Raman Systems R-2000 Operating Manual

Version 1.6

a joint venture between

Raman Systems

and

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Contents

Safety Procedures and Warnings

FOR YOUR SAFETY, READ AND UNDERSTAND ALL SAFETY AND OPERATING INSTRUCTIONS BEFORE USING THIS PRODUCT.

Optical Safety

The laser beam emerging from the R-2000 laser output port or from the fiber optic probe is a Class 3b laser. This laser product produces visible and/or invisible laser radiation. Direct contact with the laser beam *or* its specular reflections could cause skin burns, serious eye injury and blindness. Laser safety eyewear must be worn at all times while operating the R-2000. The laser will operate at full power at 785nm within 2 seconds of applying power to the unit and it operates in continuous wave (cw) mode at 785nm with a 500mw-output power.

The SYSTEM ON | OFF switch controls the power to the system. When the system is on, the *green* System Power Indicator Lamp will be on. The keyed switch on the front panel of the R-2000 labeled LASER ON | OFF controls the power to the laser. When the laser is on, the *red* Laser Power Indicator Lamp will be on.

Due to the dangers associated with operating lasers, the R-2000-GL Safety Goggles are specified with every R-2000 order. If you already own appropriate diode laser safety goggles, you will be required to 1) sign a waiver attesting to that fact, and 2) submit the signed waiver with the order. Orders without an R-2000-GL *or* without a signed waiver will not be processed. It is the customer's responsibility to supply the correct laser safety eyewear to anyone who could be exposed to the laser radiation. Reputable distributors of laser safety eyewear can recommend the best product for a user's specific needs.

Laser light presents special safety hazards not associated with other light sources. People present while a laser is in operation need to be aware of the special properties and dangers involved in laser radiation. Familiarity with the R-2000 and the properties of intense laser radiation will aid in the safe operation of this product. R-2000 users must read and understand all of the information presented in the Raman Systems R-2000 Operating Instructions before operating the Raman System. Also, R-2000 users must adhere to the following regulations:

1. Never look directly into the laser light source.
2. Never stare at the diffuse reflected beam.
3. Never sight down the beam into the source.
4. Do not turn the laser on unless the fiber-optic probe is connected to the R-2000.
5. Do not disconnect the fiber-optic probe from the R-2000 unless the laser is turned off.

6. Restrict the use of the R-2000 to qualified and well-trained users knowledgeable in laser safety practices. In addition, inform all personnel working in the area of these regulations.
7. Before the laser is in operation, notify all personnel in the room or others who might be exposed to the laser beam that a laser is about to be used.
8. Illuminate warning lights and post warning signs in the area when the laser is in operation.
9. People requiring access to areas within the nominal hazard zone must wear protective eyewear designed for 785nm lasers. The eyewear designation should permit observation of the emission indicator.
10. Position the beam path and optical components used in the operation of the R-2000 at an elevation low enough to prevent inadvertent beam-to-eye contact.
11. Reflections from shiny surfaces, such as watches, rings, window glass, polished surfaces, etc., can redirect light in dangerous directions. Whenever the laser light can possibly illuminate a shiny object, consider where the reflected light could go and make sure that a hazardous situation is not created. **Even a diffused reflection of a Class 3b laser product is dangerous.**
12. User should consult with their laser safety division, if applicable.
13. Use of a Class 3b laser product requires power interlocks installed on every door leading to the lab.

For additional information on laser safety, refer to the following publications:
- *American National Standards for the Use of Lasers*. American National Standards Institute, 1980.
- *Performance Standard for Laser Products*. FDA, (FR-40) (148): 32252-32265. Department of Health, Education and Human Service Bureau of Radiological Health, July 31, 1974.
- *Laser Safety Guide*. Laser Institute of America (5th Edition), Toledo, Ohio, 1982.
- *Safety with Lasers and other Optical Sources*. D. Sliney and M. Wolbarsht, Pleum Publishing Company, New York, NY, 1980.

It is the purchaser's responsibility to meet applicable federal regulations contained in Title 21 CFR parts 1000 and 1040.10 chapter 1, subchapter Radiological Health.

Section 1: Introduction

System Overview

Thank you for selecting the Raman Systems R-2000. This manual describes the correct operating procedures for the Raman Systems R-2000, a product of joint venture between Ocean Optics, Inc. and Boston Advanced Technologies, Inc. The Raman Systems R-2000 is a fully integrated, low-cost system for applications involving the sophistication of Raman spectroscopy techniques. Uses for the R-2000 include characterization of highly scattering particulate matter in aqueous solutions, gels, powders, creams, and other media; reaction monitoring; product identification; and remote sensing.

The Raman Systems R-2000 is comprised of five basic elements: the **diode laser, fiber-optic probe, spectrometer, A/D card,** and **operating software**. The **diode laser** supplies light through the excitation fiber in the **fiber-optic probe.** The scattered light from the sample is collected and transmitted to the **spectrometer** via the collection fibers in the **fiber-optic probe**. The **spectrometer** measures the amount of light at each wavenumber or pixel in the sampled spectrum. The **A/D card** transforms the analog data from the spectrometer into digital information that is passed to a computer. Finally, the **operating software** converts the digital data from the spectrometer into the Raman spectrum that is pertinent to the user.

Parts Included

Your Raman Systems R-2000 includes the components listed below. Optional components, such as an Auxiliary Rayleigh Line Filter Module or Ocean 32 software can be purchased separately.
- Diode laser and miniature fiber optic spectrometer in a x x x housing
- Fiber-optic probe
- ADC500, a 12-bit ISA-bus A/D card for use with desktop computers *****
- Operating software, supplied on two 3.5" high-density disks
- Laser safety goggles******
- AC Power Cord
- Amber bottle with rubber septum
- Operating instructions and accessories price list

* Note: The standard Raman Systems R-2000 interfaces to a desktop PC via an ADC500 ISA-bus A/D card and interface cable. To interface the R-2000 to a notebook PC, users can substitute a DAQ-700 PCMCIA A/D card or a Serial Port Interface A/D converter at an additional cost.

** Note: Unless you have provided a release form stating you already own laser safety eyewear, safety goggles have been added to your order.

