Operating Manual and User's Guide

IRRAD2000 Miniature Fiber Optic Spectroradiometers

Ocean Optics, Inc.
380 Main Street
Dunedin, FL 34698
(727) 733-2447
(727) 733-3962 fax

For the latest information, consult our web site:
www.OceanOptics.com

Or, e-mail our Technical Service Department:
TechSupport@OceanOptics.com

Table of Contents

Introduction

Ocean Optics miniature fiber optic spectrometers and accessories have revolutionized the analytical instrumentation market by dramatically reducing the size and cost of optical sensing systems. More than 10,000 Ocean Optics spectrometers have been sold worldwide -- striking evidence of the far-reaching impact of low-cost, miniature components for fiber optic spectroscopy. Diverse fields such as research and development, industrial process control, medical diagnostics and environmental monitoring have benefited from access to Ocean Optics technology.

Ocean Optics began in 1989 when Florida university researchers developed a fiber optic pH sensor as part of an instrument designed to study the role of the oceans in global warming. They soon formed Ocean Optics, Inc. and their ingenious work earned a Small Business Innovation Research (SBIR) grant from the U.S. Department of Energy. While designing the pH-monitoring instrument, the researchers wanted to incorporate with their sensor a spectrometer small enough to fit onto a buoy and were surprised to discover none existed. So they built their own. In 1992, the founders of Ocean Optics revolutionized the analytical instrumentation market, filled a substantial need in the research community, and changed the science of spectroscopy forever by creating a breakthrough technology: a miniature fiber optic spectrometer nearly a thousand times smaller and ten times less expensive than previous systems.

By April 1992, just 30 days after the successful completion of Phase II of the SBIR grant, Ocean Optics introduced the S1000 -- "The World's First Miniature Fiber Optic Spectrometer." Due to this dramatic reduction in size and cost of optical sensing systems, applications once deemed too costly or technologically impractical using conventional spectrometers were not only feasible, but practical.

The IRRAD2000 Spectroradiometric System

The IRRAD2000, IRRAD2000-PORT, and IRRAD2000-SAD are low-cost, PC-interface systems that turn our high-sensitivity S2000 Miniature Fiber Optic Spectrometer into a highly accurate spectroradiometer for measuring the absolute spectral intensity of light and other emission sources. These systems come with an A/D converter, OOIIrrad Irradiance Software, an LS-1-CAL NIST-traceable Calibrated VIS-Shortwave NIR Light Source, a Cosine-corrected Irradiance Probe, and a 200-µm optical fiber.

❖ The IRRAD2000 is anchored by a high-sensitivity, radiometrically calibrated S2000, pre-set to a 350-950 nm wavelength range and configured with a 50 µm entrance slit for high resolution (3.0 nm FWHM). The spectrometer's optical bench has a 2048-element linear CCD-array detector, making it especially useful for applications that demand high detector sensitivity.

❖ The IRRAD2000 is available in several platforms, depending on the A/D converter needed. The benchtop version interfaces to a desktop PC via the ADC500 or ADC1000 ISA-bus A/D card. The portable version interfaces to a notebook PC via the National Instruments DAQCard-700 PCMCIA A/D card. The serial port version interfaces to a desktop *or* notebook PC via the SAD500 Serial Port Interface.

❖ Our spectrometers are controlled through software, which in turn controls the A/D converter. OOIirrad is the standard 32-bit Windows operating software for Ocean Optics spectroradiometers. This acquisition and display software provides a real-time interface to a variety of signal-processing functions.

❖ The LS-1-CAL Calibrated Tungsten Halogen Light Source is a NIST-traceable source for the VIS-Shortwave NIR (300-1050 nm). It has a highly Lambertian internal diffuser, and is specifically calibrated for optical fibers. (The LS-1-CAL is not designed as an illumination source for absorbance, transmission or reflection measurements. The LS-1 Tungsten Halogen Light Source should be used for those applications.)

❖ The Cosine-corrected Irradiance Probe is a fiber optic spectroradiometric sampling device designed to collect radiation (light) from a 180° field of view, thus eliminating optical interface problems associated with the light collection sampling geometry inherent to other sampling devices.

❖ Also included as part of the IRRAD2000 is a 200-μm diameter, single-strand UV/VIS optical fiber that couples easily via SMA terminations to the spectrometer. This silica-core, silica-clad fiber is 2 meters in length.

These are the standard components for IRRAD2000, IRRAD2000-PORT, and IRRAD2000-SAD spectroradiometers. You may specify different size slits, optical fibers or other components. In addition to these radiometric systems, Ocean Optics offers several related components and calibration services that may be purchased separately.

Packing List
A packing list comes with each order. It is located inside a plastic bag attached to the outside of the shipment box. The invoice is mailed separately. The items listed on your packing slip include all of the components in your order. However, some items on your packing list are actually items you have specified to be installed *into* your spectrometer, such as the grating and slit. The packing list also includes important information such as the shipping address, billing address, and components on back order.

Wavelength Calibration Report
In your shipment box, you will find your spectrometer in a silver-gray anti-static bag. Your software diskettes and Wavelength Calibration Report are packaged with this manual. A Wavelength Calibration Report comes with every spectrometer channel, contains important information specific to your spectrometer, and should be retained. Use the calibration coefficients and intercept numbers on your Wavelength Calibration Report to calibrate the wavelength of your spectrometer.

Upgrades
Customers sometimes find that they need Ocean Optics to make a change or an upgrade to their system. In order for Ocean Optics to make these changes, the customer must first contact us and obtain a Return Merchandise Authorization (RMA) number. Please contact an Applications Scientist for specific instructions when returning a product.

Quick Start

The three pages in this section provide *brief* instructions on setting up your system, installing your A/D converter, installing the software, configuring the software, calibrating the spectral response of your system, and taking measurements. These instructions are provided in greater detail throughout this manual. Refer to the **Table of Contents** to locate *detailed* directions on specific functions and components.

Step 1: Interface the A/D Converter to your PC

If your A/D card is the ADC500 or the ADC1000 or if your are installing a PC2000

1. The default settings for our A/D products are a Base Address (or Input/Output Range) of 768 decimal and an IRQ of 7. You will need to match Base Address and IRQ settings on the A/D card to available settings in your computer. First determine which settings are not being used by other hardware devices.
   - If you have Windows 95/98, go to **Start | Settings | Control Panel**. Double-click the **System** icon. Choose the **Device Manager** tab and double-click on "Computer" at the top of the list of devices. Under **View Resources**, note available settings -- numbers unassigned to hardware. Remember that these I/O settings are expressed in hexadecimal and correspond to our Base Address, which is given in decimal, followed by the hexadecimal equivalent in parenthesis.
   - If you have Windows NT, go to **Start | Programs | Administrative Tools (Common) | Windows NT Diagnostics**. Click on the **Resources** tab. Select the **IRQ** button. Find an available IRQ. Select the **I/O Port** button. Find an available I/O Range (Base Address).
2. Note these available settings. When you first run OOIIrrad, you must enter these values in the "Configure Hardware" dialog box.
3. Turn off the computer and take off the computer cover. Ground yourself to the computer chassis or power supply and remove the A/D card from its static-shielded bag.
4. If necessary, change the position of the switches on the A/D board. (See **Appendix A** for switch positions.) For the ADC500, the Base Address is set via the bank of 6 switches labeled SW1 on the A/D board and the IRQ is set via the bank of 4 switches labeled SW2 on the A/D board. For the ADC1000 and PC2000, there is only one bank of switches on the A/D board: the Base Address may be changed via the first 6 switches and the IRQ may be changed via the last 3 switches.
5. Insert the A/D card into and ISA-bus slot and connect the necessary cables from the A/D card to the spectrometer. Make sure the connections are snug and restart your computer.

If your A/D converter is the DAQ-700

1. Install NI-DAQ version 6 CD Driver Software -- the device driver library necessary for Windows 95/98 and NT systems to properly use the DAQ-700 on your computer.
2. Insert the DAQ-700 into any available PCMCIA slot.
3. Find the IRQ and Base Address values.
   - If you have Windows 95/98, select **Start | Settings | Control Panel**. Double-click the **System** icon. Select the **Device Manager** tab. Double-click the hardware group named **Data Acquisition Devices**. Double-click **DAQCard-700**. Click the **Resources** tab. Find the check box next to **Use Automatic Settings**. Clear that check box (deselect it). Now 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 **Interrupt Request**. A dialog box giving the current hardware setting appears. Use the two small arrows to the right side of the **Value** box to change the hardware interface parameters. Choose values that say **No devices are conflicting**. Click **OK**. Click **Yes** at the "Creating a Forced Configuration" message box.
   - If you have Windows NT, go to **Start | Programs | Administrative Tools (Common) | Windows NT Diagnostics**. Click on the **Resources** tab. Select the **IRQ** button. Find the IRQ that your computer assigned to the A/D converter. Select the **I/O Port** button. Find the I/O Range (Base Address) that your computer assigned to the DAQ-700.
4. Note these values. When you first run OOIIrrad, you must enter these values in the "Configure Hardware" dialog box.

If your A/D converter is the SAD500

If your A/D converter is the SAD500 and is mounted onto the spectrometer, connect the cable from the SAD500 to your PC. If you ordered your SAD500 in its own housing, attach another cable from the spectrometer to the SAD500. Note the serial port number (also called COM Port) on the PC to which you are interfacing. Plug the +12VDC wall transformer into an outlet and connect it to the SAD500.

Step 2: Install OOIIrrad Software

Before installing OOIIrrad, make sure that no other applications are running.
1. Insert "Disk 1" into your floppy drive. (When prompted, insert Disks 2 and 3.) Execute **Setup.exe**.
2. At the "Welcome" dialog box, click **Next>**.
3. At the "Destination Location" dialog box, you can choose **Browse** to pick a destination directory. Click **Next>**.
4. At the "Backup Replaced Files" dialog box, select either **Yes** or **No**. We recommend selecting Yes. If you select Yes, you can choose **Browse** to pick a destination directory. Click **Next>**.
5. Select a Program Manager Group. Click **Next>**. At the "Start Installation" dialog box, click **Next>**.
6. At the "Installation Complete" dialog box, choose **Finish>**.
7. When prompted to do so, **restart your computer** when the installation is complete.

Step 3: Configure OOIIrrad Software

Now that your A/D converter and software have been installed, you need to configure your software by selecting options and entering information in a few dialog boxes.

Configure Hardware

Select **Spectrometer | Configure Hardware** from the menu to set the hardware parameters for the spectrometer. The parameters in this dialog box are usually set only once -- when OOIirrad is first installed and the software first opens. For detailed instructions on this dialog box, see page 24.

- **Spectrometer Type**. Choose the spectrometer you are using.
- **A/D Converter Type**. Select the A/D converter you are using.
- **Base Address (I/O Range)**. Select a Base Address. (This entry is for ADC500, ADC1000, and DAQ700 cards.)
- **IRQ (Interrupt Request)**. Select an IRQ. (This entry is for ADC500, ADC1000, and DAQ700 cards.)
- **SAD500 Serial Port**. Choose the COM port number your computer is using to interface to your SAD500. (This entry is for SAD500 converters.)
- **SAD500 Baud Rate**. Select the SAD500 operating speed. (This entry is for SAD500 converters.)
- **SAD500 Pixel Resolution**. Enter a resolution value. This value specifies that every n^{th} pixel of the spectrometer is transmitted from the SAD500 to the PC. (This entry is for SAD500 converters.)
- **Compress SAD500 Data**. Enable this function to minimize the amount of data transferred over the RS-232 connection. (This entry is for SAD500 converters.)

Configure Spectrometer

Select **Spectrometer | Configure Spectrometer** from the menu to configure your system and set important system parameters. Each spectrometer channel is shipped with a Wavelength Calibration Report. Enter all information from the report in this dialog box. For more information on this dialog box, see pages 24-25.

Configure Fibers

Select **Spectrometer | Configure Fibers** from the menu to enter the fiber diameter values for each channel in your setup. If using a bare fiber, enter the fiber's diameter here. If using a fiber with a CC-3 cosine corrector, enter 3,900. For detailed instructions on this dialog box, see page 25.

