

Operating Manual and User's Guide

**S1024DW Miniature Fiber Optic
Spectrometers and Accessories**

**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**



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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.

The Modular Approach

A typical Ocean Optics small-footprint system comprises of five basic elements: a Miniature Fiber Optic Spectrometer, an A/D converter, our operating software, a light or excitation source, and sampling optics. The light or excitation source supplies light through the illumination or excitation fiber to the sample and then light interacts with the sample. The light is then collected and transmitted through the read fiber to the spectrometer. The spectrometer measures the amount of light and the A/D converter transforms the analog data collected by the spectrometer into digital information that is passed to the software, providing the user with application-specific information.

This modular approach -- components are easily mixed and matched -- offers remarkable applications flexibility. Users pick and choose from hundreds of products to create distinctive systems for an almost endless variety of optical-sensing applications.

S1024DW Miniature Fiber Optic Spectrometer

The S1024DW Deep Well Detector Spectrometer is a 1024-element photodiode array detector for those applications requiring extremely high signal-to-noise (2000:1) measurements. With the S1024DW, the user can achieve micro-absorbance unit resolution. In fact, the user can reliably see an absorbance change of less than 0.00001 absorbance units. Furthermore, the S1024DW can be multiplexed with up to 8 spectrometer channels and is ideal for high light level applications such as dissolution testing.

The S1024DW accepts light energy transmitted through single-strand optical fiber and disperses it via a fixed grating across the photodiode array, which is responsive from 200-1100 nm. An SMA 905 connector allows for easy coupling to an extensive line of fiber optic light sources, probes, chemical sensors, and other spectrophotometric accessories.

SAD500 Serial Port Interface

The S1024DW interfaces to our SAD500 Serial Port Interface, a 12-bit, 8-channel, microprocessor-controlled A/D converter with a 500 kHz sampling frequency. The SAD500 can be used to interface to desktop or portable PCs, as well as to PLCs and other devices that support the RS-232 communication protocol. The SAD500 A/D converter allows the S1024DW spectrometer to acquire spectra using integration times as rapid as 31 milliseconds. For increased speed, the SAD500 can be software configured to transmit only a portion of the spectra or the averages of multiple spectral acquisitions, or a combination of both.

OOIBase32 Spectrometer Operating Software

OOIBase32 Spectrometer Operating Software is our next generation of operating software for all Ocean Optics spectrometers. OOIBase32 is a 32-bit, user-customizable, advanced acquisition and display program that provides a real-time interface to a variety of signal-processing functions for Windows 95/98 and Windows NT users. With OOIBase32, you have the ability to perform spectroscopic measurements such as absorbance, reflectance and emission; control all system parameters; collect data from up to 8 spectrometer channels simultaneously and display the results in a single spectral window; and perform reference monitoring and time acquisition experiments.

OOIBase32 is the latest edition of operating software for all Ocean Optics spectrometers. This change from 16-bit to 32-bit operating software reflects Ocean Optics' decision to upgrade its software to accommodate the increase of 32-bit operating systems. OOIBase32 still includes the functions of the original OOIBase, but numerous editing, viewing, and spectral processing functions have been added.

For detailed instructions on all of the features, menu items, and options in OOIBase32, please refer to the **OOIBase32 Spectrometer Operating Software Manual** included with your spectrometer order or the OOIBase32 online help files.

In This Manual

This manual provides users with directions on configuring your SAD500 with your computer and operating the S1024DW Miniature Fiber Optic Spectrometer. In addition, this manual covers instructions for using some of our most popular spectroscopic components including light sources, sampling chambers, sampling optics, fiber optic probes, and optical fiber assemblies. The **Experiment Tutorial** section provides specific directions on taking absorbance, transmission, relative irradiance, and reflection measurements. Additional information is included in Appendices, such as the pin-outs and jumpers of the spectrometer, instructions on adjusting the focus of a collimating lens, and directions on external triggering.

Packing List

A packing list comes with your 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, detector collection lens, and slit. The packing list also includes information such as the shipping address, billing address, and components on back order. What you won't find on the packing list is OOIBase32, the free operating software that comes with every spectrometer order.

Wavelength Calibration Data Sheet

In your shipment box you will find your spectrometer in a silver-gray anti-static bag. Also inside this bag is a calibration sheet wrapped around the operating software diskettes. A calibration sheet comes with every spectrometer channel, contains important information specific to your spectrometer, and should be retained.

Return Merchandise Authorization

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.

Software and Serial Port Interface Installation

Step 1: Interface the SAD500 to your PC

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. Interfacing the SAD500 to a desktop or portable PC is simple.

1. If you ordered your SAD500 mounted onto your S1024DW 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 S1024DW-series 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.

Step 2: Install OOIBase32

1. Before installing OOIBase32, make sure that no other applications are running.
2. Insert "Disk 1" into your floppy drive. (When prompted, install Disks 2, 3, and 4.) Execute Setup.exe.
3. At the "Welcome" dialog box, click Next>.
4. At the "Destination Location" dialog box, choose Browse, pick a destination directory and click Next>.
5. At the "Backup Replaced Files" dialog box, select either Yes or No. We recommend choosing Yes. If you select Yes, choose Browse to pick a destination directory and click Next>.
6. At the "Installation Complete" dialog box, choose Finish>.
7. When the installation is complete, you will be prompted to restart your computer. **It is absolutely necessary for you to restart your computer before you run OOIBase32 for the first time.**

Step 3: Run OOIBase32

After you restart your computer, navigate to the OOIBase32 icon and select it. The first time you run OOIBase32 after installation, you must follow several prompts before you can begin taking measurements.

Operator and Serial Number Dialog Box

First, a prompt to enter a user name and serial number appears. Certain data files will include this information in the header. (If, at a later date, you wish to change the operator name and serial number, select **Edit | Settings** from the menu and then choose the **Registration** tab.) You can find the serial number of your OOIBase32 software on the Disk 1 label. Click **OK**.

Default Spectrometer Configuration File

Next, the following message appears:

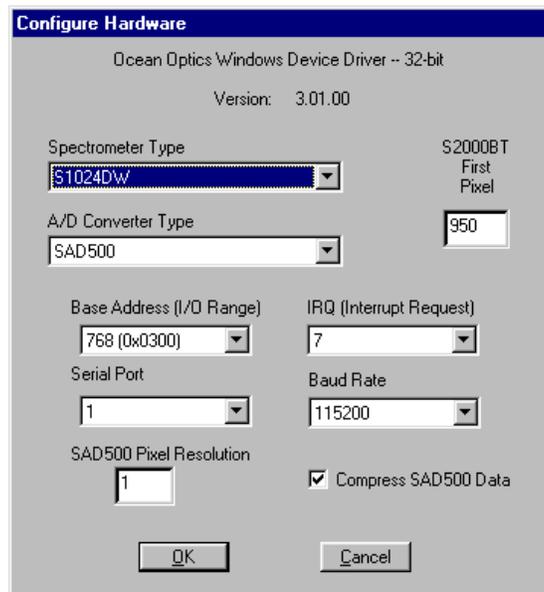
This appears to be the first time OOIBase32 has been executed. Please select a spectrometer configuration file from the following screen. This spectrometer configuration file will be used each time OOIBase32 is started.

A file open dialog box then appears. You must choose the default spectrometer configuration file. Navigate to the OOIBase32 directory, and choose the file with **.spec** as the extension. The **.spec** extension is preceded by the serial number of your spectrometer. (A default spectrometer configuration file will be named something similar to **I2J613.spec**.)

Configure Hardware Dialog Box

Next, the **Configure Hardware** dialog box opens. The parameters in this dialog box are usually set only once -- when OOIBase32 is first installed and the software first runs. You must specify your hardware configuration in this dialog box.

1. Under **Spectrometer Type**, choose S1024DW.
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 page 6 for help in determining the COM Port number.
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 pixel resolution, you gain speed. The transfer of one complete spectra requires ~0.3 seconds when communicating at 115,200 baud rate. If you need your information in <0.6 seconds, increase the resolution or enable data compression (see below).



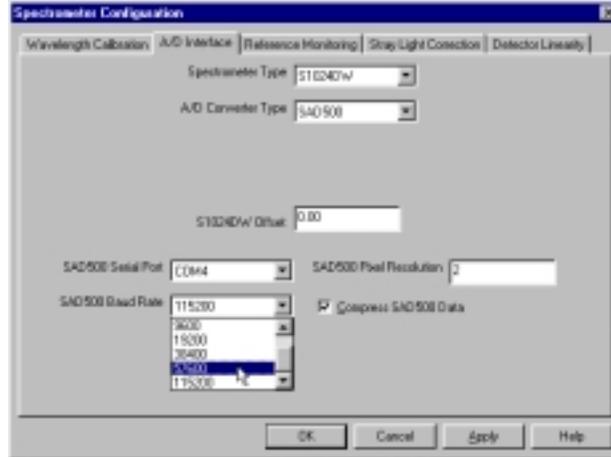
6. Enable the **Compress SAD500 Data** function to minimize the amount of data transferred over the RS-232 connection. Transmission of spectral data over the serial port is a relatively slow process. Enabling this function insures that every scan transmitted by the SAD500 will be compressed, greatly increasing the data transfer speed of the SAD500.
7. For your setup, only these parameters apply to your system. (Ignore the other settings; the driver will only read settings that pertain to the spectrometer and A/D converter you have chosen.) Click **OK**. You can always change these settings once OOIBase32 is fully operational by selecting **Spectrometer | Configure | A/D Interface**.

- . If you do not see the "Configure Hardware" screen when you start OOIBase32, exit OOIBase32 by selecting **File | Exit**. Then select **Start | Run**, and type **C:\windows\oidrv.ini**. Notepad will open. Edit the initialization 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 OOIBase32. You should now see the "Configure Hardware" dialog box.

Spectrometer Configuration Dialog Box

Now that OOIBase32 is running, you need to configure your system. Select **Spectrometer | Configure** from the menu. Go through each page in the **Spectrometer Configuration** dialog box to set system parameters. (For detailed information on each page of this dialog box, see the **OOIBase32 Spectrometer Operating Software Manual** or the software's help files.)

- In the **Wavelength Calibration** page, the coefficients for each spectrometer channel in your system have already been loaded as part of the spectrometer configuration file. Check the **Enabled** box for each spectrometer channel in your system.
- In the **A/D Interface** page, enter the same settings and values as you did in the **Configure Hardware** dialog box. The S1024DW Offset function allows you to adjust the signal baseline. Some S1024DW units have a negative baseline, which does not affect any data since all data is referenced from the same baseline. If your unit has a negative baseline and you want to insure the baseline (and therefore your data) is positive, you can enter an offset value to raise the baseline.
- The **Detector Linearity** page is for spectrometers other than the S1024DW.



At this point, OOIBase32 should be acquiring data from your spectrometer. There should be a dynamic trace responding to light near the bottom of the displayed graph.