Damage Claims and Return Shipments

Thoroughly examine your Raman Systems R-2000 and all accompanying accessories as soon as they are received. Insist that the carrier's agent verify the inspection and sign the description. Immediately notify the delivering agent in person or by telephone of damage or loss. Risk of loss of, or damage to merchandise remains with the buyer. It is the buyer's responsibility to file a claim with the carrier involved. Contact Ocean Optics, Inc. immediately so that we may assist you. Also, all returned products must have a Return Merchandise Authorization (RMA) number. Please contact an Applications Scientist for specific instructions when returning a product.

Product Specifications

High-Output Laser*

Output	500 mW
Type	785 nm solid state diode
Excitation Delivery	Via 400 um fiber optic probe
Numerical Aperture	~0.15
Class	3b

Miniature Fiber-optic Spectrometer

Detector	2048 element linear silicon CCD array
CCD elements	2048 elements @ 125um X 200um per element
Well depth (@ 600 nm)	350,000 photons
Sensitivity (estimated)	86 photons/count 2.9×10^{-17} joules/count 2.9×10^{-17} watts/count (for 1 second integration)
Integration time	4 milliseconds to 60 seconds with 500 kHz A/D card 20 milliseconds to 60 seconds with 100 kHz A/D card
Grating density	1200 lines/mm
Range	785-1000nm or 200-2700cm^{-1}
Resolution	1.5nm (FWHM) or ~30cm^{-1}
Fiber-optic connector	SMA 905
Signal-to-Noise	200:1 (observed in measuring benzene)

Collection Optics

Fiber bundle	Number of fibers varies by configuration
Configuration	Contact, immersion or stand off
Connector	SMA 905

Section 2: Basic Operating Information

Control Feature Descriptions

The Raman Systems R-2000 is designed to be easy to use. This section will familiarize you with the switches and connections that will enable you to use the analyzer to its fullest capacity.

Systems Power Switch

The system switch, labeled SYSTEM ON | OFF is located on the front panel. It turns the Raman Systems R-2000 on and off. The green system power indicator lamp illuminates when the power is on. (See Figure 1.)

Laser Power Switch

The laser power switch, labeled LASER ON | OFF is located on the front panel. This key switch turns the 785nm laser on and off. The red laser power indicator lamp illuminates when the laser is on. (See Figure 1.)

Laser Output Port

The laser output port is located on the front panel. It is equipped with a safety shutter that springs closed when a probe is disconnected. A DANGER warning flanks the laser output port. The port will accept probes equipped with a SMA-905 connector. (See Figures 1 and 3.)

WARNING:
OPERATING THE LASER WITH THE SHUTTER CLOSED CAN CAUSE DAMAGE AND/OR PRODUCT FAILURE.

Spectrometer Input Port

The spectrometer input port is located on the front panel. The port will accept probes equipped with a SMA-905 connector. (See Figures 1 and 3.)

Fiber-optic Probe

A standard immersion probe can be used with the system.

Auxiliary Rayleigh Line Filter Module (optional accessory)

The Auxiliary Rayleigh Line Filter Module is a detachable assembly designed to significantly increase the rejection of the scattered laser radiation. The Auxiliary Rayleigh Filter Module is especially useful when the sample being analyzed is a highly scattering solution. (See Figures 3 and 4.)

The 25-Pin Communication Port

The 25-pin communication port is located on the rear panel of the Raman Systems R-2000. The 25-pin communication port is used to link your computer to the Raman Systems R-2000 via an interface cable. (See Figure 2.)

The 15-Pin Communication Port

The 15-pin communication port is located on the rear panel of the Raman Systems R-2000.

The AC Power Cord Port

The 110 volt AC power cord port is located on the rear panel of the Raman Systems R-2000. (See Figure 2.)

Operating Software

The operating software is supplied on two standard 3.5" high-density diskettes. The Raman Systems OOIRaman software performs all the data acquisition and control functions for the spectrometer and provides standard spectroscopy features in a real time data acquisition environment. Please check for updated versions of our software on Ocean Optic's web site at www.oceanoptics.com.

WARNING
FOR YOUR SAFETY, READ AND UNDERSTAND ALL SAFETY AND OPERATING INSTRUCTIONS BEFORE OPERATING THIS PRODUCT. USING CONTROLS, MAKING ADJUSTMENTS, OR PERFORMING PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS RADIATION EXPOSURE.

Front Panel Diagram

LASER POWER INDICATOR LAMP

SYSTEM POWER INDICATOR LAMP

REMOTE INTERLOCK CONNECTOR

SYSTEM POWER SWITCH

LASER POWER SWITCH

RAMAN SYSTEMS R-2000

SYSTEM ON

LASER POWER

SYSTEM POWER

LASER INTERLOCK

OFF

OFF

LASER ON

DANG... DANGER

VISIBLE AND/OR INVISIBLE LASER RADIATION WITH FIBER REMOVED. AVOID DIRECT EXPOSURE TO BEAM

LASER OUTPUT
with switch shutter in
closed position

SPECTROMETER INPUT

Figure 1

Back Panel Diagram

110 VAC INPUT

25 PIN CONNECTOR

15 PIN CONNECTOR
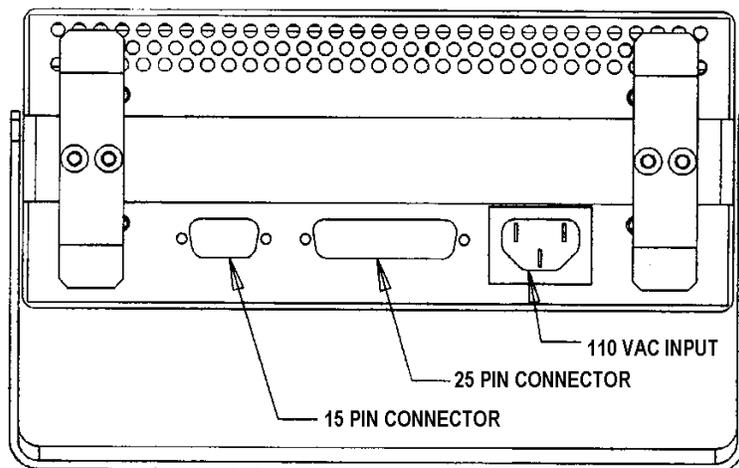
Figure 2

Auxiliary Rayleigh Line Filter Module

LASER OUTPUT

SPECTROMETER
INPUT

COUPLING
only used if filter
is in place

OPTIONAL FILTER MODULE

PROBE SUPPLY
(Single Fiber)