Set Acquisition Parameters

For detailed information about acquisition parameters, see pages 20-21.

- **Scans to Average**. Enter a value to implement a sample averaging function.
- **Smoothing Size**. Enter a value here to implement a technique that averages across spectral data.
- **Nominal Integration Period**. The higher the integration time, the longer the detector "looks" at the incoming photons. If the intensity is too low, increase this value. If too high, decrease the value.
- **Actual Integration Period**. This value is displayed after you enter your Nominal Integration Period and take a scan. You cannot modify this value, except by changing the Nominal Integration Period.

Step 4: Calibrate your System with the LS-1-CAL

Before beginning the process of calibrating the absolute spectral response of your system with the LS-1-CAL Calibrated Tungsten Halogen Light Source, make sure that the optical setup you wish to use for your application, you also use when calibrating.

For detailed instructions on calibrating the absolute spectral response of your system with the LS-1-CAL, see pages 26-27 (or pages 28-29).

Step 5: Take your Measurements

By now you have set up your spectrometer and sampling optics, established your acquisition parameters, calibrated the spectral response of your system, and taken your reference and dark scans. Now you are ready to take your absolute irradiance measurements.

1. Change from Scope Mode into **Irradiance Mode**.
2. Position the probe or fiber at the light or emission source you wish to measure.
3. Select the **Scan** button. If you wish to take multiple scans, make sure the **Continuous** option is selected.
4. Save the spectrum by choosing **File | Save**.

. If at any time any sampling variable changes -- including integration time, averaging, smoothing, etc. -- you must store new reference (re-calibrate the spectral response of your system) and dark scans.
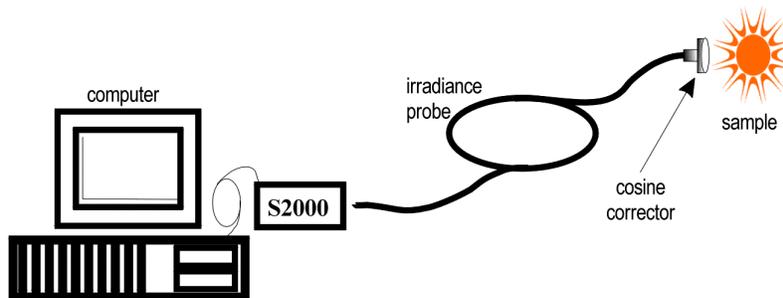
A typical configuration for an irradiance experiment.

A/D Converter and Software Installation

This section covers the basic installation instructions for the A/D converters we offer -- the ADC500, ADC1000, DAQ-700, and SAD500 -- as well as OOIIrrad Irradiance Software. Our software includes drivers that support the A/D converters we offer. Other A/D converters can be used if these conditions are met:
1. the ADC sampling rate is at least 100 kHz
2. external triggering of the A/D conversions is supported
3. there are a sufficient number of clocks and digital output lines to operate the spectrometer
4. a suitable software driver has been written and a suitable cable has been fabricated

National Instruments A/D converters can be used with special LabVIEW drivers. Other A/D converters and software can be used to control our products; however, you will need to create your own drivers. If you plan to write your own drivers, contact one of our Applications Scientists for details.

ADC500 and OOIIrrad Software Installation

The **ADC500 A/D CARD** is a 12-bit, 8-channel ISA-bus analog-to-digital converter card that connects our spectrometers to desktop PCs. This single-ended, half-length card fits into a slot in a desktop PC, and has a 500 kHz sampling frequency.

Each device in or connected to your computer is assigned specific settings; it's similar to giving each device its own name so that your computer will know what to call and how to recognize the device. In order for your ADC500 to work as a device in your computer, it has to be assigned a Base Address setting and an IRQ setting. The default settings for each are:

> **Base Address (I/O Range)**   **768 decimal (300 hexadecimal)**
> **IRQ (Interrupt Request)**   **07**

These default values are set on the A/D converter. There are dip switches on the A/D board and their positions determine the values. These default values are set in the operating software as well. Most of the time, these default settings will work with your computer. However, if you have many devices installed in your computer, you may have a conflict; other devices may be using these settings. If there is a conflict with another device in your computer, you must change the positions of the switches on the A/D board.

For the ADC500, the Base Address is set via the bank of 6 switches labeled SW1 on the A/D board and the IRQ is set via the bank of 4 switches labeled SW2 on the A/D board. To first check your computer to see which settings are available, follow the instructions for the Windows system that you use.

Windows 95 and Windows 98 Users:
Find Available Base Address and IRQ Settings

1. Go to **Start | Settings | Control Panel** and double-click on the **System** icon.
2. Choose the **Device Manager** tab and double-click on "Computer" at the top of the list of devices.
3. Under **View Resources**, find available settings -- numbers unassigned to hardware. Note these available settings for both the Interrupt Request (IRQ) and the Input/Output Range (Base Address). Remember that Input/Output settings are expressed in hexadecimal and correspond to our Base Address, which is given in decimal, followed by the hexadecimal equivalent in parenthesis. When you first run OOIIrrad, you must enter these values in the "Configure Hardware" dialog box. (For most computers, our A/D converters can share the IRQ 07 setting with a printer and conflicts will not arise. All computers have multiple Base Address settings from which to choose.)

Windows NT Users:
Find Available Base Address and IRQ Settings

1. Go to **Start | Programs | Administrative Tools (Common) | Windows NT Diagnostics**.
2. In the "Windows NT Diagnostics" dialog box, click on the **Resources** tab.
3. Select the **IRQ** button. Find an available IRQ -- a number unassigned to a device.
4. Select the **I/O Port** button. Find an available I/O Range -- a number or range of numbers unassigned to a device. (Remember that these I/O settings are expressed in hexadecimal and correspond to our Base Address, which is given in decimal, followed by the hexadecimal equivalent in parenthesis.)
5. Note these available settings. When you first run OOIIrrad, you must enter these values in the "Configure Hardware" dialog box.

.   With Windows NT, devices cannot share IRQs; each device must be assigned a unique IRQ.

Install the ADC500

1. Turn off the computer and remove the computer cover.
2. Ground yourself to the computer chassis or power supply. Remove the ADC500 from its anti-static bag.
3. If necessary, change the position of the switches on the A/D board. Position the switches to match the available settings you found in the previous section -- numbers not being used by other hardware devices. See **Appendix A** for switch setting positions.
4. Find an open ISA-bus slot and remove the slot protector.
5. Insert the A/D card into an available expansion slot on the motherboard connector by *gently* rocking the card into the slot. Make sure the card is fully seated in the motherboard before screwing the tab on the A/D card to the computer. Do not bend the card or move it from side to side once it is seated in the slot.
6. Attach the D37 end of the cable to the card and the D25 end to the spectrometer. Reinstall the cover.

Install OOIIrrad

Before installing OOIIrrad, make sure that no other applications are running.
1. Insert "Disk 1" into your floppy drive. (When prompted, insert Disks 2 and 3.) Execute **Setup.exe**.
2. At the "Welcome" dialog box, click **Next>**.
3. At the "Destination Location" dialog box, you can choose **Browse** to pick a destination directory. Click **Next>**.
4. At the "Backup Replaced Files" dialog box, select either **Yes** or **No**. We recommend selecting Yes. If you select Yes, you can choose **Browse** to pick a destination directory. Click **Next>**.
5. Select a Program Manager Group. Click **Next>**. At the "Start Installation" dialog box, click **Next>**.
6. At the "Installation Complete" dialog box, choose **Finish>**. When prompted, **restart your computer**.

Run OOIIrrad

After you restart your computer, navigate to the OOIIrrad icon and select it. The first time you run OOIIrrad after installation, you must enter values for your hardware.

Configure Hardware Dialog Box
Next, the Configure Hardware dialog box opens. The parameters in the Configure Hardware dialog box are usually set only once -- when OOIIrrad is first installed and the software first opens.

1. Under **Spectrometer Type**, choose your spectrometer
2. Under **A/D Converter Type**, choose ADC500/PC1000.
3. Under **Base Address**, choose the same setting as the dip switches on the A/D board (and the same available setting you found in your computer).

    Remember that the Input/Output Range (Base Address) you selected was expressed in hexadecimal. In this dialog box, the Base Address is given in decimal, followed by the hexadecimal equivalent in parenthesis. For example, "**768 (0x0300)**" gives the Base Address as 768 decimal and 300 hexadecimal.

4. Under **IRQ**, choose the same setting as the dip switches on the A/D board (and the same available setting you found in your computer).
5. For your setup, only these parameters apply to your system. (Ignore the other settings; they apply to other A/D converters.) Click **OK**. You can always change these settings by selecting **Spectrometer | Configure Spectrometer**.

.   If you do not see the "Configure Hardware" screen, exit the software. Then select **Start** | **Run**, and type `C:\windows\ooidrv.ini` for Windows 95/98 systems or `c:\winnt\ooidrv.ini` for Windows NT systems. Notepad will open. Edit this file for our device driver by finding the "Initialized" entry and making sure this line reads `Initialized=0`. Save the OOIDRV.INI file and exit Notepad. Restart OOIIrrad. You should now see the "Configure Hardware" dialog box.

ADC500 A/D Card Specifications

Board architecture/design:	half-length ISA-bus card for single slot in desktop PC
Resolution:	12-bit
Sampling frequency:	500 kHz (maximum)
Interface cable:	• 37-pin end to A/D card, 25-pin end to spectrometer • length is ~3.5' (slightly >1 meter)
Multiple-channel capability:	supports up to 8 spectrometer channels
Installation parameters:	• set dip switch for Base Address (default = 768 decimal, 300 hexadecimal) • set dip switch for IRQ (default = 7)
Integration time:	5 milliseconds to 60 seconds with S2000 series spectrometers

ADC1000 (or PC2000) and OOIIrrad Software Installation

The **ADC1000 A/D CARD** is a high-speed ISA-bus analog-to-digital converter card that connects our miniature fiber optic spectrometers to desktop PCs. The ADC1000 is a 12-bit, 8-channel, single-ended A/D card. The **PC2000 PC PLUG-IN SPECTROMETER** has our 2048-element linear CCD-array fiber optic spectrometer mounted onto an ADC1000 A/D card. This sturdy spectrometer-A/D card combination fits easily into a slot in the PC. Both the ADC1000 and the PC2000 are installed in the same way.

Each device in or connected to your computer is assigned specific settings; it's similar to giving each device its own name so that your computer will know what to call and how to recognize the device. In order for your ADC1000 or PC2000 to work as a device in your computer, it has to be assigned a Base Address setting and an IRQ setting. The default settings for each are:

> **Base Address (I/O Range)** **768 decimal (300 hexadecimal)**
> **IRQ (Interrupt Request)** **07**

These default values are set on the A/D converter. There are dip switches on the A/D board and their positions determine the values. These default values are set in the operating software as well. Most of the time, these default settings will work with your computer. However, if you have many devices installed in your computer, you may have a conflict; other devices may be using these settings. If there is a conflict with another device in your computer, you must change the positions of the switches on the A/D board.

For the ADC1000 and PC2000, there is only one bank of switches on the A/D board: the Base Address may be changed via the first 6 switches and the IRQ may be changed via the last 3 switches. To first check your computer to see which settings are available, follow the instructions for the Windows system that you use.