When you exit OOIBase32, all of this configuration information will be stored in the spectrometer configuration file. The next time you run OOIBase32, the software will use the **[your serial number].spec** file as the standard for your spectrometer configuration. If you wish, save the spectrometer configuration file with a different name by choosing **Spectrometer | Save Configuration As** from the OOIBase32 menu.

OOIBase32 Settings Dialog Box

At this point, it is a good idea, though not necessary, to configure several OOIBase32 operation parameters. Choose **Edit | Settings** from the menu to open the **OOIBase32 Settings** dialog box. Go through each page of this dialog box to select options for saving, opening, and printing data; to choose waveform sound files for various program events; to configure default setting files; and to select other important options such as storing and copying data and choosing warning messages. (For detailed information on each page of this dialog box, see the **OOIBase32 Spectrometer Operating Software Manual** or the software's help files.)

Configure Data Acquisition Dialog Box

Finally, select **Spectrum | Configure Data Acquisition** from the menu to set your data acquisition parameters in the **Configure Data Acquisition** dialog box. The **Basic** page allows you to set the integration time and choose averaging and boxcar smoothing values. The **External Trigger** page allows you to specify the external trigger mode and automatically save data for each external trigger. The **Strobe** page allows you to control external strobe events with the spectrometer. (For detailed information on each page of this dialog box, see the **OOIBase32 Spectrometer Operating Software Manual** or the software's help files.)

Step 4: Connect sampling optics

Check the **Table of Contents** to find step-by-step directions for setting up and operating specific sampling optics such as light sources, sampling chambers, fibers, and other accessories.

Step 5: Start the software and receive data

Run OOIBase32 in Scope Mode and take a dark spectrum and a reference spectrum (see the **Experiment Tutorial** section for details). Choose the absorbance, transmission, or relative irradiance mode to take your sample measurements.

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 OOIBase32, cycle power on the SAD500 and restart OOIBase32.
- 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** from the OOIBase32 menu and choose the **A/D Interface** page. 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.

Getting Help

Comprehensive online assistance is available from OOIBase32's Help menu. The Help files provide instructions on all buttons, options, items, and dialog boxes in OOIBase32. However, if the online Help does not answer your question, please contact Ocean Optics.

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

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 compatibility:	supports all S1024DW spectrometers
Software compatibility:	supports all 32-bit Ocean Optics software products
Spectrometer integration time:	31 milliseconds to 60 seconds (S1024DW spectrometers) 5 milliseconds to 60 seconds (S2000 spectrometers)

Light Sources

Ocean Optics light sources provide illumination and excitation sources in the UV, VIS or Shortwave NIR range for absorbance or reflection measurements, discrete line spectra for wavelength calibrations, and calibrated absolute intensity standards for irradiance measurements. Wall transformers are supplied for laboratory use. Except for the deuterium lamps, all sources are powered by +12 VDC to facilitate their use in the field. The S1024DW accepts light energy and disperses it via a fixed grating across the array, which is responsive from 200-1100 nm. Though some light sources emit energy <200 nm, or emit energy to 2 μm , their use with Ocean Optics spectrometers is limited by our detector's responsivity (200-1100 nm).

The D-1000 Deuterium Light Source is a high-output, fiber optic light source optimized for the UV. It produces intense, continuous spectral output from ~200-400 nm.

The DT-1000 Deuterium Tungsten Halogen Light Source combines the continuous spectrum of a UV and VIS/NIR light source in a single optical path. Its output range is ~200-1100 nm.



The LS-1 Tungsten Halogen Light Source is a versatile source for the VIS-Shortwave NIR (360 nm-2 μm). It offers high color temperature, a long life and a built-in filter slot for color-correcting and other uses.

The LS-1-CAL Calibrated Light Source is a NIST-traceable calibrated light source for the VIS-Shortwave NIR (300-1050 nm). It has a highly Lambertian internal diffuser, and is specifically calibrated for optical fibers. The calibration data includes absolute intensities at the fiber entrance port for wavelengths between 300-1050 nm.



The PX-2 Pulsed Xenon Lamp (~225-700 nm) is a 220 Hz short-arc flashlamp. It produces high-energy pulses of brief duration and has two trigger modes for the hardware or software controlled flash rate.

The HG-1 Mercury Argon Calibration Source produces Mercury and Argon emission lines from 253-922 nm for use in performing fast, reliable spectrometer wavelength calibrations.

Light Sources: D-1000 Deuterium Light Source

The **D-1000 DEUTERIUM LIGHT SOURCE** is a high-output, high stability fiber optic light source optimized for the UV. The D-1000 produces intense, continuous spectral output from ~200-400 nm, making it especially useful for UV spectroscopy. The D-1000 has a highly stabilized microprocessor-based power supply designed for optimum stability, with a maximum fluctuation of just 0.05% peak-to-peak and drift of +/- 0.5%/hr. The lamp can be controlled from the switches on the front panel or through digital lines.

Parts Included

- D-1000 Deuterium Light Source
- Safety eyewear for protection against dangerous ultraviolet radiation
- Power cord for connecting D-1000 to outlet
- Allen wrench for adjusting the focus of the collimating lens

Caution!

- ☠ The beam emerging from the D-1000 produces visible light and invisible ultraviolet radiation. Direct contact with the beam could cause serious eye injury. Safety eyewear must be worn at all times while operating the D-1000. Do not remove any safety device installed.
- ☠ Dangerous voltages present.
- ⚠ Only qualified service personnel should service the D-1000.
- ⚠ This instrument should not be used for any clinical or diagnostic purposes.
- ⚠ Handle with care. Dropping the D-1000 may cause permanent damage.
- ⚠ For optimum performance below 230 nm, use a solarization-resistant fiber with this lamp.

Operation

1. Put on safety eyewear.
2. Lift the black protective shutter covering the fiber optic port. Remove the red plastic cap that covers the SMA connector and install an optical fiber. (For best results, use our solarization-resistant fibers.)
3. Plug the power cord into the rear of the D-1000. Plug the other end into a 110 VAC outlet.
4. Locate the black power switch at the rear of the D-1000, just above where the power cord connects to the D-1000. Turn on the power. When the power is on, the green **Power On** light located at the bottom right of the front panel will light.
5. Push in the **UV Start** button located on the front panel. This white button turns on the deuterium lamp. Pushing in the **UV Start** button initiates the start up sequence for the lamp. First, the heater in the deuterium lamp ionizes the available deuterium. At this point, the yellow **Heater On** light on the front panel will light. Next, after ~30 seconds, the red **UV On** light located at the top of the front panel will light. (The **Heater On** light will turn off at the same time.) Once the red **UV On** light is lit, the deuterium lamp is ready for your application. Best results are obtained after the lamp has warmed up for 30 minutes.
6. Without a solarization-resistant fiber, the spectral output will decrease significantly as a function of time at wavelengths lower than 230 nm.
7. To turn off the deuterium lamp, first press the white **UV Off** button located on the front panel. Then, flip the power switch at the rear of the D-1000, just above where the power cord connects to the D-1000. The green **Power On** light on the front panel will go out.
8. Lift up the black protective shutter and disconnect your optical fiber from the SMA connector.
9. Replace the red plastic cap over the SMA connector.

Bulb Replacement

1. Order a replacement bulb, item D-1000-B, from Ocean Optics.
2. Make sure the D-1000 is turned off, the power cord is disconnected and the lamp has cooled.
3. Use a Phillips-head screwdriver to remove all 12 screws from the side panels of the D-1000 casing. **Do not** remove *any* screws from the front, back, or bottom panels. Remove the cover.
4. Locate the deuterium bulb. It is located at the front of the housing, mounted on a black platform. Three wires lead from the bottom of the bulb to the bright green electronic board: one red wire (with a time indicator on it) and two black wires.
5. Use a Phillips-head screwdriver to loosen the screws securing these three wires to the green electronic board. Once the screws are loose, gently remove the red wire and the two black wires. You do not need to completely remove the screws to detach the wires. (Note that on the green electronic board, just right of each wire, is a letter. To the right of the red wire is the letter “A”. To the right of one black wire is the letter “H” and to the right of the second black wire is the letter “C”.)
6. In order to remove the bulb, you will need to unscrew the nut holding the collimating lens and SMA connector in place. It is positioned in such a way that if the nut remains in place, you will not be able to take out the deuterium bulb. Use a 3/8” wrench to remove the nut.
7. Use a Phillips-head screwdriver to remove the two screws securing the bulb to the black platform.
8. Remove the old bulb unit.
9. Inspect the new bulb unit, but **avoid touching the glass casing** (or envelope) around the bulb as the oils from your skin will deteriorate the bulb. Inside the envelope is a triangle-shaped filament. The filament has a **square** opening. The light passes through the square opening to the collimating lens. Take the new bulb, carefully feeding the three wires through the hole in the black platform, and position it so that the square opening in the filament faces the collimating lens.
10. Screw in the two screws that secure the bulb to the black platform.
11. Screw on the nut that holds the collimating lens in place.
12. Secure the three wires to the green electronic board. Attach the red wire to the top screw, labeled “A”. Attach the black wires to the screws on the board labeled “H” and “C”. **It does not matter which black wire is attached to screw “H” or “C”.**
13. Put the D-1000 cover back on and secure it with the 12 screws.

For directions on adjusting the focus of the collimating lens on the D-1000, turn to **Appendix A**.

Specifications

Spectral range:	~200-400 nm
Time to stabilized output:	~30 minutes
Power consumption:	25-30 Watts
Bulb lifetime:	1,000 hours (replacement bulbs available)
Stability:	peak-to-peak = 0.05% (maximum); drift of +/-0.5%/hour
Aperture:	0.5 mm (at lamp)
Connector:	SMA 905
Window material:	0.4 mm thickness UV-transmissive glass
Lamp voltage:	85 volts DC (nominal)
Operating lamp current:	300 mA DC (+/- 1mA)
Timing:	microprocessor-based
Inputs:	trigger inputs for lamp (on/off)
Outputs:	levels for lamp (on/off), filament (on/off)
Power requirements:	120 volts AC @ 0.50 A, 50-60 Hz 220 volts AC @ 0.25 A, 50-60 Hz 100 volts AC @ 0.60 A, 50-60 Hz 240 volts AC @ 0.20 A, 50-60 Hz

Light Sources: DT-1000 Deuterium Tungsten-Halogen Light Source

The **DT-1000 DEUTERIUM TUNGSTEN-HALOGEN LIGHT SOURCE** combines the continuous spectrum of a deuterium UV light source and a tungsten-halogen VIS/Shortwave NIR light source in a single optical path. The combined light source produces a powerful, stable output from ~200-1100 nm. It also has a highly stabilized microprocessor-based power supply designed for optimum stability.

