans were performed for the low, middle and high channels of the DUI in both the touch and tilt positions using the right and left SAM phantoms. The DUI was operating with maximum output power and a duty cycle of 50%.

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6.3 User's Head Exposure

The accoustic output has been defined as per the above image where the visual form factor for the hanset was used to determine where the intersection of the NF and MB lines would be for placing the device against the SAM phantom.

The handset was positioned against the SAM phantom, using the defined acoustic output for the device, and aligning it with the identifiable ERP (Ear Reference Point) on the APREL SAM phantoms.

All subsequent testing for user's head exposure was performed on three channels (low: 5742.980MHz, middle: 5788.880MHz, high: 5834.780MHz) in both the touch and tilt positions using the right and left SAM phantoms. The highest 1g averaged SAR was measured on the low channel at the right head tilt position. The results are presented in Table 6 below.

1) The device had an initial area scan executed to establish the location of the maximum peak SAR. A calculated resolution of 1 mm was used to determine the location for the peak SAR.
2) The device was then explored on a refined 32 mm grid (Cube, Fine Scan) in three dimensions (X, Y & Z) measuring at 8 mm integrals X & Y and 5 mm integrals in the Z plane so as to create a physical measured point matrix. The system then runs a series of complex algorithms, which completes the matrix of calculated and measured values equivalent to a 1 mm resolution in the X, & Y planes.
3) The software runs a series of Lagrange functions to provide the data for the Z plane, which is inserted into the matrix.
4) To complete the calculated matrix (1 mm resolution) a fourth-order polynomial extrapolation is used to compute the surface values and the 1-gram averages are then calculated. The Maximum SAR value averaged over 1 gram for the user's head exposure analysis was found to be 0.25W/kg (Table 6).

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6.4 BODY-WORN EXPOSURE

All subsequent testing for the body-worn exposure was performed on three channels (low: 5742.980MHz, middle: 5788.880MHz, high: 5834.780MHz) with a belt-clip and a headset attached to the DUI and positioned against a flat phantom in normal use configurations. The belt-clip provides a 15mm separation distance. The body tissue was used during the test and the highest 1 - gram averaged SAR was found on the low channel. The results are presented in **Table 6** below.

1) The device had an initial area scan executed to establish the location of the maximum peak SAR. A calculated resolution of 1mm was used to determine the location for the peak SAR.
2) The device was then explored on a refined 32 mm grid (Cube, Fine Scan) in three dimensions (X, Y & Z) measuring at 8 mm integrals X & Y and 5 mm integrals in the Z plane so as to create a physical measured point matrix. The system then runs a series of complex algorithms, which completes the matrix of calculated and measured values equivalent to a 1 mm resolution in the X, & Y planes.
3) The software runs a series of Lagrange functions to provide the data for the Z plane, which is inserted into the matrix.
4) To complete the calculated matrix (1mm resolution) a fourth order polynomial is used to extrapolate the surface values and the 1-gram averages are then calculated. . The Maximum SAR value averaged over 1 gram for the user's body-worn exposure analysis was found to be 1.23W/kg (Table 6).

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Table 6: SAR Measurement Results

Type of Exposure	DUI Side	DUI Position	Phantom	Channel			SAR (W/kg)
				L/M/H	Ch #	Freq (MHz)	Limit: 1.6W/kg
Head Exposure	Keyboard up	Cheek/Touch	RHS	Low	1	5742.980	0.14
	Keyboard up	Cheek/Touch	RHS	Middle	18	5788.880	0.12
	Keyboard up	Cheek/Touch	RHS	High	35	5834.780	0.10
	Keyboard up	Ear/15° Tilt	RHS	Low	1	5742.980	0.25
	Keyboard up	Ear/15° Tilt	RHS	Middle	18	5788.880	0.14
	Keyboard up	Ear/15° Tilt	RHS	High	35	5834.780	0.18
	Keyboard up	Cheek/Touch	LHS	Low	1	5742.980	0.14
	Keyboard up	Cheek/Touch	LHS	Middle	18	5788.880	0.14
	Keyboard up	Cheek/Touch	LHS	High	35	5834.780	0.14
	Keyboard up	Ear/15° Tilt	LHS	Low	1	5742.980	0.17
	Keyboard up	Ear/15° Tilt	LHS	Middle	18	5788.880	0.14
	Keyboard up	Ear/15° Tilt	LHS	High	35	5834.780	0.15
Body-worn Exposure	Keyboard down	* With belt-clip and headset	FLAT	Low	1	5742.980	1.23
	Keyboard down	* With belt-clip and headset	FLAT	Middle	18	5788.880	0.68
	Keyboard down	* With belt-clip and headset	FLAT	High	35	5834.780	0.62

*** Note**: The belt-clip tested was a prototype that has the dimensions for which the final manufactured part will be made to. APREL Laboratories have been informed by Uniden that the final supplied belt-clip will not have any metallic parts in the final design."

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7. CONCLUSIONS

The maximum Specific Absorption Rate (SAR) averaged over 1 gram for the user's head exposure analysis, determined at low channel (ch#1, f_{TX}=5742.980MHz) of the DUI, is 0.25 W/kg. The overall margin of uncertainty for this measurement is **±18.0%** (Appendix D). The SAR limit given in the FCC 96-326 Safety Guideline is 1.6 W/kg for body exposure for the general population.

The maximum Specific Absorption Rate (SAR) averaged over 1 gram for body-worn exposure analysis, determined at low channel (ch#1, f_{TX}=5742.980MHz) of the DUI with a 15mm separation distance provided by the belt-clip, is 1.23 W/kg. The overall margin of uncertainty for this measurement is **±18.0%** (Appendix D). The SAR limit given in the FCC 96-326 Safety Guideline is 1.6 W/kg for body exposure for the general population.

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: Yinghi Chen Date: June, 2002

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