Windows 95 and Windows 98 Users:
Find Available Base Address and IRQ Settings

1. Go to **Start | Settings | Control Panel** and double-click on the **System** icon.
2. Choose the **Device Manager** tab and double-click on "Computer" at the top of the list of devices.
3. Under **View Resources**, find available settings -- numbers unassigned to hardware. Note these available settings for both the Interrupt Request (IRQ) and the Input/Output Range (Base Address). When you first run OOIIrrad, you must enter these values in the "Configure Hardware" dialog box. (Remember that Input/Output Range settings are expressed in hexadecimal and correspond to our Base Address, which is given in decimal, followed by the hexadecimal equivalent in parenthesis.)
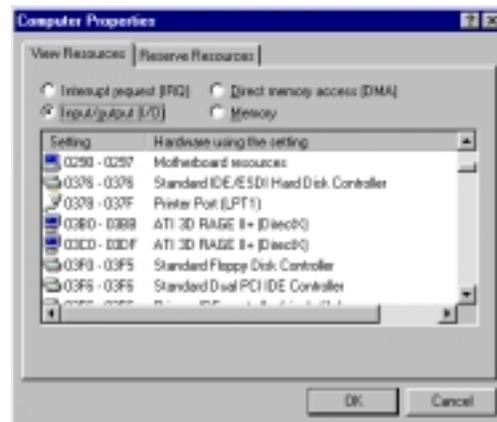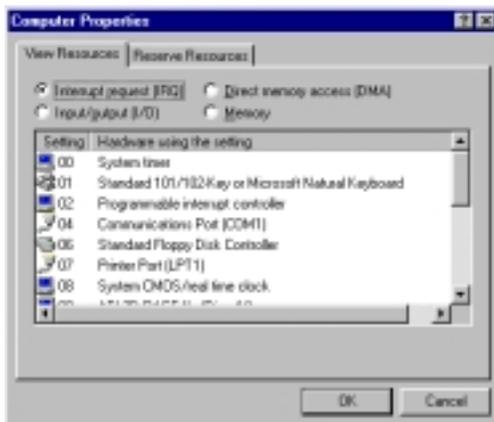
. For most computers, the default settings on our A/D converters work well. In the picture above left, it appears that the Printer occupies IRQ Setting 07, but for most computers, our A/D converters can share the IRQ 07 setting with a printer and conflicts will not arise. All computers have multiple Base Address (Input/Output Range) settings from which to choose.

Windows NT Users:
Find Available Base Address and IRQ Settings

1. Go to **Start | Programs | Administrative Tools (Common) | Windows NT Diagnostics**.
2. In the "Windows NT Diagnostics" dialog box, click on the **Resources** tab.
3. Select the **IRQ** button. Find an available IRQ -- a number unassigned to a device.
4. Select the **I/O Port** button. Find an available I/O Range -- a number or range of numbers unassigned to a device. (Remember that I/O Range settings are expressed in hexadecimal and correspond to our Base Address, which is given in decimal, followed by the hexadecimal equivalent in parenthesis.)
5. Note these available settings. When you first run OOIIrrad, you must enter these values in the "Configure Hardware" dialog box.
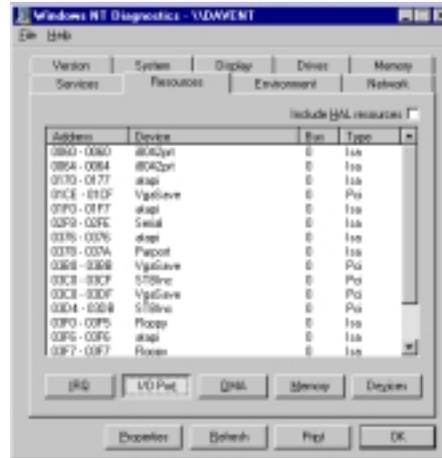
. With Windows NT, devices cannot share IRQs; each device must be assigned a unique IRQ.

Install the ADC1000 or PC2000

1. Turn off the computer and remove the computer cover.
2. Ground yourself to the computer chassis or power supply. Remove the A/D card from its anti-static bag.
3. If necessary, change the position of the switches on the A/D board. Position the switches to match the available settings you found in the previous section -- numbers not being used by other hardware devices. See **Appendix A** for switch setting positions.
4. Find an open ISA-bus slot and remove the slot protector.
5. Insert the A/D card into an available expansion slot on the motherboard connector by *gently* rocking the card into the slot. Make sure the card is fully seated in the motherboard before screwing the tab on the A/D card to the computer. Do not bend the card or move it from side to side once it is seated in the slot.
6. For the ADC1000, attach the D37 end of the cable to the card and the D25 end to the spectrometer. For the PC2000, attach the desired optical fiber to the SMA connector on the PC2000. Reinstall the cover.

Install OOIIrrad

Before installing OOIIrrad, make sure that no other applications are running.
1. Insert "Disk 1" into your floppy drive. (When prompted, insert Disks 2 and 3.) Execute **Setup.exe**.
2. At the "Welcome" dialog box, click **Next>**.
3. At the "Destination Location" dialog box, you can choose **Browse** to pick a destination directory. Click **Next>**.
4. At the "Backup Replaced Files" dialog box, select either **Yes** or **No**. We recommend selecting Yes. If you select Yes, you can choose **Browse** to pick a destination directory. Click **Next>**.
5. Select a Program Manager Group. Click **Next>**. At the "Start Installation" dialog box, click **Next>**.
6. At the "Installation Complete" dialog box, choose **Finish>**. When prompted, **restart your computer**.

Run OOIIrrad

After you restart your computer, navigate to the OOIIrrad icon and select it. The first time you run OOIIrrad after installation, you must enter values for your hardware.

Configure Hardware Dialog Box

Next, the **Configure Hardware** dialog box opens. The parameters in this dialog box are usually set only once -- when OOIIrrad is first installed and the software first opens.

1. Under **Spectrometer Type**, choose your spectrometer.
2. Under **A/D Converter Type**, choose ADC1000/PC2000.
3. Under **Base Address**, choose the same setting as the dip switches on the A/D board (and the same available setting you found in your computer).

    Remember that the Input/Output Range (Base Address) you selected was expressed in hexadecimal. In this dialog box, the Base Address is given in decimal, followed by the hexadecimal equivalent in parenthesis. For example, "**768 (0x0300)**" gives the Base Address as 768 decimal and 300 hexadecimal.

4. Under **IRQ**, choose the same setting as the dip switches on the A/D board (and the same available setting you found in your computer).
5. For your setup, only these parameters apply to your system. (Ignore the other settings; they apply to other A/D converters.) Click **OK**. You can always change these settings by selecting **Spectrometer | Configure Spectrometer**.

.   If you do not see the "Configure Hardware" screen, exit the software. Then select **Start** | **Run**, and type **C:\windows\ooidrv.ini** for Windows 95/98 systems or **c:\winnt\ooidrv.ini** for Windows NT systems. Notepad will open. Edit this file for our device driver by finding the "Initialized" entry and making sure this line reads **Initialized=0**. Save the OOIDRV.INI file and exit Notepad. Restart OOIIrrad. You should now see the "Configure Hardware" dialog box.

ADC1000 and PC2000 ISA-bus A/D Card Specifications

Board architecture/design:	half-length ISA-bus card for single slot in desktop PC
Resolution:	12-bit
Sampling frequency:	1 MHz (maximum)
Interface cable:	For the ADC1000: 37-pin connector to A/D card and 25-pin connector to spectrometer
Multiple-channel capability:	up to 8 spectrometer channels for S2000/PC2000 spectrometers
Installation parameters:	• set dip switch for Base Address (default = 768 decimal, 300 hexadecimal) • set dip switch for IRQ (default = 7)
Integration time:	3 milliseconds to 60 seconds with S2000 series spectrometers

DAQ-700 and OOIIrrad Software Installation

The **DAQ-700 A/D CARD** is a 12-bit PCMCIA-type analog-to-digital converter card that connects our spectrometers to notebook PCs. This 16-channel single-ended/8-channel differential card -- also known by its National Instruments DAQCard™-700 designation -- fits into a credit card-size slot in a notebook PC. It has a 100 kHz sampling frequency.

Before using your spectrometer, you must first configure your computer to properly detect and use the DAQ-700 and then follow several steps to use it as an interface to your Ocean Optics spectrometer.

Install OOIIrrad

Before installing OOIIrrad, make sure that no other applications are running.
1. Insert "Disk 1" into your floppy drive. (When prompted, insert Disks 2 and 3.) Execute **Setup.exe**.
2. At the "Welcome" dialog box, click **Next>**.
3. At the "Destination Location" dialog box, you can choose **Browse** to pick a destination directory. Click **Next>**.
4. At the "Backup Replaced Files" dialog box, select either **Yes** or **No**. We recommend selecting Yes. If you select Yes, you can choose **Browse** to pick a destination directory. Click **Next>**.
5. Select a Program Manager Group. Click **Next>**. At the "Start Installation" dialog box, click **Next>**.
6. At the "Installation Complete" dialog box, choose **Finish>**. When prompted, restart your computer.

Install NI-DAQ

Windows 95/98 and NT users must install NI-DAQ Driver Software -- the device driver library necessary for Windows 95/98/NT systems to properly use the DAQ-700.
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. 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 called **Install NI-DAQ**. Select that option.
4. In the "Select Components" dialog box, 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 and the default Program Group.
6. In the "Ready to Install" dialog box, click **Next>**. When prompted to do so, restart your computer. **You must restart your computer at this time.**

Install the DAQ-700

1. 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.
2. Insert the DAQ-700 into any available PCMCIA slot.
3. Windows 95/98 and NT 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.
4. To find IRQ and Base Address values, follow the instructions for the Windows system that you use.

For Windows 95/98 Users: Configure the DAQ-700

1. If you hear the "happy" sound, click **Start**, and select **Settings | Control Panel**.
2. Double-click the **System** icon. Select the **Device Manager** tab.

3. In the "Device Manager" dialog box, find the hardware group named **Data Acquisition Devices**. Either double-click the group or select the group and click **Properties**.
4. Under the Data Acquisition Devices group, find the entry for your DAQ-700. Either double-click **DAQCard-700**, or select the entry and click **Properties**.
5. 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.
6. In this dialog box, find the check box next to **Use Automatic Settings**. Clear that check box (deselect it). We need to know the settings of the hardware before any Ocean Optics software product starts.
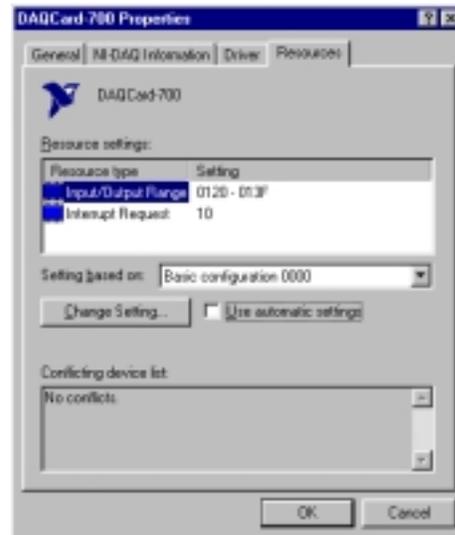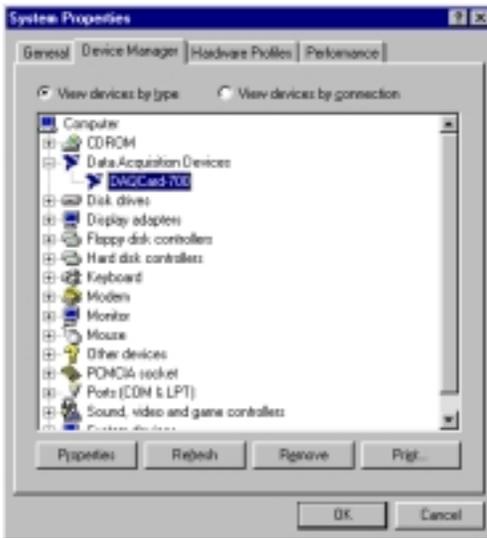
7. In the same dialog box, you will see entries for Input/Output Range and Interrupt Request. The Input/Output Range corresponds to the Base Address, and the Interrupt Request corresponds to the IRQ in our software. By deselecting the Use Automatic Settings box in the previous step, you disabled Plug-and-Play 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 **Interrupt Request** or both. A dialog box giving the

13

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.

8. 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 selecting values with no conflicts, click **OK**. You will then see the "Creating a Forced Configuration" message box. Click **Yes**.
9. Note your values of both the Input/Output Range (Base Address) and the Interrupt Request (IRQ). When you first run OOIIrrad, you must enter these values in the "Configure Hardware" dialog box.