Parts Included

- DT-1000 Deuterium Light Source
- Safety eyewear for protection against dangerous ultraviolet radiation
- Power cord for connecting DT-1000 to outlet
- Allen wrench for adjusting the focus of the collimating lens

Caution!

-  The beam emerging from the DT-1000 produces visible light and/or invisible ultraviolet radiation. Direct contact with the beam could cause serious eye injury. Safety eyewear must be worn at all times while operating the DT-1000. Do not remove any safety device installed.
-  Dangerous voltages present.
-  Only qualified service personnel should service the DT-1000.
-  This instrument should not be used for any clinical or diagnostic purposes.
-  Handle with care. Dropping the instrument may cause permanent damage.
-  For optimum performance below 230 nm, use a solarization-resistant fiber with this lamp.

Operation

Allow several minutes for the lamp to warm up and for the power to stabilize, regardless of the bulb being used. Best results are obtained after 30 minutes. The spectral output as delivered by an optical fiber will decrease significantly at wavelengths lower than 230 nm due to attenuation in the lamp envelope, the decrease in detector efficiency in the spectrometer, and attenuation by the fiber.

1. Put on safety eyewear.
2. Lift the black protective shutter covering the fiber optic port. Install an optical fiber. (For best results, use our solarization-resistant fibers.)
3. Plug the power cord into the rear of the DT-1000. Plug the other end into a 110 VAC outlet.
4. To turn on the power for the DT-1000, flip the power switch at the rear of the unit, just above where the power cord connects to the DT-1000. When the power is on, the green **Power On** light located at the bottom right of the front panel will light. At this time the user can now power up the deuterium or tungsten-halogen source or both. (See **Operating the Deuterium source** and **Operating the Tungsten-Halogen source**.) To turn off the DT-1000, both deuterium and tungsten-halogen sources must be off first. Only then can the user flip the power switch at the rear of the unit to the off position. The green **Power On** light will turn off.
5. Lift up the black protective shutter and disconnect your optical fiber from the SMA connector.

Operating the Deuterium source

6. To power the deuterium lamp, push in the **UV Start** button located on the front panel. This white button turns on the deuterium lamp. Pushing in the **UV Start** button initiates the start-up sequence for

the lamp. First, the heater in the deuterium lamp ionizes the available deuterium. At this point, the yellow **Heater On** light on the front panel will light. After ~30 seconds, the red **UV On** light located at the top of the front panel will light. (The **Heater On** light will turn off at the same time.)

7. To turn off the deuterium lamp, press the white **UV Off** button located on the front panel. The red **UV On** light should go out.

Operating the Tungsten-Halogen source

8. To power the tungsten-halogen lamp, push in the white button labeled **Visible On**. The red **Vis. On** light will come on.
9. To turn off the tungsten-halogen lamp, press the white **Visible On** button located on the front panel. The red **Vis. On** light will go out.

Bulb Replacement

Replacing the Deuterium bulb

1. Order a deuterium replacement bulb, item DT-1000-BD, from Ocean Optics.
2. Make sure the DT-1000 is turned off, the power cord is disconnected, and the source has cooled.
3. Use a Phillips-head screwdriver to remove all 12 screws from the side panels of the DT-1000 casing. **Do not** remove *any* screws from the front, back, or bottom panels. Remove the cover.
4. Locate the deuterium bulb. It is located at the front of the housing, mounted on a black platform. Three wires lead from the bottom of the bulb to the green electronic board: one red wire and two black wires.
5. Use a Phillips-head screwdriver to loosen the screws securing these three wires to the green electronic board. Once the screws are loose, gently remove the red wire and the two black wires. You do not need to completely remove the screws to detach the wires. (Note that on the green electronic board, just to the right of each wire, is a letter. To the right of the red wire is the letter “A”. To the right of one black wire is the letter “H” and to the right of the second black wire is the letter “C”.)
6. Use a Phillips-head screwdriver to remove the two screws securing the bulb to the black platform.
7. Remove the old bulb unit.
8. Inspect the new bulb unit, but **avoid touching the glass casing** (or envelope) around the bulb, as the oils from your skin will deteriorate the bulb. Inside the envelope is a triangle-shaped filament. The filament has a **square** opening. The light passes through the square opening to the collimating lens. Take the new bulb, carefully feeding the three wires through the hole in the black platform, and position it so that the square opening in the filament faces the collimating lens.
9. Screw in the two screws that secure the bulb to the black platform.
10. Secure the three wires to the green electronic board. Attach the red wire to the top screw, labeled “A”. Attach the black wires to the screws on the board labeled “H” and “C”. **It does not matter which black wire is attached to screw “H” or “C”.**
11. Put the DT-1000 casing back on and secure it with the 12 screws.

Replacing the Tungsten-Halogen bulb

1. Order a tungsten-halogen replacement bulb, item DT-1000-BT, from Ocean Optics.
2. Remove all 12 screws from the side panels of the DT-1000 casing using a Phillips-head screwdriver. **Do not** remove *any* screws from the front, back, or bottom panels. Remove the cover.
3. Locate the tungsten-halogen bulb. It is inserted on the top of a cylindrical unit held by a set screw in a hole in the black platform. The cylindrical unit is positioned behind the deuterium bulb. Two thin wires lead from the bottom of the unit to a socket on the electronic board.
4. Gently grip the top of the bulb and pull it away from the cylindrical unit. Discard the bulb.
5. Insert the new bulb into the top of the cylinder, being careful to position the bulb’s pins over the holes in the top of the cylinder.
 The cylindrical unit is held in place with a small set screw. By loosening it, the user can slide the bulb unit up and down, positioning it in front of the attenuator, a metal disc that attenuates the light before going through the collimating lens. Another set screw holds the attenuator in place.
6. Put the DT-1000 casing back on and secure it with the 12 screws.

For directions on adjusting the focus of the collimating lens on the DT-1000, turn to **Appendix A**.

Specifications

Spectral range:	~200-1100 nm
Time to stabilized output:	~30 minutes
Deuterium bulb lifetime:	1,000 hours
Tungsten-halogen bulb lifetime:	900 hours
Power consumption:	25-30 Watts
Stability:	peak-to-peak = 0.05% (maximum) drift of +/-0.5%/hour
Aperture:	0.5 mm (at lamp)
Connector:	SMA 905
Lamp voltage:	85 volts DC (nominal)
Operating lamp current:	300 mA DC (+/- 1mA)
Inputs:	trigger inputs for lamp (on/off)
Outputs:	levels for lamp (on/off), filament (on/off)
Power requirements:	120 volts AC @ 0.50 A, 50-60 Hz 220 volts AC @ 0.25 A, 50-60 Hz 100 volts AC @ 0.60 A, 50-60 Hz 240 volts AC @ 0.20 A, 50-60 Hz

Light Sources: LS-1 Tungsten Halogen Light Source

The **LS-1 TUNGSTEN HALOGEN LIGHT SOURCE** is a versatile, white-light lamp utilized for the VIS-Shortwave NIR (360 nm-2 μm). The lamp, with either a 900-hour or 10,000-hour bulb, offers high color temperature and extremely efficient output.

Parts Included

- LS-1 Tungsten Halogen Light Source
- 12 VAC power supply
- Allen wrench for adjusting the collimating lens

Caution!

-  The LS-1 becomes **HOT** during operation. No cooling fan is installed in the LS-1. Handle with care.
-  **DO NOT** insert plastic or flammable materials in the filter slot. The materials could melt or ignite.
-  The unit could ignite flammable materials that come in contact with the metal housing.

Operation

Turning On the Lamp

1. Plug the wall transformer end into a standard 110 V outlet. Plug the 12 V output end into the back of your LS-1.
2. Screw a fiber into the SMA connector on your LS-1.
3. Find the on/off switch on the back of the lamp and turn the lamp on. Allow the lamp to warm up for approximately 30 minutes.

Using the Filter Slot

The slot between the lamp and the fiber coupler can be used to hold filters or light blocks. You can place a filter into the filter slot; however, be aware of the following:

- The filter slot accepts filters up to 3 mm thick.
- Because the lamp can become hot, avoid plastic filters as they may melt.
- The unit could ignite flammable materials that come in contact with the metal housing.
- There is no filter clamping screw for holding filters in place.

The most useful filters include the following:

- an FG-3 blue filter for increasing the relative energy near 400 nm and 800 nm compared to 600 nm
- an IR cutoff filter to reduce stray light below 750 nm
- a 550 nm long pass filter to eliminate second-order effects on Shortwave NIR measurements

Replacing the Bulb

1. Order a replacement bulb (LS-1-B for a 900-hour bulb or LS-1-LL-B for a 10,000-hour bulb).
2. Turn off the LS-1 and allow the lamp to cool.
3. Use an Allen wrench to loosen the set screw on the bottom of the lamp. You do not need to remove the set screw. This screw holds the bulb in place.

4. Locate the two set screws at the back of the lamp, one above each back leg. These two screws keep the two halves of the lamp together. Remove the two screws.
5. Gently separate the two halves of the lamp.
6. Carefully pull the bulb out of its housing. Detach the wire and lamp leads from the socket. Remove the old bulb unit and discard.
7. Plug the new bulb into the socket.
8. Slide the new bulb forward into the front of the lamp as far as it will go.
9. Gently tighten the set screw on the bottom of the lamp.
10. Close together the two halves of the lamp, being careful not to pinch the wires.
11. Replace the two screws at the back of the lamp.

For directions on adjusting the focus of the collimating lens on the LS-1, turn to **Appendix A**.

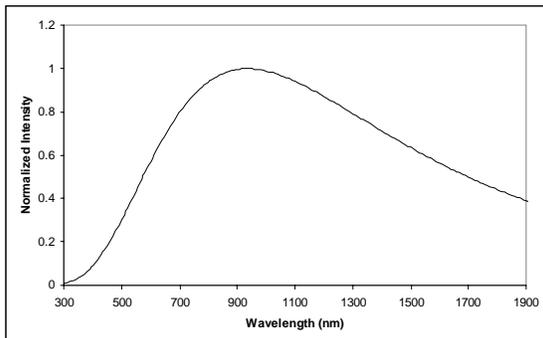
Specifications

Spectral range:	360 nm - 2 μm *
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, 7-20 VDC/0.5-2 amps
Power output:	6.5 watts
Bulb life:	900 hours (standard), 10,000 hours (long-life)
Bulb color temperature:	900-hour bulb = 3100K, 10,000-hour bulb = 2800K
Output to bulb:	5 volts/1.3 amps
Output regulation:	0.2% voltage
Time to stabilized output:	~30 minutes
Bulb output:	7400 foot-candles (7.4MSCP)
Connector:	SMA 905

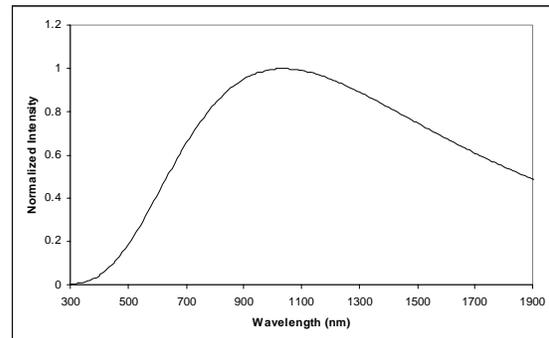
* The LS-1 has a spectral range of 360 nm-2 μm , however the range is limited to the spectral response of the detector. For the S1024DW, the detector's response goes to 1100 nm.