PROBE RETURN
(Multi-Fiber)

FIBER OPTIC PROBE
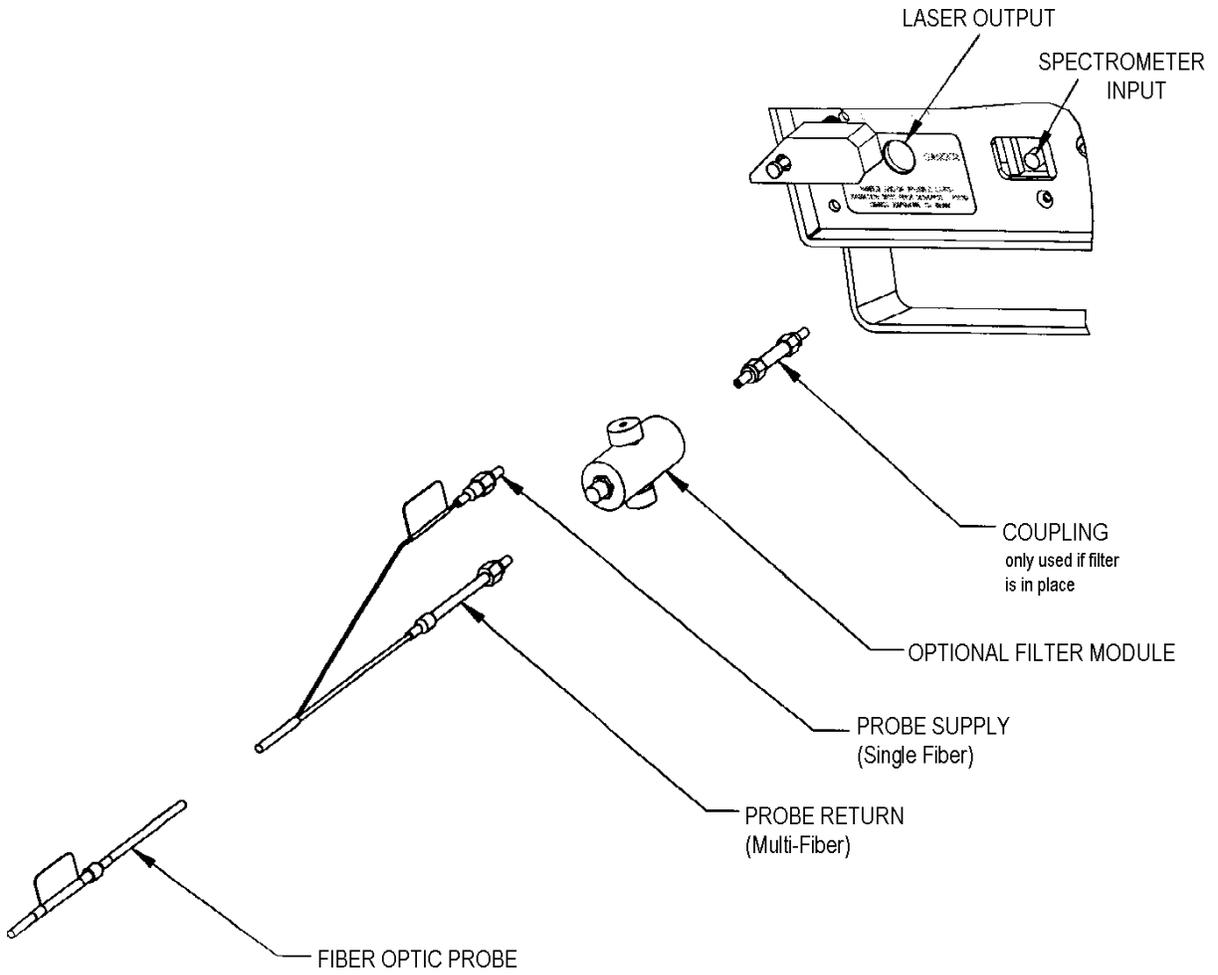
Figure 3

Identification, Warning, and Danger Labels

CERTIFICATION LABEL

SAFETY SHUTTER, LASER OUTPUT

DEFEATABLE INTERLOCK
WARNING LABELS

SINGLE FIBER
(Smaller Diameter Branch)

OPTIONAL AUXILIARY
RAYLEIGH LINE FILTER MODULE

MULTI-FIBER
(Larger Diameter Branch)