For Windows NT Users: Find the IRQ and I/O Range

1. If you hear the "happy" sound, go to **Start | Programs | Administrative Tools (Common) | Windows NT Diagnostics**.
2. In the "Windows NT Diagnostics" dialog box, click on the **Resources** tab.
3. Select the **IRQ** button. Find the IRQ that your computer assigned to the A/D converter you are using to interface to your spectrometer. Note this number.
4. Select the **I/O Port** button. Find the I/O Range (Base Address) that your computer assigned to the DAQ-700 to interface to your spectrometer. Note this number. (This number is in hexadecimal.)
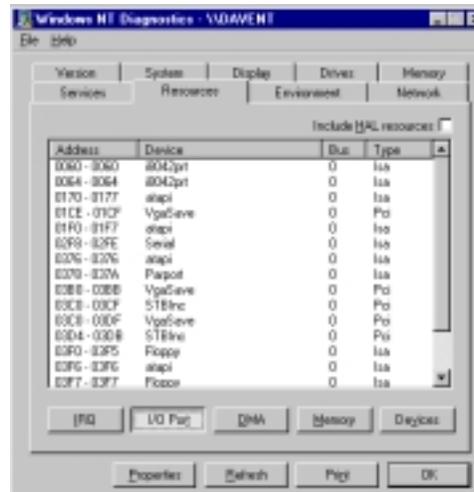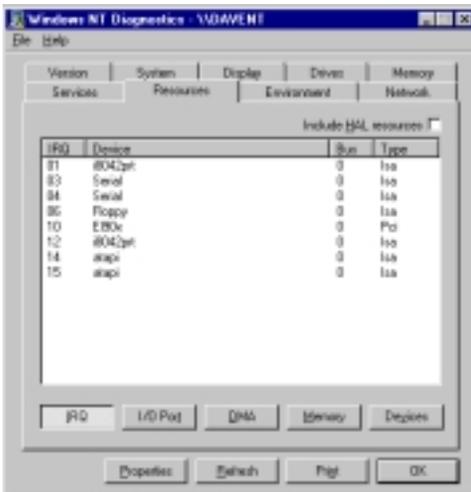
Run OOIIrrad

After you restart your computer, navigate to the OOIIrrad icon and select it. The first time you run OOIIrrad after installation, you must enter values for your hardware.

Configure Hardware Dialog Box

Next, the **Configure Hardware** dialog box opens. The parameters in this dialog box are usually set only once -- when OOIIrrad is first installed and the software first opens.

1. Under **Spectrometer Type**, choose your spectrometer.
2. Under **A/D Converter Type**, choose DAQ700.
3. If you are a Windows 95/98 user, choose the same **Base Address** value selected in steps 8 and 9 in the section, **For Windows 95/98 Users: Configure the DAQ-700** (page 14). If you are a Windows NT user, choose the same **Base Address** value selected in step 4 in the section, **For Windows NT Users: Find the IRQ and I/O Range** (page 14).

   The I/O Range (Base Address) you selected was expressed in hexadecimal. In this dialog box, the Base Address is given in decimal, followed by the hexadecimal equivalent in parenthesis. For example, "**768 (0x0300)**" is 768 decimal, 300 hexadecimal.

4. If you are a Windows 95/98 user, choose the same **IRQ** value selected in steps 8 and 9 in the section, **For Windows 95/98 Users: Configure the DAQ-700** (page 14). If you are a Windows NT user, choose the same **IRQ** value selected in step 3 in the section, **For Windows NT Users: Find the IRQ and I/O Range** (page 14).

5. For your setup, only these parameters apply to your system. (Ignore the other settings; they apply to other A/D converters.) Click **OK**. You can always change these settings by selecting **Spectrometer | Configure Spectrometer**.

. If you do not see the "Configure Hardware" screen, exit the software. Then select **Start** | **Run**, and type `C:\windows\ooidrv.ini` for Windows 95/98 systems or `c:\winnt\ooidrv.ini` for Windows NT systems. Notepad will open. Edit this file for our device driver by finding the "Initialized" entry and making sure this line reads `Initialized=0`. Save the OOIDRV.INI file and exit Notepad. Restart OOIIrrad. You should now see the "Configure Hardware" dialog box.

DAQ-700 A/D Card Specifications

Type:	PCMCIA Type II
Resolution:	12-bit
Sampling frequency:	100 kHz (maximum)
Channels:	16-channel single-ended; 8-channel differential
Interface cable:	50-pin connector to A/D card; 25-pin connector to spectrometer
Multiple-channel capability:	supports up to 4 spectrometer channels (number of supportable channels is function of electrical current limitations)

SAD500 and OOIIrrad Software Installation

The **SAD500 SERIAL PORT INTERFACE** is a microprocessor-controlled A/D converter for serial port connection or stand-alone operation. The SAD500 can be used to interface to desktop or portable PCs, PLCs, and other devices that support the RS-232 communication protocol.

Interface the SAD500 to your PC

1. If you ordered your SAD500 mounted onto your spectrometer, simply connect the 6-pin DIN end of the serial cable to the SAD500 and the DB9 end to your PC. Some PCs may require a 9-pin to 25-pin converter (not included). If you ordered your SAD500 in its own housing, attach the 25-pin conductor ribbon cable from the spectrometer to the SAD500. Then connect the 6-pin DIN end of the serial cable to the SAD500 and the DB9 end to your PC.
2. For either configuration, note the serial port number (also called COM Port) on the PC to which you are interfacing. (Older PCs may not have numbered ports.)
3. Plug the +12VDC wall transformer into an outlet and connect it to the SAD500.

Install OOIIrrad

Before installing OOIIrrad, make sure that no other applications are running.
1. Insert "Disk 1" into your floppy drive. (When prompted, insert Disks 2 and 3.) Execute **Setup.exe**.
2. At the "Welcome" dialog box, click **Next>**.
3. At the "Destination Location" dialog box, you can choose **Browse** to pick a destination directory. Click **Next>**.
4. At the "Backup Replaced Files" dialog box, select either **Yes** or **No**. We recommend selecting Yes. If you select Yes, you can choose **Browse** to pick a destination directory. Click **Next>**.
5. Select a Program Manager Group. Click **Next>**. At the "Start Installation" dialog box, click **Next>**.
6. At the "Installation Complete" dialog box, choose **Finish>**. When prompted, **restart your computer**.

Run OOIIrrad

After you restart your computer, navigate to the OOIIrrad icon and select it. The first time you run OOIIrrad after installation, you must enter values for your hardware.

Configure Hardware Dialog Box
Next, the **Configure Hardware** dialog box opens. The parameters in this dialog box are usually set only once -- when OOIIrrad is first installed and the software first runs.
1. Under **Spectrometer Type**, choose your spectrometer.
2. Under **A/D Converter Type**, choose SAD500.
3. Under **Serial Port**, choose the COM port number your computer is using to interface to your SAD500. See the **Troubleshooting** section on the next page to determine the COM Port.
4. Under **Baud Rate**, select the speed at which the SAD500 will operate.
5. Under **SAD Pixel Resolution**, enter resolution values from 1 to 500. This value specifies that every n^{th} pixel of the spectrometer is transmitted from the SAD500 to the PC. Your resolution value depends on your experiment. By sacrificing resolution, you gain speed. The transfer of one complete spectra requires ~0.4 seconds when communicating at 115,200 baud rate. If you need your information in <0.4 seconds, increase the resolution or enable data compression (see the following step).

6. Enable the **Compress SAD500 Data** function to minimize the amount of data transferred over the RS-232 connection. Transmission of spectral data over the serial port is a relatively slow process. Enabling this function ensures that every scan transmitted by the SAD500 will be compressed, greatly increasing the data transfer speed of the SAD500.

7. For your setup, only these parameters apply to your system. (Ignore the other settings; they apply to other A/D converters.) Click **OK**. You can always change these settings by selecting **Spectrometer | Configure | A/D Interface**.

.   If you do not see the "Configure Hardware" screen, exit the software. Then select **Start** | **Run**, and type `C:\windows\ooidrv.ini` for Windows 95/98 systems or `c:\winnt\ooidrv.ini` for Windows NT systems. Notepad will open. Edit this file for our device driver by finding the "Initialized" entry and making sure this line reads `Initialized=0`. Save the OOIDRV.INI file and exit Notepad. Restart OOIIrrad. You should now see the "Configure Hardware" dialog box.
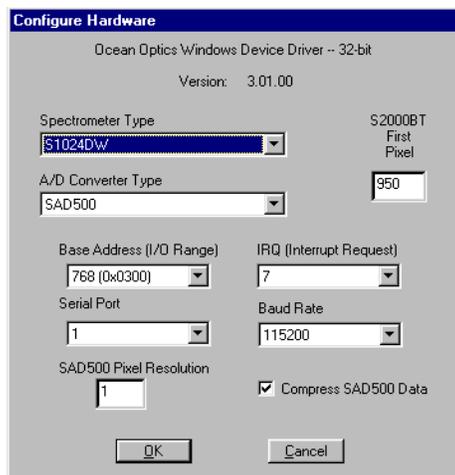
Troubleshooting

Occasionally, there will be problems associated with your PC configuration and the software. Here are a few tips to assist you.

- To ensure that the software and hardware are in-synch, exit OOIIrrad, cycle power on the SAD500 and restart OOIIrrad.
- In Windows 95/98, you can find out your Serial Port number by selecting **Start | Settings | Control Panel.** Then double-click on the **System** icon and select the **Device Manager** tab. Double-click on **Ports (COM & LPT)** and this will display the COM port numbers. Ensure that there is no yellow or red warning sign next to the COM Port you are attempting to use.
- If the ports on your PC are not labeled and you don't know which COM port you are using for your SAD500, you may have to resort to trial and error. If you choose the wrong serial port number, you will not see a dynamic trace responding to light near the bottom of the displayed graph. Instead, you will see a straight line.
- The default baud rate is 57,600. If your computer is not capable of communicating at this speed, select **Spectrometer | Configure Spectrometer** from the menu. Under **SAD500 Baud Rate**, select a slower baud rate.
- On some computers, users may have to disable any virus protection software to ensure timely and complete transfer of the data.

SAD500 Specifications

A/D resolution:	12-bit
A/D sampling frequency:	500 kHz (maximum)
Communication port:	RS-232
Baud rate:	2400-115,200
Input voltage:	10 – 24V
Input current:	130 mA without spectrometer
Interface cable:	9-pin connector to PC, 25-pin connector to spectrometer
Multiple-channel capability:	supports up to 8 spectrometer channels
Spectrometer integration time:	31 milliseconds to 60 seconds (S1024DW spectrometers) 5 milliseconds to 60 seconds (S2000 spectrometers)

OOIlrrad Irradiance Operating Software

OOIIrrad, our new 32-bit, acquisition and display operating software for the IRRAD2000 Spectroradiometer, performs a number of valuable functions in measuring the absolute spectral intensity (calculated in $\mu W/cm^2/nm$) for light and other emission sources. OOIIrrad provides a real-time interface to a variety of signal-processing functions. Data acquisition parameters -- such as averaging, smoothing, and adjusting the integration time -- are displayed just to the right of the graph for easy access. With OOIIrrad, you have the ability to obtain photopic data -- calculated in lumens or lux per unit area -- based on a CIE standard visibility curve.

You can also control the parameters for all system functions such as acquiring data, designing the graph display and configuring the cursor. Another feature provides you with the ability to create a spreadsheet display of lamp output intensity by wavelength.

The OOIIrrad software will be updated and improved continuously. You can obtain free upgrades until a completely new version is released. Download upgrades at **www.oceanoptics.com/Software_Updates.asp**. In order to download the free software upgrade, you will the password on the back of the Ocean Optics CD.

Display Functions

Several functions are accessed not through the menu but through buttons and task bars directly on the display screen, on the top and to the right of the graph area. From the display screen, you can choose a mode to view your data, choose a mode to acquire data, take scans of your sample, scale the graph, store a dark spectrum, configure the cursor, configure the graph, enter data acquisition parameters, and analyze displayed photopic data.

View Data Modes

Scope Mode
This mode allows you the ability to have complete control of signal processing before calibrating the spectral response of your system and taking absolute irradiance measurements. Use this spectral view mode when configuring your setup, adjusting the integration time, performing the spectral response calibration, and taking a dark scan.

The signal graphed in Scope Mode is the raw voltage coming out of the A/D converter. Once you open OOIIrrad and it begins to acquire data, you see the raw voltage from the detector expressed in A/D counts. Be careful when using this mode, as it represents a combination of several factors: the intensity of the light source, the reflectivity of the grating and the mirrors in the spectrometer's optical bench, the transmission of the fibers, the response of the detector, and the spectral characteristics of the sample.