Spectral Output

These graphs represent normalized blackbody curves for tungsten halogen light sources with 2800K and 3100K color temperatures. The observed spectral output of the LS-1 will vary due to bulb type, the spectrometer configuration, the sampling optics used, and inherent fluctuations in LS-1 output.



900-hour bulb / 3100K



10,000-hour bulb / 2800K

Light Sources: PX-2 Pulsed Xenon Lamp

The **PX-2 PULSED XENON LAMP** is a high flash rate, short-arc xenon lamp for applications involving absorbance, reflection, fluorescence and phosphorescence measurements. The PX-2 operates at speeds up to 220 Hz and offers critical pulse-to-pulse stability.

Parts Included

- PX-2 Pulsed Xenon Lamp
- 15-pin cable for connecting the PX-2 to the spectrometer
- 12V DC wall transformer for supplying power to the PX-2

Caution!

-  The beam emerging from the PX-2 produces ultraviolet radiation. Direct contact with the beam could cause serious eye injury. Never look directly into the light source.
-  Dangerous voltages present. Never operate the PX-2 without its housing intact.
-  The SMA connector may get **HOT** during operation.
-  This instrument should not be used for any clinical or diagnostic purposes.
-  Handle with care. Dropping the instrument may cause permanent damage.

Operation

The lamp is triggered with TTL pulses delivered through the 15-pin connector located at the rear of the unit. Our S1024DW-series spectrometers and software, or any source of TTL signals, supplies these pulses. The lamp is powered by a 12V DC transformer, or from a 12V battery if field use is desired.

1. Plug the wall transformer into a 110V outlet. Plug the other end of the cord into the jack at the rear of the PX-2.
2. Install the 15-pin cable into the rear of the PX-2. Connect the other end to the 15-pin connector on an S1024DW.
3. Connect an optical fiber to the SMA-terminated fiber optic port on the front panel.
4. Turn the power switch located at the rear of the source to the “ON” position.
5. Select either “MULTIPLE” or “SINGLE” flash mode by moving the toggle on the rear of the source. You will need to match this mode in the operating software.
6. Configure OOIBase32 operating software to operate the PX-2. In the **Acquisition Parameters** dialog bar, check the **Strobe Enable** box. You can also enable this function by selecting **Spectrum | Configure Data Acquisition** from the menu and then choosing the **Strobe** page of the dialog box.
7. The flash should fire with a clearly audible “ping.”

Application Tips

Single Flash Mode

Using the Single flash mode results in one flash per integration cycle. Since the PX-2 has a maximum repetition rate of 220 Hz, the minimum integration allowed in this mode is 31 milliseconds.

Multiple Flash Mode

When using the Multiple flash mode the user needs to ensure that a constant number of flashes occurs for every integration cycle by setting the pulse rate and integration time. This achieves a continuous and stable signal. The pulse rate is determined by a jumper setting inside the S1024DW (JP3). The integration time is controlled via the operating software. To achieve a constant number of flashes per integration cycle, the integration time must be a multiple of those shown in the following table:

S1024DW JP3 setting	Integration time must be a multiple of
2^{16} (factory default)	128
2^{14}	32
2^{12}	8
2^{10}	N/A

The PX-2 repetition rate is controlled via the S1024DW (JP3), but is also dependent upon the frequency of your A/D card. With the S1024DW, the SAD500 operates at 200 kHz, the fastest rate the S1024DW allows the SAD500 to operate. The table below shows the rep rate for the various combinations of hardware and jumper settings. (Note that the default setting from the factory is 2^{16} .)

JP3 Post #	Function	Frequency (Hz)
1	Not enabled - for future software control	
2	Divide by 2^{10}	195
3	Divide by 2^{12}	48.8
4	Divide by 2^{14}	12.2
5	Divide by 2^{16}	3.1

Specifications

Spectral range:	220-750 nm
Approximate dimensions:	<ul style="list-style-type: none"> 14 cm x 10.5 cm x 4 cm (LWH) 5.5" x 4.1" x 1.5" (LWH)
Power input:	<ul style="list-style-type: none"> 1.3 A @ 11V @ 220 Hz 100 mA @ 12V @ 10Hz
Trigger input:	external TTL positive pulse via 15-pin connector
Output:	<ul style="list-style-type: none"> 45 millijoules per pulse maximum 9.9 watts average power 220 Hz pulse rate maximum
Pulse duration:	5 microseconds (at 1/3 height of pulse)
Lifetime:	10^9 pulses (estimated 230 days continuous operation at 50 Hz pulse rate)
Aperture:	3 mm
Connector:	SMA 905
Timing signals available from S1024DW spectrometers:	<ul style="list-style-type: none"> Multiple mode = up to 220 Hz (varies with A/D sampling frequency) Single mode = varies with scan rate

Light Sources: HG-1 Mercury Argon Calibration Source

The **HG-1 MERCURY ARGON CALIBRATION SOURCE** is a wavelength calibration source for UV-VIS-Shortwave NIR spectrophotometric systems. The HG-1 produces Mercury and Argon lines from 253-922 nm, for use in performing fast, accurate spectrometer wavelength calibrations. The HG-1 has an SMA 905 termination for connecting to optical fibers.

Caution!

-  The beam emerging from the HG-1 produces ultraviolet radiation. Direct contact with the beam could cause serious eye injury. Never look directly into the light source.
-  The SMA connector may get **HOT** during operation.
-  Dangerous voltages present. No user-serviceable parts inside.
-  Never take apart the HG-1. The HG-1 contains mercury.

Operation

1. Plug the wall transformer end into a standard 110 V outlet. Plug the 12 V output end into the back of your HG-1. Or, insert a 9V battery (not included).
2. Screw a fiber into the SMA connector on your HG-1. If your spectrometer does not have an entrance slit, use a 50 μm diameter (or smaller) optical fiber. Larger fibers and slits will have lesser optical resolution. Also, keep in mind that if the spectrometer has no slit and your experimentation involves using optical fibers of different diameters, wavelength calibration will be necessary. Calibration is also recommended each time you unscrew the fiber from the spectrometer.
3. Find the on/off switch next to the SMA connector and turn the lamp on. The red indicator will light when the lamp is on.

Calibration

Users can perform wavelength calibration with a spreadsheet program such as Microsoft Excel, or a calculator that performs polynomial regressions. The following describes how to calibrate the wavelength of your spectrometer using the HG-1. Though each spectrometer is calibrated before it leaves Ocean Optics, the wavelength for all spectrometers will drift slightly as a function of time and environmental conditions. To recalibrate the wavelength of your spectrometer, just follow these simple steps.

What You Are Doing:

The relationship between pixel number and wavelength is a second-order polynomial . . .

$$\lambda_p = I + C_1p + C_2p^2$$

. . . where λ is the wavelength of pixel p , I is the wavelength of pixel 0, C_1 is the first coefficient (nm/pixel) and C_2 is the second coefficient (nm/pixel²). You will be calculating the value for I and the two C s.

What You Will Need:

- Your HG-1 Mercury-Argon lamp.
- Your spectrometer.
- An optical fiber. For spectrometers without a built in slit, a 50- μm fiber works best.
- Either a spreadsheet program (Excel or Quattro Pro, for example) or a calculator that performs second-order linear regressions. (If you are using Microsoft Excel, select **Tools | Add-Ins** and make sure that that **Analysis ToolPak** has been chosen.)

What You Will Need To Do:

1. After placing OOIBase32 into Scope Mode, take a spectrum of the HG-1. Adjust the integration time until there are several peaks on the screen that are not off-scale.
2. Move the cursor to one of the peaks and carefully position it so that it is at the point of maximum intensity. Record the pixel number that is displayed in the status bar. Repeat this step for all of the peaks in your spectrum.
3. Using your spreadsheet, create a table like the one shown below. In the first column, place the exact wavelength of the spectral lines that you used. In the second column of this worksheet, place the observed pixel number. In the third column, place the pixel number squared.

Independent Variable ↓ TRUE Wavelength (nm)	Dependent Variables ↙ ↘ Pixel # Pixel #²		Values computed from the regression output ↙ ↘ Predicted Wavelength Difference	
253.65	105	11025	253.516577	0.133422619
296.73	179	32041	296.979662	-0.249662049
302.15	188	35344	302.220703	-0.070702657
313.16	206	42436	312.6735	0.486499891
334.15	243	59049	334.037188	0.112812248
365.01	298	88804	365.489132	-0.479132164
404.66	368	135424	404.991651	-0.331651335
435.84	423	178929	435.615094	0.224905808
546.08	626	391876	545.48766	0.592339659
696.54	921	848241	696.302678	0.237321917
706.72	942	887364	706.638812	0.081187518
727.29	984	968256	727.151647	0.138352544
738.40	1007	1014049	738.294786	0.105214107
750.39	1033	1067089	750.814613	-0.424612735

4. Now you are ready to calculate the wavelength calibration coefficients. In your spreadsheet program, find the functions to perform linear regressions:
 - in Quattro Pro, look under **Tools | Advanced Math**
 - in Excel, look under **Tools | Data Analysis**
5. Select the true wavelength as the dependent variable (Y). Select BOTH the pixel number and pixel number squared as the independent variables (X). After you execute the regression, an output similar to the one shown below is obtained.

Regression Statistics

Multiple R	0.999998327
R Square	0.999996654
Adjusted R Square	0.999996096
Standard Error	0.371756477
Observations	15

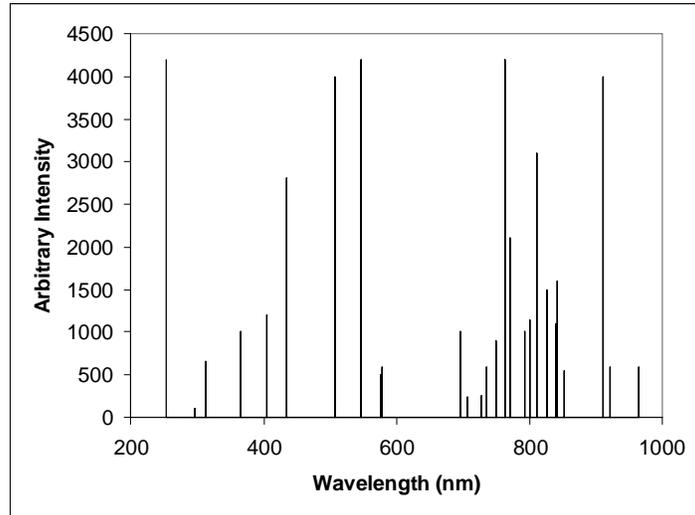
	<u>Coefficients</u>	<u>Standard Error</u>	
Intercept	190.713498	0.369047536	intercept
X Variable 1	0.604451305	0.001684745	
X Variable 2	-6.02547E-05	1.41503E-06	first coefficient
			second coefficient

6. You will need to record the Intercept as well as the First and Second Coefficients. Also, look at the value for R squared. It should be very close to 1. If it is not, you have probably assigned one or more spectral lines incorrectly.
7. Select the menu option **Spectrometer | Configure | Wavelength Calibration** to update the wavelength coefficients within OOIBase32.
8. Repeat this process for each channel in your spectrometer.