LASER EMISSION
WARNING LABEL

RAMAN SYSTEMS R-2000
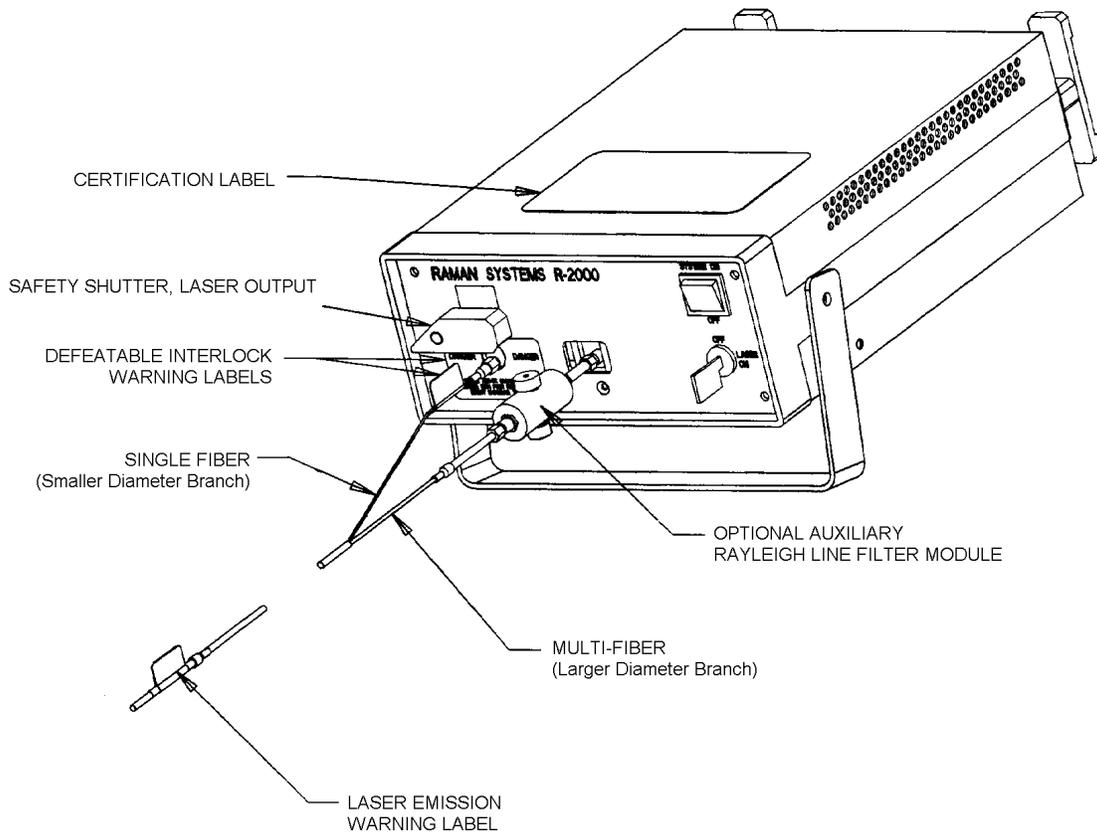
Figure 4

Identification, Warning, and Danger Labels

DANGER

VISIBLE AND/OR INVISIBLE LASER RADIATION
AVOID DIRECT EXPOSURE TO BEAM

500mW MAX. OUTPUT AT 785nm

CLASS IIIB LASER PRODUCT

BOSTON ADVANCED
TECHNOLOGIES, INC.
257 CEDAR HILL STREET
MARLBOROUGH, MA 02172
1-800-989-3660
MADE IN USA

1.
2.
INT:

BAT

**Wavelength
Calibration
Coefficients**

MODEL: RAMAN SYSTEMS R-2000
SERIAL NUMBER:
MANUFACTURED:

US PATENT 5,139,334   OTHER PATENTS PENDING
THIS PRODUCT COMPLIES WITH DHHS RADIATION PERFORMANCE
STANDARDS 21 CFR (J) FOR CLASS IIIB LASER PRODUCTS

Certification Label

DANGER   DANGER

VISIBLE AND/OR INVISIBLE LASER
RADIATION WITH FIBER REMOVED. AVOID
DIRECT EXPOSURE TO BEAM

Defeatable Interlock Danger Label

DANGER▶
VISIBILE AND/OR INVISIBLE LASER
RADIATION WITH FIBER REMOVED.
AVOID DIRECT EXPOSURE TO BEAM

AVOID EXPOSURE▶
VISIBLE AND/OR INVISIBLE
LASER RADIATION IS EMITTED
FROM THIS APERATURE

Defeatable Interlock Danger Label
(on Fiber-optic Probe)

Laser Emission Danger Label
(on Fiber-optic Probe)

Section 3: Installation of A/D Cards and Operating Software

Installing the ADC500 A/D Card and OOIRaman Software

Ocean Optics spectrometers interface to a PC via an analog-to-digital conversion board, or A/D card. Standard A/D cards, such as the ADC500, interface to desktop PCs. For successful installation, there are two parameters that must be set via dip switches on the ADC500 board: the Base Address and IRQ settings. These are the default settings for each:

Base Address (I/O Range) 768 decimal (300 hex)
IRQ (Interrupt Request)   7

There may be other devices in your computer that use these settings. If there is a conflict with another device in your computer, you must change the settings of the switches on the ADC500 board. The Base Address may be changed via the bank of switches labeled SW1 and the IRQ may be changed via the bank of switches labeled SW2. See Changing the Settings on pages 12-13 for complete details.

Hardware Installation

Installation of the ADC500 is similar to that of any PC card installation:
1. Ground yourself to the computer chassis or power supply.
2. Turn off and unplug the computer
3. Take off the computer cover.
4. Remove the ADC500 from its static-shielded bag.
5. Find an open ISA-bus slot and remove the slot protector.
6. Insert the ADC500 into an available expansion slot on the mother board connector by *very gently* rocking the card into the slot. Make sure the ADC500 is fully seated in the mother board before screwing the tab on the ADC500 to the computer.
7. Reinstall the cover and reconnect the computer power cord
8. Connect the D37 interface cable to the ADC500 card
9. Attach the D37 interface cable from the ADC500 to the spectrometer.

Software Installation

Installation with OOIRaman (Windows)
1. Insert the OOIRaman floppy disk into a drive.
2. Select **Run** and type **(drive):setup**. Click **OK**.
3. Click **OK** at the "Welcome!" dialog box.
4. Select the **Destination Directory**. Choose the default destination or type where you want the software housed. Click **OK**.
5. In the "Make Backups" dialog box, click **YES**.
6. After the software installation is complete, you will go back out to your desktop.
7. Start OOIRaman by double-clicking the OOIRaman icon or selecting Programs and OOIRaman.
8. The "Interface Setup Parameters" dialog box allowing you to specify your Spectrometer, A/D Converter, Base Address (I/O Range), and IRQ (Interrupt Request) opens. Select the appropriate Spectrometer and A/D Converter entries. For Base Address and IRQ, you must choose the same settings as the dip

switches on the ADC500 board. If you did not change the dip switches, accept the default settings (Base Address of 768 and IRQ of 7). If you did change the dip switches, then you must select the same settings as those on the ADC500 board. Only these four parameter options apply to your system. Click **OK**. You can always return to this dialog box by selecting **Setup | Configure Spectrometer**.

9. If you do not see the "Interface Setup Parameters" dialog box when you start OOIRaman, exit OOIRaman by selecting **File | Exit**. Then select **Start** | **Run**, and type `C:\windows\ooidrv.ini`. This will open Notepad and allow you to edit the initialization file for our device driver. Find the "Initialized" entry within this file. Make sure this line reads: `Initialized=0`. Save the OOIDRV.INI file and exit Notepad. Restart OOIRaman. You should now see the "Interface Setup Parameters" dialog box allowing you to specify your hardware configuration.