μW/cm^2/nm (or Absolute Irradiance Mode)
The signal graphed in this mode is the calibrated irradiance intensity of the sample. Use the Irradiance Mode after calibrating the spectral response of your system and taking a dark scan.

Acquire Data Modes

Scan/Stop Button

When in **Single** mode, the Scan button acts as a snapshot. After selecting the Single mode, click on the Scan button to take an irradiance scan of the sample. The button depresses and Stop replaces Scan. The button will stay depressed until the scan has been completed (the time set in the Nominal Integration Period box).

When in **Continuous** mode, the Scan button continuously takes as many irradiance scans of the sample as needed. After each integration cycle, another scan will immediately begin. The button depresses and Stop replaces Scan. Click on Stop to halt the scanning process and discontinue acquiring data.

Scale the Graph

Auto Scaling

The **Auto Scale Y** function automatically adjusts the vertical scale of a current graph so the entire vertical spectrum fills the graph. The **Auto Scale X** function automatically adjusts the horizontal scale of a current graph so the entire horizontal spectrum fills the graph.

X and Y Scaling

You can change the vertical and/or horizontal scales of the graph by simply clicking on an X and Y endpoint and manually typing in a value. The graph will then resize itself.

Store a Dark

This function stores the current spectrum as the dark spectrum for all active channels. A dialog box opens with the message **Block light path to spectrometer for a DARK scan. Will be save in "dark.txt."** The dark spectrum is taken with the light path to the sample blocked. Saving a dark spectrum is requisite before the computer can make the calculation of absolute irradiance spectra.
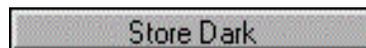
Cursor Functions

Channel

When the cursor is being used, the first box in the configure cursor task bar names the spectrometer channel the cursor is currently reporting.
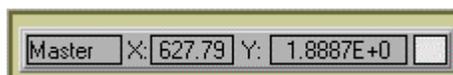
X and Y Values

When the cursor is being used, the second and third box in the configure cursor task bar gives the X value and Y value of the cursor point.

Cursor Properties

To the right of the X and Y values of the cursor is a cursor selection button that allows you to choose a cursor style and a point style. You can also choose a color for the cursor and whether or not to display the name of the channel the cursor is currently reporting. Finally, you can bring the cursor to the center of the spectrum or center the spectrum around the cursor's current position.

Graph Functions

These functions provide you with several graphing tools. You can also select the foreground and background colors for each channel.

Channels Activated

Choose which channels should be displayed in the graph by clicking in the box to the left of the channel's name.

Display Properties

Also, you can click on the channel's name or designated spectrum color to choose from several aesthetic functions such as: the plot design of the spectrum, the point style used in the spectrum, the line style and width desired, color or the plot, and a bar plot design. You can also choose to fill the baseline in the spectrum.

Move Cursor

To move the cursor left or right in small increments in the graph area, click on the left and right sections of the "move cursor" diamond. The top and bottom sections of the "move cursor" diamond will send the cursor to the next or previous channel in your system.
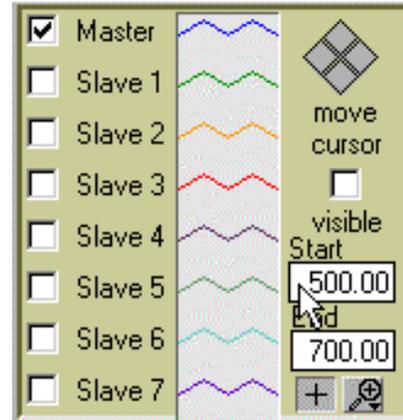
Enable Cursor

To activate the cursor functions, the **visible** box must be checked. To view the graph without the cursor, simply deselect the visible box.

+ Sign

When the + is selected, the pointer becomes a crosshair symbol, enabling you to drag the cursor around the graph.

Magnify Symbols

There are several magnify functions from which to choose. The function chosen will remain in use until another magnify icon or the crosshair symbol is selected. Clockwise, beginning with the top left symbol, the magnify icons perform the following functions:
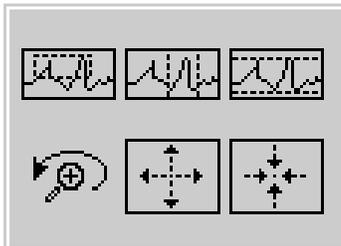
1. magnifies a specific area by clicking and dragging a box around the area
2. zooms in on the horizontal scale, but the vertical scale remains the same
3. zooms in on the vertical scale, but the horizontal scale remains the same
4. zooms in approximately one point vertical and horizontal, click once or press continuously
5. zooms out approximately one point vertical and horizontal, click once or press continuously
6. reverts to the last zoom function

Acquisition Parameters

Scans to Average

Enter a value to implement a sample averaging function that averages x number of spectra. The value chosen affects all channels in the system. The higher the value entered the better the signal-to-noise ratio. The S:N improves by the square root of the number of scans averaged.

Smoothing Size

Enter a value here to implement a boxcar smoothing technique that averages across spectral data. This method averages a group of adjacent detector elements. A value of 5, for example, averages each data point with itself, 5 points to its left and 5 points to its right. The greater this value, the smoother the data and the higher the signal-to-noise ratio. If the value entered is too high, a loss in spectral resolution will result. The S:N improves by the square root of the number of pixels averaged.
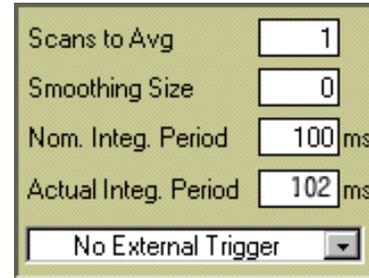
Scans to Avg	1
Smoothing Size	0
Nom. Integ. Period	100 ms
Actual Integ. Period	102 ms
No External Trigger	

Nominal Integration Period

The integration time of the spectrometer is analogous to the shutter speed of a camera. The higher the integration time, the longer the detector "looks" at the incoming photons. If the intensity is too low, increase this value. If the intensity is too high, decrease the value. While watching the graph trace in Scope Mode, adjust the Nominal Integration Time until the signal intensity level is approximately 3500 counts.

Actual Integration Period

This value is displayed after you enter your Nominal Integration Period and take a scan. You cannot modify this value. The value will change if the Nominal Integration Period changes. The calculations used for the Actual Integration Period are:

Nominal Integration x 1.024 milliseconds (for the ADC500, ADC1000, and SAD500)
Nominal Integration x 1.28 milliseconds (for the DAQ-700)

No External Trigger and External Software Trigger

The default No External Trigger Mode (or Normal Mode) is a continuously scanning mode. The External Software Trigger Mode is an external control mode allowing you to signal the spectrometer to take complete data sets. When the External Software Trigger is used, some external event tells the spectrometer when to scan. To use the External Software Trigger you would have to apply a trigger pulse to Pin 8 of the D-SUB-15 connector. For details on using the External Software Trigger Mode, see Appendix B on page 37.

Photopic Units Display

You have the ability to view calculated photopic data based on a CIE standard visibility curve, which is reported in lumens or lux per unit area. To change the photopic data displayed to lumen or to lux, select **Spectrometer | Configure Spectrometer** from the menu. In the bottom of the Configure Spectrometer dialog box, find the entry that reads **Display photopic data as**. Select either lumen or lux. For the photopic data to appear in the photopic display area, the channel must be activated and **Spectrometer | Lumen** (or **Lux**) **Values** must be selected from the menu.

Lumen

By selecting Lumen, the lumen values will be displayed to the right of the graph. A lumen is a "light watt." Lumens are calculated as the absolute spectral response of the human eye.

Lux

By selecting Lux, the lux values will be displayed to the right of the graph. The lux value is arrived by calculating the lumen per square meter. Lux is also called a meter candle.

File Menu Functions

Open

Select **File | Open** from the menu to open a dialog box that allows you to reload a saved set of spectra. If you saved the dark or the reference spectra, they are also restored.

Save

Select **File | Save** from the menu to save the current sample spectrum as a tab-delimited ASCII file. Serial numbers and data acquisition parameters are included in the headers of these files.

Export

Select **File | Export** from the menu to export the current sample spectrum as a tab-delimited ASCII file for use in other applications, such as Microsoft Excel.

Printer Setup

Select **File | Print Setup** from the menu to select and configure a printer for printing graphical spectra.

Print

Select **File | Print** from the menu to print a graph. The graph title, grid and cursor are all printed if they are displayed on the screen.

Restore Settings

Select **File | Restore Settings** from the menu to open a saved display settings file. By default, these files have a **.cfg** extension.

Save Settings

Select **File | Save Settings** from the menu to save display settings. By default, display settings files have a **.cfg** extension.

Exit

Select **File | Exit** from the menu to quit OOIIrrad. A message box appears asking you if you are sure you want to exit the software.

Lamp Menu Functions

Select Lamp

This function is used when selecting a lamp file for calibrating the spectral response of your system with the LS-1-CAL Calibrated Tungsten Halogen Light Source. With your LS-1-CAL, you also received two Lamp Calibration Reports and a disk with file copies of the reports. One file has the calibration numbers for calibrating the spectral response of your with the lamp and a bare fiber; its name contains the lamp's serial number, followed by **FIB.LMP**. The second file has the calibration numbers when calibrating the spectral response of your system with the lamp and a CC-3 cosine corrector and fiber; its name contains the lamp's serial number, followed by **CC3.LMP**.

These two files should be copied from the disk into your OOIIrrad directory. When you are about to calibrate the spectral response of your system, you will choose the Lamp Calibration Report file that reflects your optical setup.

Edit Lamp Calibration File

This file came with the LS-1-CAL Calibrated Tungsten Halogen Light Source and contains the data necessary to calibrate the spectral response of your system before taking absolute irradiance measurements.

You should only edit this data if you wish to use another calibrated light source with your system. Select **Lamp | Edit Lamp Calibration File** from the menu and delete or change intensity and wavelength values for your lamp. When you change the calibration data, click **Save As** and rename the lamp calibration file. It is important to rename the edited file; the data for the LS-1-CAL should remain unaltered.

View Lamp File

This function gives you the opportunity to verify that the calibration process was done correctly by viewing the spectral data of the LS-1-CAL after using the lamp to calibrate the spectral response of your system. When viewing the lamp file, make sure the lamp calibration points overlap with the active spectral data. You can only view the lamp's spectral output if you are in Irradiance Mode. If you are in Scope Mode and select **Lamp | View Lamp Data** from the menu, you will receive a message box instructing you to change from Scope Mode to Irradiance Mode.