Spectral Output

Mercury emission lines are <600 nm. Argon emission lines are >600 nm, and are shown here on the right on an exaggerated amplitude scale. Below is a list of the most prominent mercury and argon peaks.

Mercury Lines	Argon Lines
253.65	696.54
296.73	738.40
302.15	750.39
313.16	763.51
334.15	772.40
365.01	794.82
404.66	800.62
435.84	811.53
546.08	826.45
576.96	842.46
579.07	912.30



Specifications

Output:	low-pressure gas discharge lines of Mercury and Argon
Spectral range:	253-922 nm
Dimensions:	11.4 cm x 6.98 cm x 2.54 cm (LWH), 4.5'' x 6.98'' x 1.0'' (LWH)
Power requirements:	12 VDC wall transformer (comes with unit) or 9 VDC battery
Internal voltage:	600 volts at 30 kHz
Bulb life:	~3,500 hours
Amplitude stabilization:	~1 minute
Aperture:	3 mm
Connector:	SMA 905

Light Sources: LS-1-CAL Calibrated Light Source

The **LS-1-CAL CALIBRATED LIGHT SOURCE** for the VIS-Shortwave NIR (300-1050 nm) provides the user with known absolute intensity values at several wavelengths, expressed in $\mu\text{W}/\text{cm}^2/\text{nm}$. Since the spectral intensity of the LS-1-CAL can be traced to an intensity standard provided by National Institute of Standards and Technology (NIST), it can be used in measuring absolute spectral intensities. This lamp has a highly Lambertian internal diffuser, and its 900-hour bulb has a 3100K color temperature.

Parts Included

- LS-1-CAL 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 a bare fiber and one for using a CC-3 cosine-corrected irradiance probe
- A disk that holds files for both calibration reports
- Allen wrench for adjusting the collimating lens

Caution!

-  The LS-1-CAL becomes **HOT** during operation. Handle with care.
-  DO NOT insert flammable materials in 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.

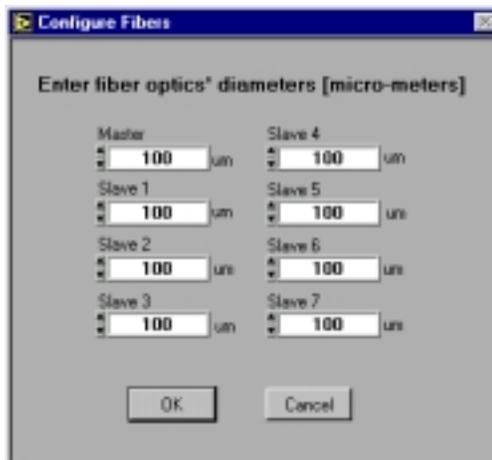
Setting Up

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 OOIrrad software. (If you have an IRRAD2000 spectroradiometric system, 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.)

Calibration

1. 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.
2. Plug the other end into the back of the switching AC adapter. Plug the wall transformer end of the power cord into a standard 110V outlet.
3. Take off the fiber cover and screw a fiber *all the way* into the SMA connector.
 - Whatever optical setup you wish to use for your application, you must also use for your calibration. For example, if you use a 200 μm fiber with a CC-3 cosine corrected irradiance probe for your application, you must use the same 200 μm fiber and CC-3 for your calibration.
4. Find the on/off switch on the back of the lamp and turn the lamp on.
5. Let the lamp warm up for 15 minutes.
6. Insert the disk that came with your lamp. 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 lamp with a bare fiber; its name contains the lamp's serial

- number, followed by **FIB.LMP**. The second file has the calibration numbers when calibrating with a CC-3 cosine-corrector and fiber; its name contains the lamp's serial number, followed by **CC3.LMP**.
7. Copy these two files into your OOIIrrad directory.
 8. Start OOIIrrad by selecting **Start | Programs | OOIIrrad | OOIIrrad**.
 9. 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.
 10. Under the Spectrometer menu function, 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 your calibration. 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 the same cosine corrector for your calibration.
 11. To the right of the displayed spectrum, enter the parameters for your setup next to **Scans to Avg**, **Smoothing Size**, and **Integration Period (ms)**.
 - Scans to Avg: Enter a value to implement a sample averaging function that averages x number of spectra. The higher the value, the better the Signal-to-Noise.
 - Smoothing Size: Enter a value to implement a smoothing technique that averages across spectral data. A value of 5, for example, averages each data point with 5 points to its left and 5 points to its right. The greater this value, the smoother the data and the higher the S:N. However, if the value is too high, a loss in spectral resolution will result.
 - Integration Period (ms): Enter a time in milliseconds to regulate the amount of time the detector "looks" at the incoming photons. If your Scope Mode intensity is too low, increase this value. If the intensity is too high, decrease the value. While watching the graph trace, adjust the integration time until the signal intensity level is approximately 3500 counts.
 12. Under **Spectrometer** menu options, choose **Calibrate** and then the channel you are calibrating.
 13. A dialog box opens with the message "Verify lamp was ON for at least 15 minutes for a REFERENCE scan." Click **OK**. You have just taken your reference measurement.
 14. Another dialog box opens with the message "Block light path to spectrometer for a DARK scan." Before clicking OK, be sure to block the light path by inserting an opaque object into the lamp's filter slot. Do not turn the lamp off. Click **OK**.
 15. The spectrometer is now calibrated.



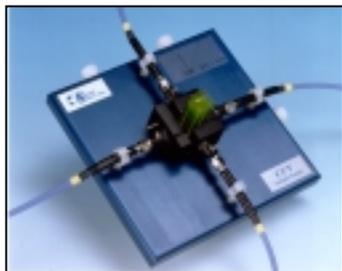
Specifications

Spectral range (calibrated):	360-1050 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

Sampling Chambers

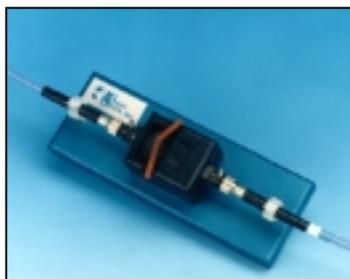
Ocean Optics offers a comprehensive line of compact, low-cost sampling chambers for a variety of UV-VIS-Shortwave NIR applications. All sampling chambers have SMA terminations for easy coupling to optical fibers. Options include a variety of cuvette holders for 1-cm and 10-cm cuvettes, in-line filter holders, flow cells, and other sampling devices.

Standard cuvette holders are available for 1-cm and 10-cm cuvettes, and couple via SMA-terminated optical fibers to our spectrometers and light sources to create small-footprint systems for absorbance experiments. Each cuvette holder comes with a pair of 5-mm diameter f/2 collimating lenses optimized for UV-VIS-NIR or VIS-NIR applications, and has a slot for optical filters. Also available is the CUV-FL-DA, a 1-cm cuvette holder that attaches directly to light sources.



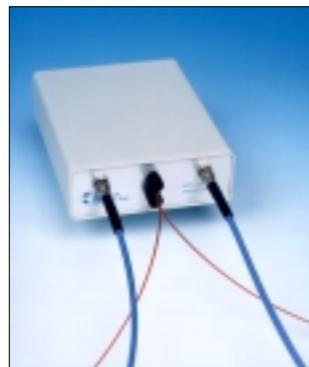
The CUV-ALL is a cuvette holder for 1-cm cuvettes that has fiber optic couplings at four collimators -- a pair of 5-mm diameter f/2 collimating lenses optimized for the UV-VIS and a pair optimized for the VIS-NIR. Optical fibers can be attached at these collimators to read or illuminate the sample. When combined with our spectrometers and light sources, the CUV-ALL can measure absorbance, fluorescence, scattering, or any combination of these optical phenomena.

ISS Integrated Sampling System consists of a compact tungsten-halogen light source with integrated cuvette holder for 1-cm cuvettes. This versatile sampling device couples to our miniature spectrometers via optical fibers to create fully integrated, small-footprint sampling systems for VIS-NIR absorbance and transmission measurements. The ISS is designed specially for use with S1024DW Spectrometers.



FHS In-Line Filter Holders for the UV-VIS-NIR or VIS-NIR provide a convenient platform for rapid absorbance or transmission measurements of optical and other filters. Filter holders come with a pair of 5-mm diameter collimating lenses, and accept 1" round or any size square optical filters, up to 6 mm in thickness. FHS assemblies are typically used either to measure filters or to put filters into optical setups.

LPC Long Pass Flow Cells couple to our fiber optic spectrometers and compact light sources to measure low-concentration (ppb-ppt) aqueous samples. LPC Flow Cells are available in 1-meter, 5-meter and 10-meter path lengths for absorbance measurements, and in a 1-meter path length with built-in 365-nm excitation source for fluorescence measurements. Each assembly has 560 μm inner-diameter Teflon® tubing with an internal volume of 250 μl /meter, and will function with most liquids having a refractive index ≥ 1.30 .



Sampling Chambers: CUV-VIS, CUV-UV Cuvette Holders

The **CUV-VIS** and **CUV-UV CUVETTE HOLDERS** for 1-cm path length cuvettes couple via SMA-terminated optical fibers to our spectrometers and light sources to create small-footprint spectrophotometric systems for absorbance and transmission experiments. These holders can be optimized for VIS-NIR (~360-1100 nm) or UV-VIS-NIR (~200-1100 nm) applications.

Parts Included

- Cuvette holder assembly for holding 1-cm cuvettes
- Black cover for eliminating ambient light
- Two barbed fittings for connecting a temperature stabilizing water source
- Screwdriver for adjusting the fit of the cuvette
- Allen wrench for adjusting the collimating lenses

Operation

Attaching the Fibers

1. Attach one end of a SMA-terminated optical fiber to one of the collimating lenses. Attach the other end of this fiber – the illumination fiber – to a light source.
2. Attach another SMA-terminated optical fiber to the other collimating lens. Attach the other end of this fiber – the read fiber – to the spectrometer.