10. At this point, OOIRaman should be acquiring data from your spectrometer. There should be a jumpy trace near the bottom of the displayed spectrum and that trace should respond to light. If your spectrometer is not responding to light (or your computer hangs or crashes), please contact our Technical Support Department.

11. Exit and restart OOIRaman. This enables the hardware changes to take effect.
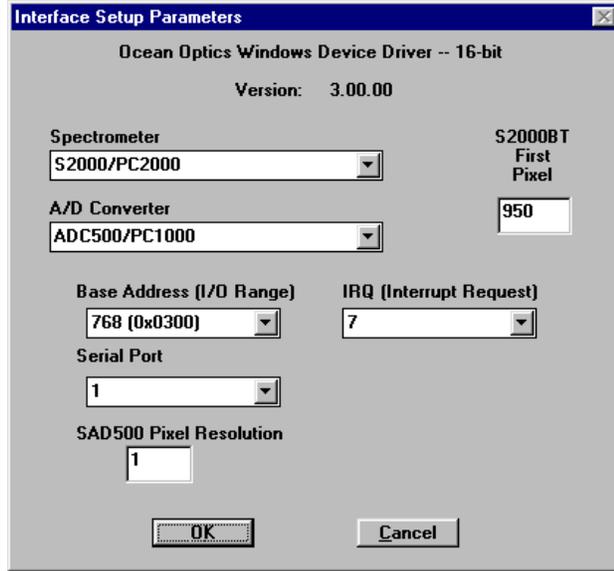
Changing the Settings for Base Address (SW1)

To change the Base Address settings on the ADC500 board, see the bank of 6 dip switches labeled SW1. Switches in the OFF position have the decimal values shown. Switches in the ON position have a value of zero. The Base Address is the sum of the values of the switches. In the default setting, switches 5 and 6 are added to give a total of 768. A few of the many combinations for Base Address settings are below. After you have changed the switches, reinstall the card and change the software settings to match the hardware settings (see the appropriate software section for instructions).

☐ = Switch is in the on, upward position

Example: 768 decimal = Hex300 = 0x300 (Default Setting)

Switch #	1	2	3	4	5	6
ON	■	■	■	■		
OFF					■	■

	1	2	3	4	5	6
Decimal equivalent	16	32	64	128	256	512
Value as shown					256	512

Example: 784 decimal = Hex310 = 0x310

Switch #	1	2	3	4	5	6
ON		■	■	■		
OFF	■				■	■

	1	2	3	4	5	6
Value as shown	16				256	512

Example: 800 decimal = Hex320 = 0x320

Switch #	1	2	3	4	5	6
ON	■		■	■		
OFF		■			■	■

Value as shown		32			256	512

Example: 816 decimal = Hex330 = 0x330

Switch #	1	2	3	4	5	6
ON			■	■		
OFF	■	■			■	■

Value as shown	16	32			256	512

Changing the Settings for IRQ Interrupt Level (SW2)

To change the IRQ settings on the ADC500 board, see the bank of 4 dip switches labeled SW1. In the default setting, the IRQ is set to 7. Other combinations for IRQ settings are below. After you have changed the switches, reinstall the card and change the software settings to match the hardware settings (see the appropriate software section for instructions).

▭ = Switch is in the on, upward position

IRQ 7 (Default Setting)

Switch #	1	2	3	4
ON				■
OFF	■	■	■	

IRQ value		3	5	7
Value as shown				7

IRQ 5

Switch #	1	2	3	4
ON			■	
OFF	■	■		■

IRQ value		3	5	7
Value as shown			5	

IRQ 3

Switch #	1	2	3	4
ON		■		
OFF	■		■	■

IRQ value		3	5	7
Value as shown		3		

Installing the DAQ-700 A/D Card and OOIRaman Software

Before using your spectrometer, you must first configure your computer to properly detect and use the DAQ-700. Windows 95/98/NT users will have to install NI-DAQ Driver Software in order for a computer to properly use the DAQ-700 A/D card. You must follow several steps to use the DAQ-700 A/D card as an interface to your Ocean Optics spectrometer. The following instructions will guide you through the installation of NI-DAQ – the device driver library necessary for Windows 95/98/NT systems to use the DAQ-700. If you have problems with any of the instructions, please contact our Technical Support Department.

<u>**NOTE:**</u> **Windows 95/98/NT users DO NOT INSTALL CardWare.**

Install OOIRaman

Insert each OOIRaman spectrometer operating software diskette into your floppy drive. Run the **SETUP** application. DO NOT run OOIRaman at this time. Your computer must be properly configured to use the DAQ-700 before you can use OOIRaman.

Install NI-DAQ

1. Insert your NI-DAQ version 6 CD into your CD-ROM drive. If you do not have a CD-ROM drive in your notebook computer, you can order the diskette version of NI-DAQ from Ocean Optics for $75. Please order part number NIDAQ-D.

2. After you insert your CD, a setup program should automatically start. If it does not, run the **SETUP.EXE** program from the CD.

3. The installation program has an option **Install NI-DAQ**. Select that option.

4. On the "Select Components" screen, make sure **NI-DAQ Driver Files (Minimal Install)** is checked. Choose any of the other options you wish to install. Click **Next>**.

5. Accept the default destination directory. Click **Next>**.

6. Accept the default Program Group. Click **Next>**.

7. On the "Ready to Install" screen, click **Next>**.

8. When prompted to do so, restart your computer.

9. After the computer restarts, wait until all disk drive activity stops -- that is, wait until your computer is completely restarted. Connect the spectrometer cable between your DAQ-700 and your spectrometer. Insert the DAQ-700 into any available PCMCIA slot.

10. Windows 95/98 will identify your card as a "National-Instruments-DAQCard-700" and will automatically install drivers for it. When the drivers are completely installed, you may be prompted to restart the computer. If you are prompted to restart your computer, please do so, but remove the DAQ-700 before your computer restarts.

11. After installing the driver and restarting your computer, reinsert the DAQ-700. Windows 95/98 will play a sound consisting of two tones of increasing pitch. If you do not hear this sound, and you do have internal speakers in your notebook computer, try turning the speaker volume up and reinserting the DAQ-700. If you still do not hear the "happy" sound, contact our Technical Support Department.

