Certification Report on

Specific Absorption Rate (SAR) Experimental Analysis

UNIDEN AMERICA Corporation

Cordless Phone (Base) TRU5885(xx)

Test Date: June 2002

TRU5885(XX)

UESB-TRU5885-CORDLESS PHONE-3916

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Experimental Analysis SAR Report

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

FCC ID: AMWUC789

Product: Cordless Phone (Base)

Model: TRU5885(xx)

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
Nepean, Ontario
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Approved by ______________________ Date: Jun-19-2002.
Stuart Nicol
Director Product Development, Dosimetric R&D

Submitted by ______________________ Date: July 18, 2002
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Technical Director of Standards & Certification

Released by ______________________ Date: July 19/02
Dr. Jacek J. Wojcik, P. Eng.

LICENSED PROFESSIONAL ENGINEER J.J. WOJCIK PROVINCE OF ONTARIO

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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

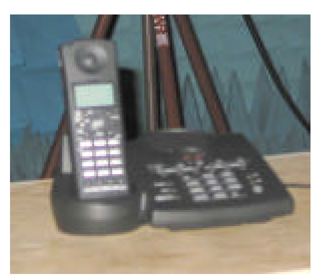
FCC Rule Parts: **2.1093, FCC/OET Bulletin 65 Supplement C(2001)**

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 (Base)
Model: TRU5885(xx)
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 TRU5885(xx) Cordless Phone (Base). The measurements were carried out in accordance with FCC 96-326. The TRU5885(xx) Cordless Phone (Base) was evaluated for compliance to FCC RF exposure requirements at **maximum power level** of 21.2dBm (0.132W) EIRP while operating with a 50% duty cycle.

The TRU5885(xx) Cordless Phone (Base) is a Base unit with an internal antenna. The TRU5885(xx) Cordless Phone (Base) has no body worn applications.

The TRU5885(xx) Cordless Phone (Base) was evaluated for both body exposure and direct contact SAR (extremities) at low(ch#1), middle(ch#18) and high(ch#35) channels for the frequency range 5742.980MHz to 5834.780MHz, with keyboard side up, keyboard side down, left side up and top side up positions.

The maximum 10 g SAR was found to be 0.63 W/kg for the peak RF output power of low channel (ch#1, f=5742.980MHz) with the top side of the device facing up (Graph 1).

At a separation distance of 10.0 mm from the top side of the device the maximum 1 g SAR was found to be 1.05 W/kg for the peak RF output power of low channel (ch#1, f=5742.980MHz). The operational manual will contain a warning stating that bystanders and parts of the user's body other than extremities, must be at least 10.0mm away from the device and its antenna.

Evaluation data and graphs are presented in this report. All measurements conducted and documented in this report were performed while the DUI was connected to the A/C supply.

Based on the measured 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 TRU5885(xx) Cordless Phone (Base). 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 (Base), model no: TRU5885(xx) , received in June, 2002.

The Uniden TRU5885(xx) Cordless Phone (Base) 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.
5742.980	1	Low	0.132W

DUI: Uniden TRU5885(xx) Cordless Phone (Base)

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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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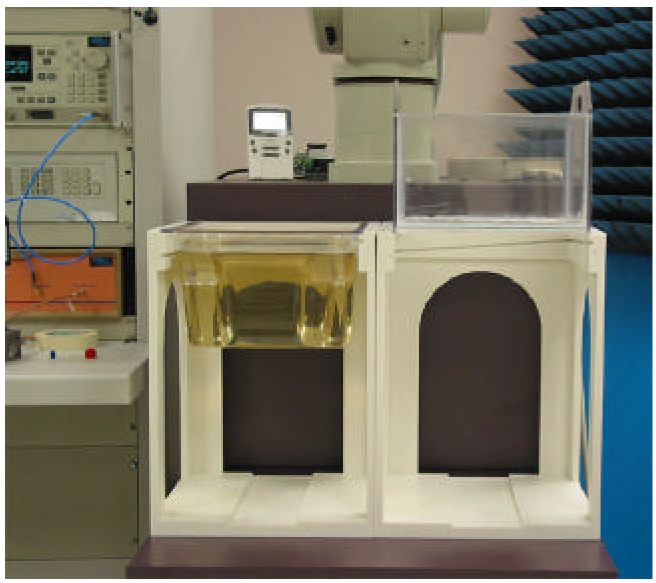
5.3 Body & Bystander Analysis

Measurements were made on the device using the APREL Universal Phantom, on the low, mid, and high channel of the device. The device was assessed for the keyboard up and keyboard down permutations. The separation distance used was 0 mm for the conservative SAR assessment. A secondary assessment was executed on the device at the position and frequency for the conservative value at a distance of 10mm from the phantom. The results from this exercise are presented in section 6 test results.

The image below shows part of the setup used for body measurements.