Using the Fiber Supports

1. Snap the clamps around the fibers after the fibers are screwed into the light source and spectrometer.
2. Lift the clamps until they support the fibers.
3. Unsnap the clamps to remove the fibers.

Installing Filters

1. Loosen the filter clamping screw with the provided screwdriver.
2. Insert the filter into the filter slot. The filter slot can accommodate filters up to 6 mm thick.
3. Clamp the filter in place by gently tightening the clamping screw finger-tight.

Adjusting the Fit of the Cuvette

The Cuvette Holder is designed to hold 1-cm square cuvettes. When properly adjusted, the cuvette should fit snugly into the holder.

1. Locate the two ball plunger screws.
2. Remove the fiber clamps for easier access to the screws.
3. Use the provided screwdriver to loosen the two ball plunger screws until the ball end of the screws is just visible in the cell holder and insert your cuvette into the holder.
4. Tighten the ball plunger screws until the ball contacts the cuvette and starts to compress. Do not over-tighten.

Using the Temperature Stabilization Feature

This feature is used to heat or cool the cuvette holder base and cuvette.

1. Remove the plugs from the top side of the base. (The plug on the right side of the base should stay in place but may require thread tape.)
2. Replace the plugs with the two barbed fittings (or any 1/8" NPT pipe thread fittings). Thread tape may be required on the fittings to prevent leakage.
3. Connect the fittings to a water source. Water will circulate through the base.

Specifications

Path length:	1 cm
Collimating lenses (VIS-NIR):	BK 7 glass, 5 mm diameter, f/2
Collimating lenses (UV-VIS-NIR):	Dynasil quartz, 5 mm diameter, f/2
Collimating lens termination:	SMA 905
Collimating lenses assembly (sample compartment) dimensions:	2.0" x 1.5" (LW)
Filter slot:	accepts filters up to ¼" (6 mm) in thickness
Base material:	aluminum
Base length:	5.5"
Connections in base:	<ul style="list-style-type: none"> • water inlet • water outlet • extra connection
Water input fittings:	1/8" NPT pipe thread
Typical optical fibers specified for optimum performance (light throughput and optical resolution)**:	<ul style="list-style-type: none"> • 200 µm illumination fiber • 50 µm read fiber

* Though the VIS-NIR lens is optimized for use to 2 µm, it can be configured to “see” only to 1100 nm with our S1024DW spectrometer.

** For all intents, there is no single combination of optical fibers that will satisfy the requirements of every application. As a rule, however, it is best to use a large-diameter (>50 µm) illumination fiber to get the maximum light throughput, and a small-diameter (<50 µm) read fiber to achieve the best optical resolution.

Sampling Chambers: CUV-VIS-10, CUV-UV-10 Cuvette Holders

The **CUV-VIS-10** and **CUV-UV-10 CUVETTE HOLDERS** for 10-cm cuvettes couple to our spectrometers and light sources to create spectrophotometric systems for absorbance and transmission measurements of aqueous solutions and gases for VIS-NIR (~360-1100 nm) or UV-VIS-NIR (~200-1100 nm) applications.

Parts Included

- Cuvette Holder assembly for holding 10-cm cuvettes
- Black Cover for eliminating ambient light
- Two Barbed Fittings for connecting a temperature stabilizing water source
- Screwdriver for adjusting the fit of the cuvette
- Allen wrench for adjusting collimating lenses

Operation

Attaching the Fibers

1. Attach one end of a SMA-terminated optical fiber to one of the collimating lenses. Attach the other end of this fiber -- the illumination fiber -- to a light source.
2. Attach another SMA-terminated optical fiber to the second collimating lens. Attach the other end of this fiber -- the read fiber -- to the spectrometer.

Using the Fiber Supports

1. Snap the clamps around the fibers after the fibers are screwed into the light source and spectrometer.
2. Lift the clamps until they support the fibers. To remove the fibers, simply unsnap the clamps.

Installing Filters

1. Tighten the thumb wheel completely when not using a filter.
2. Loosen the thumb wheel on the left side of the cuvette holder, creating enough space for the filter.
3. Insert the filter into the filter slot, which can hold filters up to 6 mm thick, and tighten the thumb wheel.

Using the Temperature Stabilization Feature

This feature is used to heat or cool the cuvette holder base and cuvette.

1. Remove the two plugs from the top side of the base. (The plug on the right side of the base should stay in place but may require thread tape.)
2. Replace the plugs with the two barbed fittings (or any 1/8" NPT Pipe thread fittings). Thread tape may be required on the fittings to prevent leakage.
3. Connect the fittings to a water source. Water will circulate through the base.

Specifications

Collimating lenses (VIS-NIR):	BK 7 glass, 5 mm diameter
Collimating lenses (UV-VIS-NIR):	Dynasil 1100 quartz, 5 mm diameter
Base material and length:	Aluminum, 5.5"
Water input fittings:	1/8" NPT pipe thread

Sampling Chambers: CUV-ALL 4-way Cuvette Holder

The **CUV-ALL 4-WAY CUVETTE HOLDER** for 1-cm path length cuvettes has four collimating lenses that couple to optical fibers, light sources, and spectrometers to measure absorbance, fluorescence, scattering, or any combination of these optical phenomena.

Parts Included

- CUV-ALL assembly for holding 1-cm cuvettes
- Black Cover for eliminating ambient light
- Two Barbed Fittings for connecting a temperature stabilizing water source
- Screwdriver for adjusting the fit of the cuvette
- Allen wrench for adjusting the collimating lenses

Operation

Attaching the Fibers for Absorbance Measurements

1. For UV measurements, attach one end of a SMA-terminated optical fiber to one of the collimating lenses with a red lens cap. Attach the other end of this fiber to a UV light source. Attach another SMA-terminated optical fiber to the collimating lens directly opposite of the first fiber. It too has a red lens cover. Attach the other end of this fiber to the spectrometer.
2. For VIS measurements, attach one end of a SMA-terminated optical fiber to one of the collimating lenses with a black lens cover. Attach the other end of this fiber to a light source. Attach another SMA-terminated optical fiber to the collimating lens directly opposite of the first fiber. It too will have a black lens cover. Attach the other end of this fiber to the spectrometer.

Attaching the Fibers for Fluorescence Measurements

1. Attach one end of a SMA-terminated optical fiber to one of the collimating lenses. Attach the other end of this fiber to a light or excitation source. Typically, for fluorescence measurements, the illumination fiber connects to a UV lens.
2. Attach another SMA-terminated optical fiber to the collimating lens to the immediate left or right of the first fiber. The two collimators must be positioned at 90° for fluorescence measurements. Attach the other end of this fiber to the spectrometer. Typically, for fluorescence measurements, the read fiber connects to a VIS lens.

Using the Fiber Supports

1. Snap the clamps around the fibers after the fibers are screwed into the light source and spectrometer.
2. Lift the clamps until they support the fibers.
3. Unsnap the clamps to remove the fibers.

Adjusting the Fit of the Cuvette

The CUV-ALL is preset for use with a 1-cm quartz cuvette. When properly adjusted, the cuvette should fit snugly in the holder.

1. Locate the two ball plunger screws. They are under two of the four collimating lenses.
2. Remove the fiber clamps for easier access to the screws.
3. Use the provided screwdriver to loosen the two ball plunger screws until the ball end of the screws is just visible in the cell holder.
4. Insert your cuvette into the holder.
5. Tighten the ball plunger screws until the ball contacts the cuvette and starts to compress. Do not over-tighten.

Installing Filters

1. Loosen the filter clamping screw with the provided screwdriver.
2. Insert the filter into the filter slot. The filter slot can accommodate filters up to 6 mm thick.
3. Clamp the filter in place by gently tightening the clamping screw finger-tight.

Using the Temperature Stabilization Feature

This feature is used to heat or cool the cuvette holder base and cuvette.

1. Remove the two plugs from the top side of the base. (The plug on the right side of the base should stay in place but might require thread tape.)
2. Replace the plugs with the two barbed fittings (or any 1/8" NPT pipe thread fittings). Thread tape might be required on the fittings to prevent leakage.
3. Connect the fittings to a water source. Water will circulate through the base.

Specifications

Path length:	1 cm
Collimating lenses (VIS-NIR):	(2) BK 7 glass, 5 mm diameter, f/2
Collimating lenses (UV-VIS-NIR):	(2) Dynasil 1100 quartz, 5 mm diameter, f/2
Collimating lens termination:	SMA 905
Filter slot:	accepts filters up to ¼" (6 mm) in thickness
Base material:	aluminum
Water input fittings:	1/8" NPT pipe thread

Sampling Chambers: CUV-FL-DA Direct Attach Cuvette Holder

The **CUV-FL-DA CUVETTE HOLDER** attaches directly to our light sources and couples via SMA-terminated optical fibers to our spectrometers, creating an incredibly small-footprint spectrophotometric system for fluorescence as well as absorbance experiments. The CUV-FL-DA, optimized for UV-VIS-NIR (200-1100 nm) applications, holds 1-cm square cuvettes.

The CUV-FL-DA is especially useful for fluorescence measurements. Mirrored screw plugs have been incorporated into the CUV-FL-DA to make the fluorescence signal stronger. These mirrors are UV-enhanced aluminum-coated for optimal signal reflection. One mirrored screw plug collects the fluorescence that would otherwise be lost. The second screw plug works to reflect the excitation energy back through the sample. The increase in signal intensity is also a result of the direct attachment of the CUV-FL-DA to the light source.

The CUV-FL-DA has a 74-UV collimating lens to collect the light and funnel it to the fiber. Collection efficiency, spatial resolution, transmission angle, and acceptance (or collection) angle are adjustable and are easily optimized. The CUV-FL-DA is packaged with the collimating lens screwed on at a 90° angle from the light source for fluorescence measurements. However, the lens is removable and can be relocated for “straight-through” absorbance measurements.

Operation

Using with the D-1000 and DT-1000

To attach the CUV-FL-DA to the D-1000 or the DT-1000 the safety shutter must first be removed.

1. Use a Phillips-head screwdriver to remove all 12 screws from the side panels of the D-1000 or DT-1000 casing. **Do not** remove *any* screws from the front, back, or bottom panels. Remove the cover.
2. Remove the screws securing the safety shutter in place.
3. The collimating lens for the lamp must also be removed. Using the Allen wrench, remove the small silver screw on the inner barrel of the lens and pull out the lens.
4. Place the CUV-FL-DA over the SMA termination and secure the holder to the lamp by gently tightening the set screw on the CUV-FL-DA.

Adjusting the Fit of the Cuvette

The CUV-FL-DA is preset for use with a 1-cm cuvette. When properly adjusted, the cuvette should fit snugly in the holder.

1. Visually check that the mirrored screws are flush with the inside of the holder (of course the cuvette is absent). If necessary, adjust the mirrored screws so that they are flush with the inside of the holder.
2. Locate the two ball plunger screws.
3. Loosen the two ball plunger screws until the ball end of the screws is just visible in the cell holder.
4. Insert your cuvette into the holder.
5. Tighten the ball plunger screws until the ball contacts the cuvette. Do not over-tighten.