Configure your DAQ-700 card

12. If you hear the "happy" sound, click **Start**, and select **Settings | Control Panel**.

13. Double-click the **System** icon. Select the **Device Manager** tab.

14. On the "Device Manager" screen, find the hardware group named **Data Acquisition Devices**. Either double-click the group or select the group and click **Properties**.

15. Under the Data Acquisition Devices group, find the entry for your DAQCard-700. Either double-click **DAQCard-700**, or select the entry and click **Properties**.
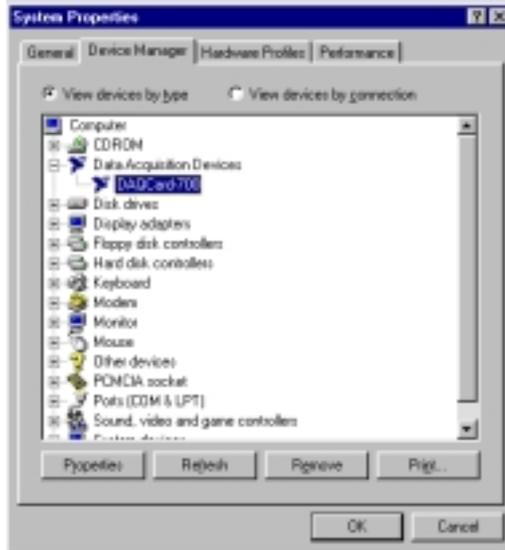
16. Once you have selected your DAQCard-700 from the Device Manager, click the **Resources** tab. The entries on this page control the hardware interface to your DAQ-700.
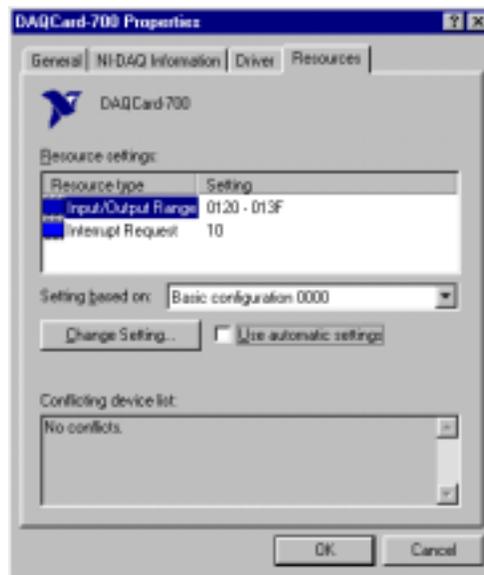
17. In this dialog box, find the check box next to **Use Automatic Settings**. Clear that check box (deselect it). OOIRaman and other Ocean Optics software are currently *not* Plug-and-Play compatible. We need to know the settings of the hardware before any Ocean Optics software product starts.

18. In the same dialog box, you will see entries for Input/Output Range and Interrupt Request. The Input/Output Range corresponds to the Base Address, and the Interrupt Request corresponds to the IRQ in Ocean Optics software. By deselecting the Use Automatic Settings box in step 18, you disabled Plug-and-Play for the DAQ-700. But in order to *fully* disable Plug-and-Play, you must also change the settings for either (or both) the Input/Output Range or the Interrupt Request. To make this change, double-click either **Input/Output Range** or the **Interrupt Request**. A dialog box giving the current hardware setting appears. On the right side of the **Value** box are two small arrows: one up

and one down. You must use these arrows to change the hardware interface parameters of either the Input/Output Range or the Interrupt Request.

19. While making this change, notice the Conflict Information area at the bottom. Make sure you choose a value that says **No devices are conflicting**. If it shows a conflict, you must select a different value. After changing the values, click **OK**. You will then see a "Creating a Forced Configuration" message box. Click **Yes**.

20. Note your values of both the Input/Output Range and the Interrupt Request. When you start OOIRaman, you will be prompted to enter these values.

Run OOIRaman

21. Start OOIRaman. The "Interface Setup Parameters" screen allowing you to specify your Spectrometer, A/D Converter, Base Address (I/O Range), and IRQ (Interrupt Request) opens. Select the values appropriate to your configuration. These are the same values selected in steps 18 and 19. Remember, the Input/Output Range you selected in steps 18 and 19 is expressed in hexadecimal. In this dialog box, the base address is given in decimal, followed by the hexadecimal equivalent. For example, "768 (0x0300)" gives the base address as 768 decimal and 300 hexadecimal. After you enter your Base Address and IRQ, verify that the Spectrometer and A/D Converter entries match your configuration and click **OK**. (Only these four parameter options apply to your system; ignore the other options.) You can always return to this dialog box by selecting **Setup | Configure Hardware**.
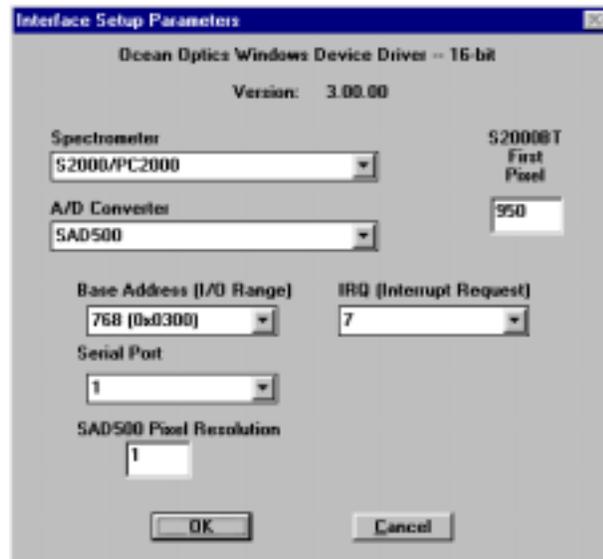
22. If you do not see the "Interface Setup Parameters" screen when you start

OOIRaman, exit OOIRaman by selecting **File | Exit**. Then select **Start** | **Run**, and type `C:\windows\ooidrv.ini`. This will open Notepad and allow you to edit the initialization file for our device driver. Find the "Initialized" entry within this file. Make sure this line reads: `Initialized=0`. Save the OOIDRV.INI file and exit Notepad. Restart OOIRaman. You should now see the "Interface Setup Parameters" screen allowing you to specify your hardware configuration.