Edit Lamp Calibration File

C:\WINDOWS\DESKTOP\Irrad LV\LSC013CC3.lmp

Wavelength [nm]	Intensity [uW/cm^2/nm]
360.00	0.132567
370.00	0.164178
380.00	0.204897
390.00	0.246333
400.00	0.291496
420.00	0.392688
440.00	0.510178
460.00	0.639007
480.00	0.778424
500.00	0.930103
525.00	1.125102
550.00	1.325988
575.00	1.532611
600.00	1.733835
650.00	2.110557
700.00	2.433292
750.00	2.692270
800.00	2.872634
850.00	2.972577
900.00	3.005755
950.00	2.984131
1000.00	2.010070

Save As...   Close

Spectrometer Menu Functions

Configure Hardware

The Configure Hardware dialog box sets the hardware parameters for the spectrometer. The parameters in this dialog box are usually set only once -- when OOIIrrad is first installed and the software first opens. Options include:

- **Spectrometer Type**. Choose the spectrometer you are using.
- **A/D Converter Type**. Select the A/D converter you are using.
- **Base Address (I/O Range)**. Choose an available setting you found in your computer. See the section regarding your A/D converter for details. In this dialog box, the Base Address is given in decimal, followed by the hexadecimal equivalent in parenthesis. For example, "**768 (0x0300)**" gives the Base Address as 768 decimal and 300 hexadecimal. (This entry is for ADC500, ADC1000, and DAQ700 A/D converters.)
- **IRQ (Interrupt Request)**. Choose an available setting you found in your computer. See the section regarding your A/D converter for details. (This entry is for ADC500, ADC1000, and DAQ700 A/D converters.)
- **SAD500 Serial Port**. Choose the COM port your computer is using to interface to your SAD500. (This entry is for SAD500 A/D converters.)
- **SAD500 Baud Rate**. Select the speed at which the SAD500 will operate. (This entry is for SAD500 A/D converters.)
- **SAD500 Pixel Resolution**. Enter resolution values from 1 to 500. This value specifies that every nth pixel of the spectrometer is transmitted from the SAD500 to the PC. Your resolution value depends on your experiment. By sacrificing pixel resolution, you gain speed. The transfer of one complete spectra requires ~0.4 seconds when communicating at 115,200 baud rate. If you need your information in <0.4 seconds, increase the resolution or enable data compression. (This entry is for SAD500 A/D converters.)
- **Compress SAD500 Data**. Enable this function to minimize the amount of data transferred over the RS-232 connection. Transmission of spectral data over the serial port is a relatively slow process. Enabling this function insures that every scan transmitted by the SAD500 will be compressed, greatly increasing the data transfer speed of the SAD500. (This entry is for SAD500 A/D converters.)
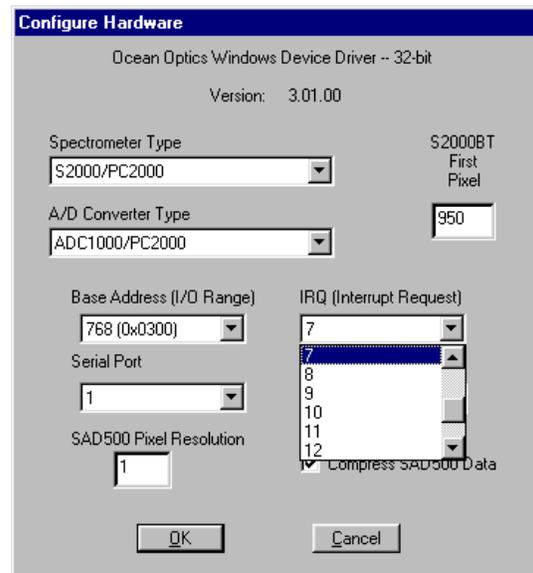
Configure Spectrometer

Select **Spectrometer | Configure Spectrometer** from the menu to configure your system and set important system parameters. Each spectrometer channel is shipped with a Wavelength Calibration Report. Enter all information from the report in this dialog box.

Lamp Serial
Enter the serial number from the bottom of your LS-1-CAL into this area. (However, when you later choose a Lamp File before calibrating, the software will enter the lamp's serial number for you.)

Spectrometer Serial
Enter the serial number from the bottom of the spectrometer into this area. Entering the serial number is not mandatory, but some acquisition functions will display serial numbers in the data files.

Intercept

Enter the Intercept from the Wavelength Calibration Report that came with each channel in your system.

First, Second and Third Coefficients

Enter the First Coefficient, Second Coefficient and Third Coefficient from the Wavelength Calibration Report that came with each channel in your system.

Limit display range

If this box is selected, you can enter the graph display range in the boxes to the immediate right. Enter the first wavelength of the spectral range to be displayed. Enter the last wavelength of the spectral range to be displayed.

Display calibration info when calculating

If this box is selected, you will be able to view the results of the procedure for calibrating the spectral response of your system. The diagnostic screen provides you with the spectral results of the calibration procedure in three graphs. The top left graph represents the linear 15th order polynomial regression. The top right graph represents the dark scan. The bottom graph is the calibration curve representing the spectral response of the process.

Select integrated intensity mode

You can choose to have the integrated spectral data displayed in μJoule and μWatt, in μJoule/cm^2 and μWatt/cm^2, or both. Joule is a unit of energy and watt is a unit of power equal to one joule per second. To have this data displayed, you must also select **Spectrometer | μJoule and μWatt** (or **μJoule/cm^2 and μWatt/cm^2**) **Values** from the menu.

Display photopic data as

By selecting Lumen, the lumen values will be displayed to the right of the graph. A lumen is a "light watt." Lumens are calculated as the absolute spectral response of the human eye. By selecting Lux, the lux values will be displayed to the right of the graph. The lux value is arrived by calculating the lumen per square meter. Lux is also called a meter candle. These values become present when the channel on the graph is activated.

Configure Fibers

Enter the fiber diameter values for each channel in your setup. If using a bare fiber, enter the fiber's diameter here. If using a fiber with a CC-3 cosine corrector, enter 3,900. Whatever optical setup you wish to use for your application, you must also use when calibrating the spectral response of your system. For example, if you are going to use a 200-μm fiber with a CC-3 cosine corrector for your application, you must use the same 200-μm fiber and cosine corrector when calibrating the spectral response of your system.

Scan

When the single mode is selected in the display screen, the Scan menu function acts as a snapshot. After selecting the Single mode, select **Spectrometer | Scan** from the menu to take an absolute irradiance scan of the sample. The Scan button depresses and Stop replaces Scan. The button will stay depressed until the scan has been completed (the amount of time in the Nominal Integration Period box).

When the continuous mode is selected in the display screen, select **Spectrometer | Scan** from the menu to continuously take scans. After each integration cycle, another scan will immediately begin. The Scan button depresses and Stop replaces Scan. Click on Stop to halt the scanning process and stop acquiring data.

Store Dark

This function stores the current spectrum as the dark spectrum for the channel activated. A dialog box opens with the message **Block light path to spectrometer for a DARK scan. Will be save in "dark.txt."** The dark spectrum is taken with the light path to the sample blocked. You must use the same Nominal Integration Period for your dark and irradiance scans. Saving a dark spectrum is requisite before the computer can make the calculation of absolute irradiance spectra.

Calibrate

This function is for calibrating the spectral response of your system with the LS-1-CAL Calibrated Tungsten Halogen Light Source. Before beginning, make sure the optical setup you wish to use for your application, you also use when calibrating the spectral response of your system. For example, if you use a 200-μm fiber with a CC-3 cosine corrector for your application, you must use the same 200-μm fiber and CC-3 for your calibration. Also, make sure that the disk containing the two Lamp Calibration Report files, one for using the LS-1-CAL with a fiber and one for using it with a CC-3 cosine-corrected irradiance probe, is ready to install into your computer.
1. Use an Allen wrench to loosen the set screw on the LS-1-CAL's SMA connector.
2. If you are using a bare fiber with the lamp, withdraw the inner barrel from the SMA connector. Screw this connector barrel onto the end of your fiber. The connection should be tight. Insert the barrel/fiber all the way into the LS-1-CAL's SMA connector.
   If you are using a fiber and cosine corrector with the lamp, remove the inner barrel from the SMA connector. Screw the CC-3 cosine corrector onto the end of the fiber. The connection should be tight. Insert the CC-3/fiber all the way into the LS-1-CAL's SMA connector.
3. Use an Allen wrench to tighten the set screw on the SMA connector of the LS-1-CAL. Take the other end of the fiber and screw it all the way into the SMA connector of the spectrometer.
4. Plug the switching AC adapter (the black rectangle-shaped box) into the back of the LS-1-CAL. The adapter stabilizes the power coming into the lamp to insure constant spectral intensity.
5. Plug the wall transformer end of the power cord into a standard 110V outlet. Plug the other end into the back of the switching AC adapter.
6. Find the on/off switch on the back of the lamp and turn the lamp on.
7. Let the LS-1-CAL warm up for at least 15 minutes before using.
8. Insert the disk that came with your lamp into your computer. The disk contains two ASCII files. These files have the same information as the Lamp Calibration Reports that came with your LS-1-CAL. One file has the calibration numbers for calibrating the spectral response of your system with the lamp and a bare fiber; its name contains the lamp's serial number, followed by **FIB.LMP**. The second file has the calibration numbers when calibrating the spectral response of your system with the lamp and a CC-3 cosine-corrector and fiber; its name contains the lamp's serial number, followed by **CC3.LMP**.
9. Copy these two files into your OOIIrrad directory. (The default directory is **Program Files | OOIIrrad**.)
10. Start OOIIrrad. Make sure you are in **Scope Mode**.
11. Under the **Lamp** menu options, choose **Select Lamp**. A window opens in which you must choose the Lamp Calibration Report file that reflects your optical setup.

12. Under the **Spectrometer** menu options, choose **Configure Fibers**. Enter the fiber diameter values for each channel in your setup. If using a bare fiber, enter the fiber's diameter here. If using a fiber with a CC-3 cosine corrector, enter 3,900. Whatever optical setup you wish to use for your application, you must also use for calibrating the spectral response of your system. For example, if you are going to use a 200-μm fiber with a CC-3 cosine corrector for your application, you must use the same 200-μm fiber and CC-3 for calibrating the spectral response of your system.

13. To the right of the displayed spectrum, enter the data acquisition parameters for your setup. The values for Scans to Average and Smoothing Size must be the same for your reference, dark and irradiance scans. You may use a different integration period for your reference scan, but you must use the same integration period for your dark and irradiance scans.

14. Under **Spectrometer** menu options, choose **Calibrate** and then select the channel you are calibrating.

15. A dialog box opens with the message **Verify lamp was ON for at least 15 minutes for a REFERENCE scan.** Make sure nothing is blocking the light path going to your spectrometer. Your setup (spectrometer, fiber, and sampling optics) for taking a reference should be identical to your setup for measuring your sample, except that the sample you want to measure must be absent while taking a reference. Taking a reference spectrum is requisite before the software can calculate absolute irradiance measurements. Click **OK**.

16. Another dialog box opens with the message **Block light path to spectrometer for a DARK scan.** If possible, do not turn off the light source. Instead, completely block the light path going to your spectrometer by inserting an opaque object into the lamp's filter slot. Taking a dark spectrum is requisite before the software can calculate absolute irradiance measurements. Click **OK**. The spectral response of your system is calibrated.

17. If you selected **Display calibration info when calculating** in the **Configure Spectrometer** dialog box, you will now see the results of the calibration procedure. The top left graph represents the linear 15th order polynomial regression. The top right graph represents the dark scan. The bottom graph is the calibration curve representing the spectral response of the process.

18. The calibration procedure is saved in a file named **CH0.CAL** for calibrating the master spectrometer channel, **CH1.CAL** for calibrating the first slave spectrometer channel, and so on.

Lumen and Lux Values

Photopic data can be displayed in lumen or lux values in the photopic display area. Select **Spectrometer | Configure Spectrometer** from the menu. In the bottom of the Configure Spectrometer dialog box, find the entry that reads **Display photopic data as**. Select either **Lumen** or **Lux**. For the photopic data to appear in the photopic display area, the channel must be activated and **Spectrometer | Lumen** (or **Lux**) **Values** must be selected from the menu.

A lumen is a "light watt." Lumens are calculated as the absolute spectral response of the human eye. The lux value is arrived by calculating the lumen per square meter. Lux is also called a meter candle. These values will be displayed to the right of the graph.

μJoule and μWatt Values

The information provided in these boxes is the irradiance intensity data of the sample. Joule is a unit of energy and watt is a unit of power equal to one joule per second. In order for this information to be displayed, select **Spectrometer | Configure Spectrometer** from the menu. In the bottom of the Configure Spectrometer dialog box, find the entry that reads **Select integrated intensity mode**. You can choose to have the spectral data displayed in μJoule and μWatt, in μJoule/cm^2 and μWatt/cm^2, or both. For the photopic data to appear in the photopic display area, the channel must be activated and **Spectrometer | μJoule and μWatt** (or **μJoule/cm^2 and μWatt/cm^2**) **Values** must be selected from the menu.

LS-1-CAL Calibrated Light Source

The **LS-1-CAL CALIBRATED TUNGSTEN HALOGEN LIGHT SOURCE** for the VIS-Shortwave NIR (300-1050 nm) provides you with known absolute intensity values at several wavelengths, expressed in $\mu W/cm^2/nm$. Since the spectral intensity of the LS-1-CAL can be traced to an intensity standard provided by the National Institute of Standards and Technology (NIST), it is specifically designed for calibrating the absolute spectral response of your system.