Installing Filters

1. Loosen the filter clamping screw with a screwdriver.
2. Insert the filter into the filter slot. The filter slot can accommodate filters up to 6 mm thick.
3. Clamp the filter with the screwdriver.

Specifications

Path length:	1 cm
Dimensions:	1.4" x 1.4" x 1.0" (L x W x H)
Material:	Black anodized aluminum
Hole diameter for mounting to light source:	0.375"
Collimating lens:	Dynasil 1100 quartz (200-1000 nm), 5 mm diameter
Collimating lens termination:	SMA 905
Filter slot:	accepts filters up to ¼" (6 mm) in thickness
Reflection mirrors:	UV-enhanced, aluminum-coated for optimal signal reflection and collection
Mirror diameter:	0.3" (7.5 mm)
Size of light beam reaching sample:	¼" minimum divergent

Sampling Chambers: ISS Integrated Sampling System

The **INTEGRATED SAMPLING SYSTEM** is a fully integrated 1-cm cuvette holder and tungsten halogen light source. It couples to a spectrometer with optical fiber to create a small-footprint system for VIS-NIR (~360-1100 nm). The ISS has a 10,000-hour bulb.

Parts Included

- ISS cuvette holder and light source assembly
- 12VDC wall transformer for providing power
- 1-cm square, plastic cuvette for holding samples
- Screwdriver for adjusting the fit of the cuvette
- Allen wrench for adjusting the collimating lens

Operation

Attaching the Fibers

1. Attach a SMA-terminated optical fiber to the collimating lens.
2. Attach the other end of this fiber -- the read fiber -- to the spectrometer.

Adjusting the Fit of the Cuvette

The ISS is preset for use with a 1-cm cuvette. When properly adjusted, the cuvette should fit snugly into the holder.

1. Locate the two ball plunger screws.
2. Use the screwdriver to loosen the two ball plunger screws until the ends are visible in the holder.
3. Insert your cuvette into the holder.
4. Tighten the screws until the ball contacts the cuvette and starts to compress. Do not over-tighten.

Installing Filters

1. Loosen the filter clamping screw with an Allen wrench.
2. Insert the filter into the filter slot. The filter slot can accommodate filters up to 6 mm thick.
3. Clamp the filter in place by gently tightening with an Allen wrench.

Turning On the Lamp

1. Plug the wall transformer end into a 110 V outlet. Plug the 12 V output end into the back of your ISS.
2. Screw a fiber into the SMA connector.
3. Find the on/off switch on the back of the lamp and turn the lamp on.

Replacing the Bulb on the ISS

1. Order a replacement bulb.
2. Turn off the lamp and allow it to cool.
3. Use your Allen wrench to loosen the set screw on the bottom of the lamp. You do not need to remove the set screw. This screw holds the bulb in place.
4. Locate the two set screws at the back of the lamp, one above each back leg. These two screws keep the two halves of the lamp together. Remove the two screws.
5. Gently separate the two halves of the lamp and pull the bulb out of its housing.
6. Detach the wire and socket from the lamp leads. Remove bulb unit and discard.
7. Plug the new bulb into the socket and slide it forward into the front of the lamp as far as it will go.
8. Tighten the set screw on the bottom of the lamp.
9. Close the two halves without pinching the wires. Replace the two screws at the back of the lamp.

Specifications

Path length:	1 cm
Collimating lens:	BK 7 glass (~360 nm - 2 μ m*), 5 mm diameter, f/2
Collimating lens termination:	SMA 905
Filter slot:	accepts filters up to ¼" (6 mm) in thickness
Base material:	aluminum
Spectral range:	360 nm - 2 μ m*
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, 7-20 VDC/0.5-2 amps
Power output:	6.5 watts
Bulb life:	10,000 hours
Bulb color temperature:	2800K
Output to bulb:	5 volts/1.3 amps
Output regulation:	0.2% voltage
Time to stabilized output:	~ 30 minutes
Bulb output:	7400 foot-candles (7.4MSCP)

- * The useable range of each ISS sampling device is limited to the wavelength range of the spectrometer to which it is coupled -- i.e., though ISS lenses are optimized for use to 2 μ m, they can be configured to "see" only to 1100 nm with our spectrometers.

Sampling Chambers: FHS In-line Filter Holders

The **FHS-VIS** and **FHS-UV IN-LINE FILTER HOLDERS** are low-cost spectrophotometric accessories for fast, convenient absorbance/transmission measurements of optical and other filters. Optimized for VIS-Shortwave NIR (~360-1000 nm) or UV-VIS-Shortwave NIR (200-1100 nm) measurements, each holder has a pair of 5-mm diameter $f/2$ collimating lenses to maximize light throughput, and comes with a manual light-block wheel for taking dark readings.

The FHS In-line Filter Holder accepts 1" round or any size $>1/2$ " square optical filters, up to $1/4$ " (6 mm) in thickness. Plastic supports hold SMA-terminated fibers steady during use. The light that passes through the filter is collimated. This process makes it possible to measure either glass or interference filters.

Operation

Installing Filters

1. Loosen the filter thumb wheel on the left side of the filter holder to create enough space for the filter you wish to use.
2. If the filter is round, place it in the filter slot.
3. If the filter is square, place it in the filter slot at a 45° angle, so the filter is in the beam path.
4. Clamp the filter in place by tightening the thumb wheel.
5. When filters are not being used in the holder, tighten the thumb wheel completely.

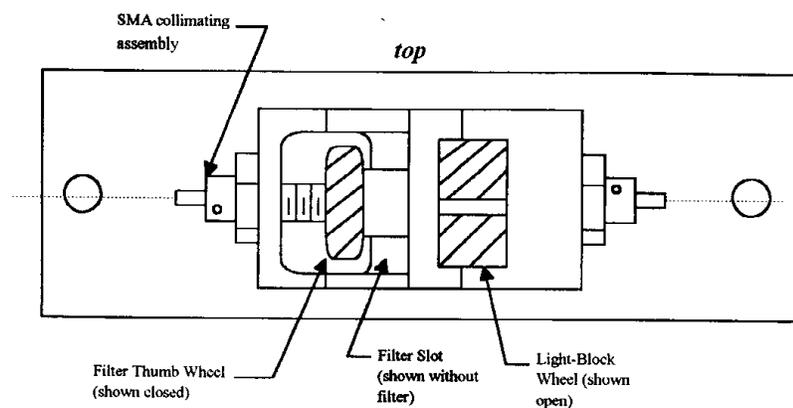
Using the Fiber Supports

1. Snap the clamps around the fibers after the fibers are screwed into the light source and spectrometer.
2. Lift the clamps until they support the fibers.
3. Unsnap the clamps to remove the fibers.

Using the Shutter

Use the shutter to take dark readings.

- The shutter is in the OPEN position when the knurled light-block wheel shows a scored depression (shown open on the drawing).
- The shutter is in the CLOSED position when the light-block wheel is rotated so only the knurling shows (the wheel will lock into this position with a positive action).



Specifications

FHS-VIS Collimating lenses (VIS-NIR):	BK 7 glass (~360 nm - 2 μm^*) 5 mm diameter f/2
FHS-UV Collimating lenses (UV-VIS-NIR):	Dynasil 1100 quartz (~200-1000 nm) 5 mm diameter f/2
Collimating lens termination:	SMA 905
Filter slot:	accepts filters 1" round or any size >1/2" square, up to 1/4" (6 mm) in thickness
Base material:	aluminum

- * The useable range of the filter holder is limited to the wavelength range of the Ocean Optics spectrometer to which it is coupled -- i.e., though the lens is optimized for use to 2 μm , it can be configured to "see" only to 1100 nm with our spectrometer.

Sampling Chambers: LPC Long Pass Flow Cells

The **LPC LONG PASS FLOW CELLS** from Ocean Optics couple to our spectrometers and compact light sources via SMA terminations for simple, efficient measurement of low-volume or low-concentration (ppb-ppt) aqueous samples. LPC Flow Cells are available in 1-meter, 5-meter and 10-meter path lengths for absorbance measurements. The Flow Cells will function with most liquids (one exception: perfluorinated solvents) having a refractive index ≥ 1.30 .

Caution!

-  DO NOT USE PERFLUORINATED SOLVENTS WITH THE LPC BECAUSE THE AMORPHOUS FLUOROPOLYMER TUBING IS SOLUBLE IN THESE CHEMICALS.
-  DO NOT exceed a fluid pressure of 45psi.
-  LPC Flow Cells will function with most liquids (one exception: perfluorinated solvents) having a refractive index > 1.30 .
-  Ensure the plumbing fittings through the front panel are tight and free of leaks.
-  Minimize the injection of bubbles into the LPC since they will cause erratic results. Continuous pumping will typically flush the bubbles through the system.
-  At the end of each experimental session, flush the system with solvent and then pump dry. Avoid leaving fluid in the LPC for extended periods of time.

Operation

Using the Plumbing Connections

On the front panel, there are two plumbing feed-through ports. It does not matter which one is used for the plumbing input or the plumbing output. However, for experimental consistency, once you have assigned which fitting will be the plumbing input and which one will be the plumbing output, try not to switch the plumbing configuration. The tubing goes over the plumbing fittings, which are standard 1/4-28 threads. The tubing should fit snugly over the fittings and be free of leaks.

- Attach one end of the tubing to your pump. The pump used must not pump the solution so fast that the fluid pressure exceeds 45psi. Remember to always turn off the pump in-between taking a reference and taking sample measurements. Make sure you have a proper waste receptacle for the other end of the tubing.
- The plumbing connections inside the LPC are standard industry fittings. No maintenance should be required. However, if leaks develop, the plumbing connections will need to be tightened. To tighten the connections, first remove the back panel. Carefully slide off the top cover, being careful not to damage or pinch the tubing or fiber. Hand-tighten the fittings and reassemble the cover and back panel.

Installing Fibers

On the front panel, there are two fiber feed-through ports. It does not matter which one is used for the fiber input or the fiber output. However, for experimental consistency, once you have assigned which fiber port will be the input and which one will be the output, try not to switch the fiber configuration. The fiber inside the LPC has a core diameter of 200 μm . External coupling fibers should be 200 μm or larger for maximum coupling efficiency.

- Attach one end of an illumination fiber to a port on the LPC and the other end to your light source.
- Attach one end of a read fiber to the second port on the LPC and the other end to your spectrometer.