23. At this point, OOIRaman should be acquiring data from your spectrometer. There should be a jumpy trace near the bottom of the displayed spectrum and that trace should respond to light. If your spectrometer is not responding to light (or your computer hangs or crashes), please contact our Technical Support Department.

Installing Ocean 32 (optional software)

Ocean 32 is a 32 bit Windows software suite for acquiring, processing, viewing, organizing and accessing spectral data. OCEAN32 is a complete graphic spectral desktop publishing system that also includes hundreds of quantitative tools -- smoothing, derivatives, integration, deconvolution, curve fitting, editing, averaging, splicing and peak statistics. The new Spectral Notebase provides tools for organizing spectra, experimental data, graphics, and other information into a powerful database with sort, search, and query functions.

Macro Wizard and Array Basic language routines gives the user complete control over data processing modules. Add on modules for PLS, Color, Kramers Kronig Transform and Univariate analysis provides additional quantitative tools. It is a good idea to install OOIRaman first, to verify the proper operation of the hardware.

Ocean 32 comes with extensive documentation, which should be consulted for proper installation. However, like other Windows based programs, software is installed automatically using a SETUP program.

Consult our web site at www.oceanoptics.com for the latest software documentation, releases, debug information, patches, and more.

Section 5: Getting Started

> **WARNING**
> YOU MUST READ AND UNDERSTAND ALL SAFETY PROCEDURES AND OPERATING
> INSTRUCTIONS BEFORE OPERATING THIS PRODUCT. FOR SAFETY PROCEDURES, SEE 1–4.

Set-Up

Remove and thoroughly examine your Raman Systems R-2000 and all accompanying accessories from the shipping container. If any objects appear damaged in any way DO NOT OPERATE INSTRUMENT. After determining that all components are accounted for and in proper condition, assemble as follows.

Install Fiber-optic Probe

Install the fiber-optic probe or the Rayleigh Line Filter Module with coupler to spectrometer input port, and laser output port. The single-fiber (smaller diameter branch of the probe) installs into the laser output port, and the multi-fiber (larger diameter branch of the probe) installs into the spectrometer input port. (See Figure 4.) Be sure you have read and understood all safety procedures prior to use.

Install A/D Card

Install the A/D card into your computer. If you are installing the ADC500 A/D card to use with your desktop computer, see Section 4 beginning on page 12. If you are using the DAQ700 A/D card to use with your portable computer, see Section 4 beginning on page 15.

Attach AC Power Cord

Attach the power cord to the rear panel of Raman Systems R-2000. **Ensure that <u>both</u> the power and laser switches are off, and the key is removed prior to installing the AC power cord.**

Attach Interface Cable

While your computer is off, attach the interface cable from the A/D card installed in the computer to the Raman Systems R-2000. If using a desktop computer, attach a 25-pin blue cable from the A/D card to the Raman Systems R-2000.

Install Operating Software

Install operating software. See Section 4 for detailed instructions.

You are now ready to use your Raman Systems R-2000. Please ensure you have read and understood all the optical safety precautions in this manual prior to use.

Sample Run

Preparing Sample

To become familiar with the operation of the R-2000, we suggest you first make a sample run with Ethanol using the included amber bottle and a rubber septum. Fill the bottle at least half way with ethanol. Insert the rubber septum to seal the bottle.
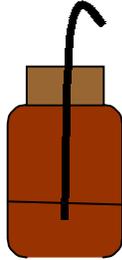
The rubber septum has a fine hole through which the probe tip should be inserted into the bottle. Carefully insert the metal tip of the probe through the hole in the septum until the metal tip just protrudes into the ethanol. Be careful to apply pressure to the metal tip only, not the optical fiber. The ideal orientation of the probe should be perpendicular to the bottom of the bottle. This orientation minimizes reflections of the laser light off the sidewalls and bottom back into the probe's collection fibers.

Setting Collection Parameters

To initialize the spectrometer, enter the following settings:

- Integration Time: 500 msec
- Spectra to Average: 1
- Smoothing: 7
- Select Continuous mode
- Select Master for the spectrometer mode
- Set the Laser Wavelength to 785 nm
- Set the Acquisition Mode to Wavelength (nm)
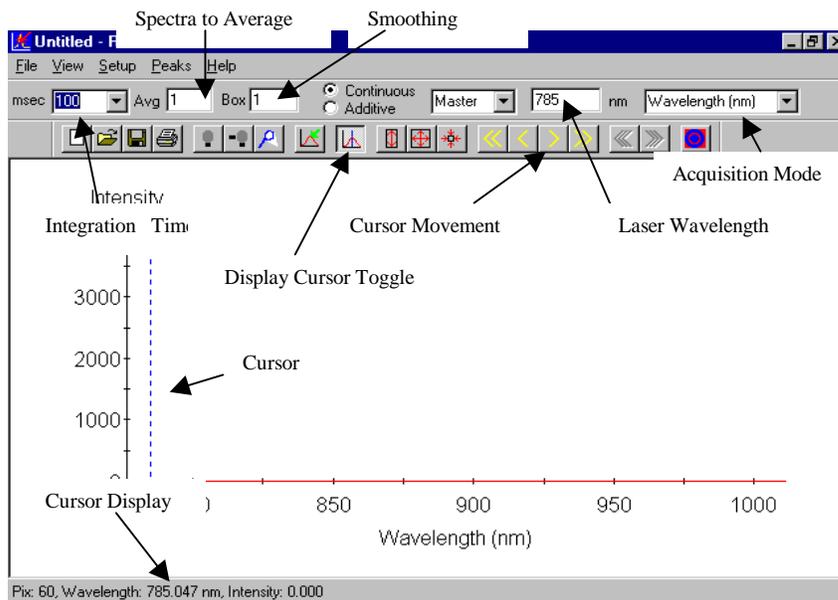
Figure 5

Setting the Laser Wavelength

When the probe has been installed with its tip secure in the Ethanol sample, and when all optical safety precautions have been taken, turn the laser key to the "on" position. Within 20 seconds, the laser pulse (the Rayleigh line) will appear on the screen. Click on "Display Cursor Toggle" (see Figure 5) and the cursor will appear on the screen. Use the "Cursor Movement" controls (see Figure 5) to position the cursor in the middle of the Rayleigh line, approximately around 785 nm. Note that the cursor controls consist of 6 buttons which move the cursor in the direction indicated on the button. The buttons with double arrows are for coarse movements, while the buttons with single arrows are for fine movements. The buttons marked with triple arrows cause the cursor to move from peak to peak in the indicated directions. See Figure 5.