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5.4 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

BODY Tissue	APREL	Target Value	D (%)
Dielectric constant, ε_r	46.1	48.2	-4.4
Conductivity, σ [S/m]	6.9	6.0	+15.0
Tissue Conversion Factor,	2.5	-	-

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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5.5 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).

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

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 (body).

   Section 5.4 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 with no separation distance for conservative analysis.

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 device has been developed to operate only with AC power supply. The device was analyzed with the AC cord attached, for the position, and frequency, for which the conservative SAR was. Located the values recorded in table 5 represent the assessed drift while attached to the AC power supply.

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)**
		Before scanning	**After scanning**	
Hand Exposure	Coarse	-40.00	-40.00	0
	Fine	-40.00	-40.00	0
Body Exposure	Coarse	-40.00	-40.00	0
	Fine - body	-40.00	-40.00	0

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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. Graph 1 provides the worst-case conservative SAR plot for channel #1 (5742.980MHz) with top side up. 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. The DUI was operating with maximum output power and a duty cycle of 50%. The DUI was placed up against the phantom during the test process. The phantom shell thickness is 2 mm overall.

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6.3. DIRECT CONTACT SAR

All subsequent testing for the direct contact SAR (user's hand exposure) was performed on three channels (low: 5742.980MHz, middle: 5788.880MHz, high: 5834.780MHz) at four positions - with the keyboard side, keyboard down side, left side and the top side of the DUI facing up against the phantom. The highest 10 g averaged SAR was measured on the low channel with the top side facing up. 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 and 10-gram averages are then calculated.
5) Where two (or more) peaks with similar values are measured the location of the peaks is recorded. A refined grid is then created to asses each peak location individually, and the maximum value from the assesment is used to record conservative SAR for this report. The highest conservative SAR value averaged over 10 grams for the direct contact exposure (user's hand exposure) analysis was found to be 0.63W/kg (Table 6).

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6.4. BODY EXPOSURE

All subsequent testing for the direct contact SAR (user's hand exposure) was performed on three channels (low: 5742.980MHz, middle: 5788.880MHz, high: 5834.780MHz) at four positions - with the keyboard side, keyboard down side, left side and the top side of the DUI facing up against the phantom. The highest 1 g averaged SAR was measured on the low channel with the top side facing up. 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 (1 mm resolution) a fourth order polynomial is used to extrapolate the surface values and the 1 and 10-gram averages are then calculated.
5) Where two (or more) peaks with similar values are measured the location of the peaks is recorded. A refined grid is then created to asses each peak location individually, and the maximum value from the assesment is used to record conservative SAR for this report.
6) The maximum conservative SAR value averaged over 1 gram for the body analysis was found to be 1.53W/kg from the top side of the device`. At a separation distance of 10.0 mm from the top side of the device the highest 1 g SAR was found to be 1.05W/kg. The operational manual for the DUI will contain a warning stating that bystanders and parts of the user's body other than extremities, must be at least 10.0 mm away from the device.

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Table 6: Testing results - 1 g and 10 g SAR values for
Uniden TRU5885(xx) Cordless Phone (Base)

Type of Test	DUI position	Channel			SAR (W/kg)		
		L/M/H	Channel #	Freq (MHz)	Peak SAR	1g SAR Limit: 1.6W/Kg	10g SAR Limit: 4.0W/Kg
Body/Hand Exposure	Top side Up	Low	1	5742.980	3.94	1.53	0.63
	Top side Up	Middle	18	5788.880	1.74	0.69	0.30
	Top side up	High	35	5834.780	0.94	0.37	0.19
	Top side Up ***	Low	1	5742.980	2.67	1.05	0.45
	Keyboard up	Low	1	5742.980	2.85	1.03	0.45
	Keyboard up	Middle	18	5788.880	1.30	0.56	0.29
	Keyboard up	High	35	5834.780	1.09	0.32	0.22
	Keyboard down	Low	1	5742.980	0.79	0.37	0.24
	Keyboard down	Middle	18	5788.880	0.82	0.31	0.24
	Keyboard down	High	35	5834.780	0.44	0.25	0.21
	Left side up	Low	1	5742.980	0.78	0.38	0.27
	Left side up	Middle	18	5788.880	0.88	0.30	0.22
	Left side up	High	35	5834.780	0.38	0.22	0.20

*** Test was performed on 10.0mm separation distance.

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7. CONCLUSIONS

The maximum Specific Absorption Rate (SAR) averaged over 10 grams, determined at low channel (ch#1, f_{TX}=5742.980MHz) of the DUI , is 0.63 W/kg (direct contact SAR for the exposed extremities – hands, wrists, feet and ankles). 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 4.0 W/kg for direct contact exposure for the general population.

The maximum Specific Absorption Rate (SAR) averaged over 1 gram, determined at low channel (ch#1, f_{TX}=5742.980MHz) of the DUI at 10.0mm separation distance is 1.05 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: Yingshi Chen   Date: June, 2002

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