Parts Included

- LS-1-CAL Calibrated Tungsten Halogen Light Source
- Switching AC adapter for stabilizing power
- Power cord for supplying power to the power supply
- Two Lamp Calibration Reports; one for using the LS-1-CAL with a bare fiber and one for using the LS-1-CAL with a CC-3 cosine-corrected irradiance probe
- A disk that holds files for both lamp calibration reports
- Allen wrench for adjusting the inner barrel of the SMA connector

Caution!

☠ The LS-1-CAL becomes **HOT** during operation. Handle with care.

☠ DO NOT insert flammable materials into the filter slot. The materials could melt or ignite.

☇ The LS-1-CAL is not designed as an illumination source for absorbance, transmission or reflection measurements. The LS-1 Tungsten Halogen Light Source should be used for those applications.

Setting Up

The LS-1-CAL is designed to calibrate the absolute spectral response of your system. Before beginning, make sure you have your LS-1-CAL, your spectrometer, an SMA-terminated optical fiber or CC-3 cosine-corrected irradiance probe, and Ocean Optics Irradiance Software. (If you have an IRRAD2000, use a 200-μm or smaller fiber. If you have another spectrometer setup -- one that is highly sensitive, for example -- you may not be able to use the LS-1-CAL as a calibration source.)

Using the LS-1-CAL for Calibration

1. Use an Allen wrench to loosen the set screw on the LS-1-CAL's SMA connector.
2. If you are using a bare fiber with the lamp, withdraw the inner barrel from the SMA connector. Screw this connector barrel onto the end of your fiber. The connection should be tight. Insert the barrel/fiber all the way into the LS-1-CAL's SMA connector.
   If you are using a fiber and cosine corrector with the lamp, remove the inner barrel from the SMA connector. Screw the CC-3 cosine corrector onto the end of the fiber. The connection should be tight. Insert the CC-3/fiber all the way into the LS-1-CAL's SMA connector.
3. Use an Allen wrench to tighten the set screw on the SMA connector of the LS-1-CAL. Take the other end of the fiber and screw it all the way into the SMA connector of the spectrometer.
4. Plug the switching AC adapter (the black rectangle-shaped box) into the back of the LS-1-CAL. The adapter stabilizes the power coming into the lamp to insure constant spectral intensity.
5. Plug the wall transformer end of the power cord into a standard 110V outlet. Plug the other end into

the back of the switching AC adapter.
6. Find the on/off switch on the back of the lamp and turn the lamp on.
7. Let the lamp warm up for at least 15 minutes before using.
8. Insert the disk that came with your lamp into your computer. The disk contains two ASCII files. These files have the same information as the Lamp Calibration Reports that came with your LS-1-CAL. One file has the calibration numbers for calibrating the spectral response of your system with the lamp and a bare fiber; its name contains the lamp's serial number, followed by **FIB.LMP**. The second file has the calibration numbers when calibrating the spectral response of your system with the lamp and a CC-3 cosine-corrector and fiber; its name contains the lamp's serial number, followed by **CC3.LMP**.
9. Copy these two files into your OOIIrrad directory. (The default directory is **Program Files | OOIIrrad**.)
10. Start OOIIrrad. Make sure you are in **Scope Mode**.
11. Under the **Lamp** menu options, choose **Select Lamp**. A window opens in which you must choose the Lamp Calibration Report file that reflects your optical setup.
12. Under the **Spectrometer** menu options, choose **Configure Fibers**. Enter the fiber diameter values for each channel in your setup. If using a bare fiber, enter the fiber's diameter here. If using a fiber with a CC-3 cosine corrector, enter 3,900. Whatever optical setup you wish to use for your application, you must also use for calibrating the spectral response of your system. For example, if you are going to use a 200-μm fiber with a CC-3 cosine corrector for your application, you must use the same 200-μm fiber and CC-3 for calibrating the spectral response of your system.
13. To the right of the displayed spectrum, enter the data acquisition parameters for your setup. The values for Scans to Average and Smoothing Size must be the same for your reference, dark and irradiance scans. You may use a different integration period for your reference scan, but you must use the same integration period for your dark and irradiance scans.
14. Under **Spectrometer** menu options, choose **Calibrate** and then select the channel you are calibrating.
15. A dialog box opens with the message **Verify lamp was ON for at least 15 minutes for a REFERENCE scan.** Make sure nothing is blocking the light path going to your spectrometer. Your setup (spectrometer, fiber, and sampling optics) for taking a reference should be identical to your setup for measuring your sample, except that the sample you want to measure must be absent while taking a reference. Taking a reference spectrum is requisite before the software can calculate absolute irradiance measurements. Click **OK**.
16. Another dialog box opens with the message **Block light path to spectrometer for a DARK scan.** If possible, do not turn off the light source. Instead, completely block the light path going to your spectrometer by inserting an opaque object into the lamp's filter slot. Taking a dark spectrum is requisite before the software can calculate absolute irradiance measurements. Click **OK**. The spectral response of your system is calibrated.
17. If you selected **Display calibration info when calculating** in the **Configure Spectrometer** dialog box, you will now see the results of the calibration procedure. The top left graph represents the linear 15th order polynomial regression. The top right graph represents the dark scan. The bottom graph is the calibration curve representing the spectral response of the process.
18. The calibration procedure is saved in a file named **CH0.CAL** for calibrating the master spectrometer channel, **CH1.CAL** for calibrating the first slave spectrometer channel, and so on.

LS-1-CAL Specifications

Spectral range (calibrated):	300-1050 nm
Dimensions:	9.0 cm x 5.0 cm x 3.2 cm (LWH); 3.5" x 2.0" x 1.25" (LWH)
Power input:	12 VDC/800 mA (regulated)
Power output:	6.5 watts
Bulb life:	900 hours (recalibrate after ~50 hours of use)
Bulb color temperature:	3100K
Output to bulb:	5 volts/1.3 amps
Output regulation:	0.2% voltage
Time to stabilized output:	~30 minutes
Connector:	SMA 905

CC-3 Cosine-corrected Irradiance Probe

Cosine-corrected fiber optic irradiance probes are spectroradiometric sampling optics designed to collect radiation (light) from a 180° field of view, thus eliminating light collection interface problems inherent to other sampling devices. The **CC-3 COSINE-CORRECTOR** (300-1000 nm) has glass diffusing material. The **CC-3-UV COSINE-CORRECTOR** (200 nm to 2 μm) has Teflon® diffusing material. The diffusing material is a thin disk that sits at the end of the barrel (the Teflon material is 0.30" thick).

Operation

Both cosine correctors have SMA 905 connectors for convenient coupling to optical fibers. Screw the CC-3 or CC-3-UV onto the end of any SMA-terminated optical fiber, such as the 200-μm fiber that came with your IRRAD2000, and the combination becomes a cosine-corrected irradiance probe. When coupled to a spectrometer, these irradiance probes can be used to measure UV-A and UV-B solar radiation, environmental light fields, lamps and other emission sources.
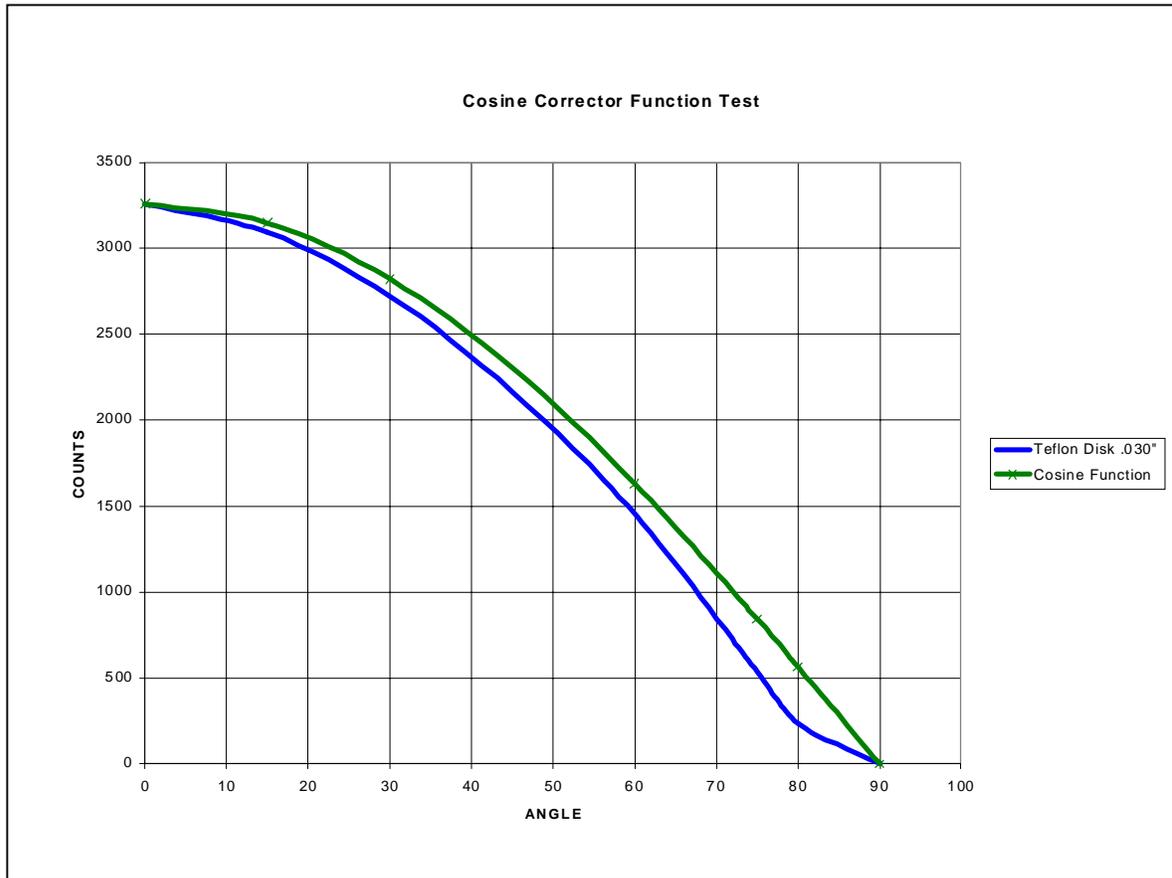
CC-3 Cosine Corrector Specifications

Diffusing material:	CC-3: opaline glass (300-1000 nm), CC-3-UV: Teflon (200 nm - 2 μm)
Barrel dimension:	0.25" O.D.
Sampling geometry:	accepts light at/from 180° FOV

Optical Fiber Assemblies

Ocean Optics offers an extensive line of optical fibers and accessories -- including patch cords, bifurcated assemblies, bushings, and splitters -- for a variety of UV-VIS and VIS-NIR applications. All optical fibers couple easily via SMA terminations to our miniature fiber optic spectrometers, lights sources and sampling optics. Ocean Optics optical fibers offer great flexibility, both in the literal sense (by transporting light around corners, for example) and in the way fiber-based systems are constructed (by linking light sources and sampling optics, for example, to create an optical interface to the spectrometer). Optical fibers allow you to easily convert the optical interface from one set-up to another -- absorbance, reflectance and emission are the three basic options -- to create an almost endless variety of optical-sensing systems.

These single-strand, silica-core and silica-clad optical fibers are optimized for the UV-VIS (200-750 nm) or VIS-NIR (450-1000 nm). Standard assemblies are 2 meters in length, and are available in sizes ranging from 8 μm to 1000 μm in diameter. Custom options include optical fibers with solarization-resistance properties (for applications <260 nm), and in lengths other than 2 meters.

Caution!

- When fibers break, they stop transmitting light. Inspect fibers by eye to determine if the fiber is transmitting light.

- Do not coil the fiber too tightly. The maximum sustained bend radius of a 400 μm fiber is 10 cm. Bending the fiber will cause attenuation. To minimize this effect, add extra strain relief to both ends of the fiber.

- Do not exceed the temperature specifications for the materials involved: 200^0C for the fiber, 100^0C for PVC cabling, 100^0C for standard epoxy.

- Do not allow the fiber to be bent at a sharp angle. A bending radius of less than one inch is dangerous.

- Keep connectors and probe tips covered when the fibers are not being used.