As the cursor moves, the wavelength and intensity corresponding to its position is shown in the cursor display at the bottom of the screen. Once the cursor is centered on the Rayleigh line, enter the laser wavelength displayed in the laser wavelength window along the top of the screen. Change the acquisition mode from "Wavelength (nm)" to "Raman Shift (cm-1)." See Figures 5 and 6. You are now ready to record Raman spectra.

Collecting and Storing Dark Currents

Turn the laser off with the key and set the integration time to 10,000 msec. After 10 to 20 seconds, the smoothed dark current spectra will appear on the screen. It will be similar to the spectra below.

Integration Time ➔
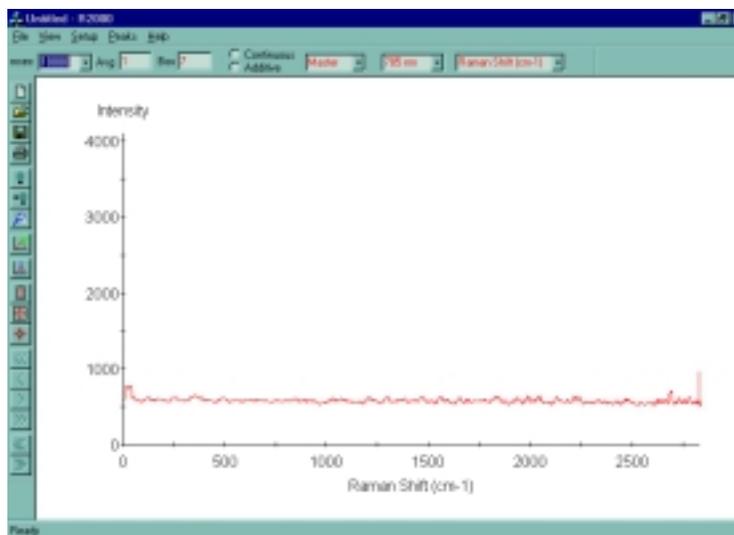
Figure 6

At this point, store the dark current by clicking on the store dark button. Click on the subtract dark button to subtract the recorded dark current from the signals stored in the CCD at the end of each integration period. After 10 to 20 seconds, the spectrum on the screen will go to near zero.

Store Dark   Subtract Dark
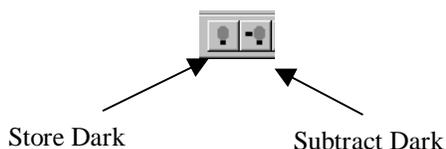
Collecting Spectra

Follow all optical safety precautions stated throughout this manual. Turn the laser on and begin acquiring the ethanol spectrum. The first spectrum to appear on the screen will correspond to a partial charge of the CCD array – the laser has a built-in 20 second delay and it's very unlikely that the beginning of the integration cycle was in-sync at the moment of switching the system on. At the end of the next 10 second integration cycle, the full spectrum displayed on the screen will correspond with Figure 7. To zoom in on the region of interest, select the Set Scale button.

Autoscale

Set Scale   Unscale
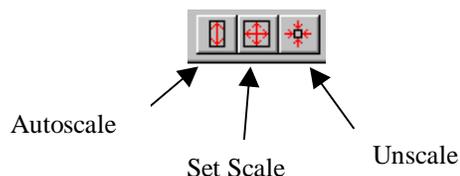
A dialog box (shown below) will open. Enter the minimum and maximum values of the horizontal and vertical axes, and the enlarged region of interest will appear on your screen (see Figure 6). Another way to zoom in on the area you want to see is to hold the shift key and drag a box around region of interest. This portion of the spectrum can fill up the vertical area by selecting the Autoscale button.

If attenuation of the laser light is desired, an optional Rayleigh Line Filter Module is available at an additional cost. Contact of our Applications Scientists for more information.
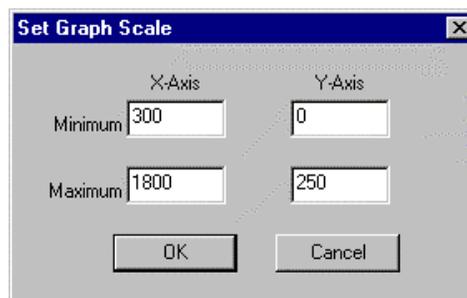
The effect of the module is to raise the optical density of the combined Rayleigh filter from three to approximately seven. At the same time, it reduces the Raman signal strength to 40% of its strength without the filter module. The effect on the spectra (see Figure 7) is to reduce the peak at 885 cm-1 to a peak height of 90 counts. For ethanol in an amber bottle, we can compensate for the reduced Raman signal strength by increasing the integration time. Repeat the previous procedure by first recording the dark current with a 30 second integration period to observe the effects of the filter and then increasing the integration time.
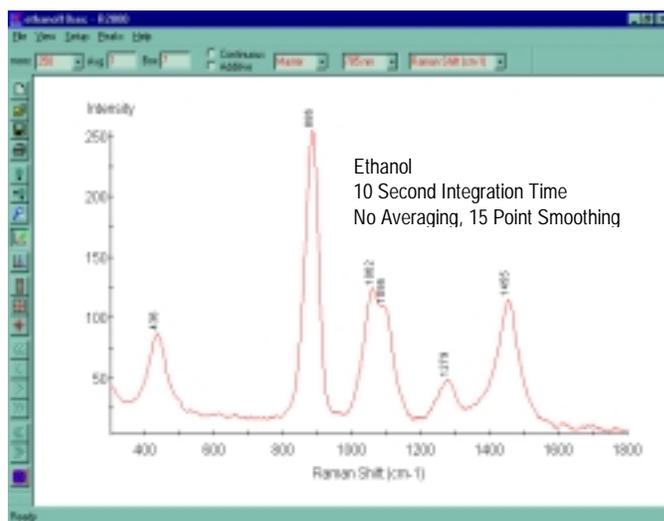
Figure 7
Raman Spectrum of Ethanol

**For additional technical assistance, please contact one of our Applications Scientists
or our Technical Support Department at:**

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