- Clean the ends of the fibers with lens paper and distilled water, alcohol or acetone. Avoid scratching the surface.

- Do not immerse fiber ends in caustic materials or other solutions that can damage glass.

Operation

Patch Cords
Patch cords are single strands of optical fiber. The active part consists of a silica core, surrounded by a silica cladding material. The fiber is very fragile, and if not protected by a suitable buffer material, would be nearly useless for most applications. The buffer materials are polymer coatings -- polyimide or Teflon -- that provide mechanical strength, either. Cabling further protects the buffer-coated fiber. Our standard laboratory cabling is blue PVC. Other cabling that is available is stainless steel monocoil. The ends of the fibers are cleaved, epoxied into the connectors, and polished.

Bifurcated Assemblies and Splitters
Bifurcated assemblies and splitters allow you to route light from 1 location to 2 locations, or to collect light from 2 locations and combine the output into 1 location. The assemblies are shaped like a "Y" with a stainless steel breakout located midway from the ends of the fibers. The common end of bifurcated assemblies has 2 fibers side by side. The spatial difference between the two fibers may be important in your application. If this difference matters, then a splitter is required. The common end of a bifurcated

fiber can be coupled to a larger diameter single fiber with a splice bushing to create a functional splitter.

Splice Bushings, Bulkheads

Splice bushings are used to couple two SMA-terminated fibers together. Simply screw each fiber into the splice bushing finger tight. Bulkhead fittings are used to fixture a fiber. Install the bulkhead by drilling a hole in the wall where you wish to mount the fiber. Fasten with the lock washer and nut provided.

Optical Fiber Color Codes

All Ocean Optics optical fibers are color-coded for simple identification. There are two color bands on one end of the fiber. The color band nearest the termination identifies the fiber type (i.e., its wavelength optimization), and is either white (UV/VIS) or black (VIS/NIR). The second color band identifies the diameter of the fiber, and is one of several different colors. Use the table below as a handy reference.

Band Color	Core Diameter (µm)
Purple	8 (VIS/NIR only)
Blue	50
Green	100
Yellow	200
Red	400
Brown	600
Clear	1000

Band Color	Fiber Type
White	UV/VIS
Black	VIS/NIR

Specifications

Jacket:	• Acrylate (temperature range -40 to 100° C), for 50 µm optical fibers • Nylon (temperature range -40 to 100° C), for 100 µm, 200 µm, 400 µm, 600 µm and 1000 µm optical fibers
Sheathing/cabling:	• PVC (standard) • PVC Monocoil (optional) • BX flexible metal sleeve (optional)
Connector/termination:	SMA 905
Fiber core:	pure fused silica
Cladding:	doped fused silica
Fiber profile:	step-index multi-mode*
Operating wavelengths:	• UV-VIS (200-750 nm) • VIS-NIR (450-1000 nm)
Numerical aperture:	0.22
Recommended minimum bend radius:	• momentary = 200x the fiber radius • long term = 400x the fiber radius

* The only exception is the VIS-NIR 8-µm diameter patch cord, which is single-mode optical fiber.

Appendix A: Changing A/D Converter Settings

Base Address Settings for the ADC500

To change the Base Address setting, find the bank of 6 dip switches labeled SW1 on the ADC500 board. 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 decimal (which converts to 300 hexadecimal). A few combinations for Base Address settings follow. After you have changed the switches, reinstall the card and change the software settings to match the hardware settings. The gray block indicates the position of the switch.

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

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

▓ = Position of the switch

Interrupt Request Settings for the ADC500

To change the IRQ setting, find the bank of 4 dip switches labeled SW2 on the ADC500 board. In the default setting, the IRQ is set to 7. Other combinations for IRQ settings follow. After you have changed the switches, reinstall the card and change the software settings to match the hardware settings. The gray block indicates the position of the switch.

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		

▓ = Position of the switch

Base Address Settings for the ADC1000 and PC2000

To change the Base Address setting, find the bank of 9 switches on the A/D board. The Base Address may be changed via the first 6 switches. 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 decimal (which converts to 300 hexadecimal). A few combinations for Base Address settings follow. After you have changed the switches, reinstall the card and change the software settings to match the hardware settings. The gray block indicates the position of the switch.

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

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

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	■				■	■

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

■ = Position of the switch

Interrupt Request Settings for the ADC1000 and PC2000

To change the IRQ setting, find the bank of 9 switches on the A/D board. The IRQ may be changed via the last 3 switches. (The following matrix defines the different Interrupt Request settings by switch positions 7, 8, and 9.) In the default setting, the IRQ is set to 7. Other combinations for IRQ settings follow. After you have changed the switches, reinstall the card and change the software settings to match the hardware settings. The gray block indicates the position of the switch.

IRQ 7 (Default Setting)

Switch #	7	8	9
ON	■	■	
OFF			■

IRQ 3

Switch #	7	8	9
ON			
OFF	■	■	■

IRQ 4

Switch #	7	8	9
ON	■		
OFF		■	■

IRQ 5

Switch #	7	8	9
ON		■	
OFF	■		■

IRQ 9

Switch #	7	8	9
ON			■
OFF	■	■	

IRQ 10

Switch #	7	8	9
ON	■		■
OFF		■	

IRQ 11

Switch #	7	8	9
ON		■	■
OFF	■		

■ = Position of the switch

Appendix B: External Triggering

With the IRRAD2000 and OOIIrrad Operating Software, you have two methods of acquiring data. In the No External Trigger Mode (or Normal Mode), the spectrometer is "free running." That is, the spectrometer is continuously scanning, acquiring, and transferring data to your computer, according to parameters set in the software. In this mode, however, there is no way to synchronize the scanning, acquiring and transferring of data with an external event. To synchronize data acquisition with external events, another mode of acquiring data is available. It involves applying an external trigger to the spectrometer before the software receives the data.

In the External Software Trigger Mode, the spectrometer is "free running," just as it is in the Normal Mode. The spectrometer is continually scanning and collecting data. With each trigger, the data collected up to the trigger event is transferred to the software. If you continuously apply triggers, such as by holding down the button on an external switch, this mode is equivalent to operating in the Normal Mode.

In the External Software Trigger Mode, you set the integration time in the software. All other acquisition parameters are set in the software as well. The source for the integration clock comes from the A/D converter.

Use the Software Mode if you:
- are using a continuous illumination source, and the light intensity is constant before, during and after the trigger
- need to set the integration time in the software

To Use the Software Mode:
1. Supply a line from your triggering device to Pin 3 of the J2 Accessory Connector to provide the positive voltage +5VDC to the spectrometer. (See figure below for pin location.) We do not advise using an outside source to supply the voltage, as it is based on a referenced ground and your reference may be different from ours. Using Pin 3 to supply voltage ensures that the spectrometer will receive the appropriate voltage for the trigger event.
2. Supply a line from Pin 8 of the J2 Accessory Connector to your triggering device. (See figure below for pin location.)
3. Set your acquisition parameters in the software's display screen.
4. Select **External Software Trigger** in the software's display screen.
5. Once you select **External Software Trigger**, it will appear on your computer that your spectrometer is unresponsive. Instead, it is waiting for the trigger. Activate your triggering device.
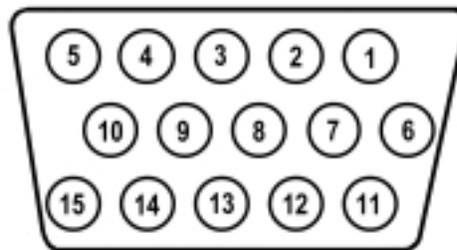
J2 (D-SUB-15) Accessory Connector (female)

It is important to note that since this is a level-triggered mode, the amount of delay between the trigger pulse and when a spectrum is acquired is indeterminate because the delay is dependent upon:
- how fast the software polls the Pin 8 line and recognizes it is HIGH
- the amount of time until the start of the next integration period

Appendix C: S2000 Pin-outs and Jumpers

It is not necessary for the average user to worry about the interconnect scheme, as the cables supplied with all of the units need only be plugged into the matching connectors on the hardware. However, if the need arises to design and fabricate your own cabling system, the following table supplies the necessary data.

J1 (D-25) Connector

J1 Pin	Function	A/D Pin Connection
1	Analog Channel 0	37
2	Analog Channel 1	36
3	Analog Channel 2	35
4	Analog Channel 3	34
5	Analog Ground	19
6	Reserved	
7	N/C	
8	N/C	
9	Digital Ground	7
10	A/D Trigger	25
11	Master Clock	20
12	Digital Ground	Not in Cable
13	+5VDC	1
14	Analog Channel 4	33
15	Analog Channel 5	32
16	Analog Channel 6	31
17	Analog Channel 7	30
18	Analog Ground	Not in Cable
19	N/C	
20	Continuous Strobe In	8 (or use internal jumpers)
21	External Software Trigger Out (DO3)	5
22	Spectrometer Mode Input S1	4
23	Integration Time Clock In	2
24	Strobe Enable, Spectrometer Mode Input S0	23
25	Enable Read In	3

J2 (D-SUB-15) Accessory Connector: Pin Function Descriptions

J2 Pin	DB-15 (Female)	Description
1	Single Strobe	TTL output signal used to pulse a strobe that is high at the start of each integration period.
2	Continuous Strobe	TTL output signal used to pulse a strobe that is divided down from Master Clock signal.
3	V$_{CC}$	The positive supply voltage +5VDC.
4	External Hardware Trigger	TTL trigger signal (rising edge trigger input) used in the External Hardware Trigger mode.
5	External Synchronization Trigger	TTL signal used to define the integration time (time between rising edges) when using the External Synchronization Trigger mode.
6	Channel 7	The analog signals that correspond to the output from the 8 spectrometer channels.
7	Channel 6	The analog signals that correspond to the output from the 8 spectrometer channels.
8	D3 or External Software Trigger	Active high TTL input signal used to trigger the acquisition system in the External Software Trigger mode. The input from J1-8 is passed unbuffered to this line.
9	Channel 1	The analog signals that correspond to the output from the 8 spectrometer channels.
10	GND	Ground (supply voltage return) or case ground.
11	Channel 4	The analog signals that correspond to the output from the 8 spectrometer channels.
12	Channel 5	The analog signals that correspond to the output from the 8 spectrometer channels.
13	S0 and S1	TTL inputs used to determine the triggering mode: S1 S0 Mode L X Normal or Continuous Scan L X External Software Trigger H L External Synchronization Trigger H H External Hardware Trigger X = does not matter In the first 2 modes, S0 is also used to enable/disable light sources.
14	Channel 3	The analog signals that correspond to the output from the 8 spectrometer channels.
15	Channel 2	The analog signals that correspond to the output from the 8 spectrometer channels.

H1 Header Pins (Analog)

1	Analog Channel 0
2	Analog Channel 1
3	Analog Channel 2
4	Analog Channel 3
5	Analog Channel 4
6	Ground
7	Reserved
8	Analog Channel 7
9	Analog Channel 6
10	Analog Channel 5

H2 Header Pins (Digital)

D	N/C
C	A/D Trigger
B	Digital In 3 (D3)
A	S1
1	Ground
2	+5 VDC
3	Phi A/D clock
4	Phi Read Out Gate
5	Reserved
6	Temperature (optional)
7	Read Enable
8	S0
9	Strobe Single flash
10	Strobe Multiple Flash
11	Integration Clock
12	Master Clock

J1 = 25 pin connector that connects the S2000 master with the A/D board; J2 = 15 pin accessory connector
H1, H2 = header blocks that connect a master unit to one or more slave units

Continuous Strobe Rate

The continuous strobe rate is controlled by the A/D frequency input to the spectrometer and the position of the jumper JP3. The jumper selects a divider for the input clock.

Jumper Position	Divisor	DAQ700 Flash Rate	ADC500/SAD500 Flash Rate	ADC1000 Flash Rate
1	Buffered input from D25 pin 20			
2	2^{10}	97.6 Hz	488 Hz	976 Hz
3	2^{12}	24.4 Hz	122 Hz	244 Hz
4	2^{14}	6.1 Hz	30.5 Hz	61 Hz
5	2^{16}	1.5 Hz	7.6 Hz	15.2 Hz