Assessing if the LPC is Free of Particles

Fluids need to be relatively particle-free. Particles larger than 20 μm can be trapped inside the tubing and can then block or scatter a significant amount of light. To rid the LPC of particles, follow these steps:

1. Pump the sample fluid through the LPC.
2. While in Scope Mode, save a dark spectrum with the light source off and a reference spectrum with the light source on.
3. Continue to pump the sample fluid and switch to the Absorbance Mode. Ideally, you should see a spectrally flat line. Particle effects manifest themselves as an exponentially decreasing curve from shorter to longer wavelengths. The length of time that you pump the sample and the magnitude of the absorbance peak depends upon the time required and the minimum detectable absorbance value for your specific analyses. Pre-filtering of the sample may be required to eliminate this exponentially decreasing absorbance spectrum if it is significant to your analyses.

Specifications

Path lengths:	1-meter, 5-meter and 10-meter options (standard); custom lengths also available
Tubing:	<ul style="list-style-type: none">• Teflon® Amorphous Fluoropolymer 2400• ~560 μm inner diameter, ~800 μm outer diameter
Refractive index:	1.29
Internal volume:	250 μl /meter
Chemical resistance:	tubing can be altered by perfluorinated solvents, FREON® 113, and Perclene®
Recommended optical fibers for coupling to spectrometers, light sources:	<ul style="list-style-type: none">• 400 μm illumination fiber (UV-VIS)• 200 μm or 400 μm read fiber (UV-VIS)
Plumbing fittings:	standard 1/4" x 28 chromatography fittings

Sampling Optics

Ocean Optics offers numerous spectroscopic accessories. A short description of those accessories featured in this manual is listed below.

- The 74-UV and 74-VIS Collimating Lenses screw on to the end of SMA-terminated optical fibers and other sampling optics to convert divergent beams of radiation (light) into a parallel beam.
- The 74-UV-90 Reflector for collimating lenses has a mirror located under its cap that reflects light from the collimating lens to 90°.
- The 74-OPM Optical Post Mount is a 3/8-24 threaded black anodized aluminum assembly used for mounting collimating lenses on breadboard laboratory tables, rail carriers and other bench plates.
- The 74-ACH Adjustable Collimating Lens Holder is a versatile assembly for mounting lenses at multiple positions, and is especially useful for large or thick samples.
- FVA-UV Fiber Optic Variable Attenuator decreases the magnitude of light entering the optical bench.
- The WS-1 Diffuse Reflectance Standard is a compact physical standard for use in performing diffuse reflectance measurements, especially color analysis.
- The ISP-REF Integrating Sphere is an illuminated sampling optic that couples via optical fiber to our spectrometers to measure reflectance of solid objects or emission of spectral sources.

Sampling Optics: 74-UV and 74-VIS Collimating Lenses

The **74-UV** and **74-VIS COLLIMATING LENSES** screw on to the end of SMA-terminated optical fibers and other sampling optics to convert divergent beams of radiation (light) into a parallel beam. In order to obtain accurate data, the light entering the sample and the light collected after exiting the sample must be well collimated.

Application Tips

- Using a collimating lens is easy. Screw a collimating lens onto the end of any SMA-terminated port to collect, shape, or focus light.
- Collimating lenses are useful for any optical setup that requires the acceptance or transmission of parallel beams of light at either the illumination source or at the entrance optics -- or at both ends (illumination and read) of the setup. That's important because the optical fibers Ocean Optics specifies for use with its spectrometers and light sources have a field of view (FOV) of ~25° -- an acceptance angle that may not be appropriate for some experiments. Collimating lenses are adjustable, providing FOV angles from collimation (near 0°) to ~45°. Without the collimating lenses, the light would disperse more than is required for efficient transmission and collection of the signal.
- For directions on adjusting the focus of a collimating lens, see **Appendix A**.

Specifications

Lens diameter:	5 mm
Lens length:	10 mm
f-number:	f/2
74-UV material:	Dynasil 1100 quartz (200 nm – 1.5 μm)
74-VIS material:	BK 7 glass (360 nm - 2 μm)
Lens barrel:	stainless steel with black oxide finish
Threads:	3/8-24

Sampling Optics: 74-UV-90 Right Angle Reflector

The **74-90-UV RIGHT ANGLE REFLECTOR** is a 3/8-24 threaded black anodized aluminum assembly for mounting collimating lenses at right angles, and is useful for applications involving limited space and inconvenient optical fiber routing.

Application Tips

- The 74-90-UV Right Angle Reflector has a plane mirror located under its cap that reflects light from the collimating lens to 90°. This mirror is coated with a UV-enhanced aluminum substrate that is >90% reflective from 200-1100 nm.
- The 74-UV-90 has two 3/8-24 threaded ports -- at top and bottom -- that accommodate collimating lenses. The top port has a 3/8" x 1" threaded nipple that can be removed for connecting to a male adapter.
- Using the 74-90-UV is easy. Simply screw the reflector on to the end of any SMA-termination to collect, shape, and focus light to 90°.
- For directions on adjusting the focus of a collimating lens, see **Appendix A**.

Specifications

Assembly material:	black anodized aluminum
Dimensions:	0.65" x .065" x 0.787" (LWH)
Mirror coating:	UV-enhanced aluminum
Mirror reflectivity:	>90% from 200-1100 nm
Threads:	3/8-24 (ports) 3/8 x 1" (nipple)

Sampling Optics: 74-OPM Optical Post Mount

The **74-OPM OPTICAL POST MOUNT** is a 3/8-24 threaded black anodized aluminum assembly used for mounting collimating lenses on breadboard laboratory tables, rail carriers and other bench plates.

Application Tips

- The 74-OPM Optical Post Mount has an 8-32 x 1/2" bore for mounting collimating lenses on breadboard laboratory tables, rail carriers and other bench plates. The 74-OPM is 1-1/2" in diameter and 0.4" thick, and can be used to mount lenses securely in place, in a variety of positions.
- Mount the Optical Post Mount onto a post for your laboratory breadboard or any other bench plate. Post and screw are not included.
- Screw either a fiber or a collimating lens into the Optical Post Mount.

Specifications

Assembly material:	black anodized aluminum
Dimensions:	1-1/2" diameter x 0.4" thick
Threads:	3/8-24
Bore for mounting:	8-32 x 1/2"

Sampling Optics: 74-ACH Adjustable Collimating Lens Holder

The **74-ACH ADJUSTABLE COLLIMATING LENS HOLDER** is a versatile assembly for mounting lenses at multiple positions, and is especially useful for transmission measurements of large or thick samples not easily accommodated by other sampling optics such as our FHS-UV and FHS-VIS In-line Filter Holders.

Application Tips

- The 74-ACH consists of an anodized aluminum base and adjustable mount bars.
- Each bar has four 3/8-24 threaded holes, spaced 1" apart starting 1" from the top of the bar, to accommodate collimating lenses.
- The bars can be adjusted on the base by loosening two 10-32 threaded set screws with a 5/32" hex-head wrench (not included).
- The bars can be set far enough apart to accept samples up to ~10 cm thick.
- The base is scored at ½ cm intervals as a path length guide.

Specifications

Assembly material:	base is blue anodized aluminum mount bars are black anodized aluminum
Dimensions:	base is 3" x 6" x ¼" thick mount bars are 1" wide x 0.3" thick entire assembly is 6" in height
Threads:	mounting bars accept 3/8-24 threads set screws for mounting bars have 10-32 threads (use 5/32" hex-head wrench to loosen)
Measurement bar:	has ½ cm gradations as path length measurement guide (total length is 10 cm)

Sampling Optics: FVA-UV Fiber Optic Variable Attenuator

The **FVA-UV FIBER OPTIC VARIABLE ATTENUATOR** is an opto-mechanical device that controls the amount of light being transmitted by a fiber and the amount of light entering the optical bench of the spectrometer. Each end of the attenuator has SMA 905 terminations for connecting the attenuator to light sources, sample holders, and fibers. The FVA-UV attenuates light uniformly at all wavelengths.

Application Tips

- The attenuator can be used for applications where more light reaches the spectrometer than likely can be digitized successfully by the spectrometer's detector. Some absorbance experiments may also require signal attenuation, as too much light can saturate the reference measurement.
- In some instances, detector saturation can be avoided by adjusting (through software) the spectrometer integration time to limit the interval during which the detector collects light -- somewhat akin to changing the shutter speed on a camera to a faster exposure time. Other options include using different gratings, changing the optical bench entrance aperture (by installing slits or using small-diameter optical fibers), or adding neutral-density filters to the optical path. The FVA-UV fits in where these intensity-reduction techniques are either unworkable or undesirable.

Operation

- The attenuator comes with two collimating lenses, one screwed in at each side. The thumb wheel position is held in place with a set screw.
- A 6-32 white nylon screw pinches the mechanical adjustment wheel. Loosening the white nylon screw allows the mechanical adjustment wheel to be turned. When the wheel is positioned to your liking, tighten the white nylon screw to keep the wheel in place during your measurement. The wheel is placed between two Teflon washers to provide smooth operation and is knurled along the edge for fingertip gripping.
- To completely close the attenuator, turn the wheel to the white line marking and tighten the white nylon screw. You will hear a "snap" in the closed position.

Using the Adapters

With the FVA-ADP-UV and FVA-ADP-VIS, users can connect the attenuator directly to any light source having a collimating lens at its aperture. To use these adapters, simply:

1. Use an Allen wrench to loosen the set screw of one of the collimating lenses on the attenuator and take out the inner barrel.
2. Slip in the adapter and tighten the set screw.
3. Loosen the set screw on the collimating lens of the light source. Remove the inner barrel of the lens and slide the adapter/attenuator into the collimating lens. Tighten the set screw.

Specifications

Dimensions:	1.5" x 1.5" x 1.0"
Assembly ports:	3/8-24 threads for collimating lenses
Adjustment wheel:	diameter = 3/32" material = black anodized aluminum with knurled edge
Adjustment wheel lock:	6-32 Nylon thumb screw
Connector:	SMA 905

Sampling Optics: WS-1 Diffuse Reflectance Standard

The **WS-1 DIFFUSE REFLECTANCE STANDARD** is a compact physical standard for use in performing diffuse reflectance measurements, especially color analysis. The reflectance material that comprises the WS-1 is Spectralon[®], a highly Lambertian thermoplastic substance that provides a nearly 100% diffuse reflective surface for applications from 200 nm to 2.5 μm . (With an Ocean Optics spectrometer, the practical use of the WS-1 is limited to 200-1100 nm.) The reflective area of the WS-1 is 1.25" in diameter. The diffusing material is encased in a small, black receptacle with a screw-on top.

Operation

Reflection is the return of radiation by a surface, without change in wavelength. Reflection is expressed as a percentage relative to the reflection from a standard substance, such as the WS-1 white reference material. The WS-1 is mostly used in a setup with a reflection probe and reflection probe holder for diffuse reflection measurements or with the ISP-REF Integrating Sphere. To use the WS-1 as a reference in a diffuse reflection measurement:

1. Make sure you are in Scope Mode. Take a reference spectrum by first making sure nothing is blocking the light path going to your reference. Place the reflection probe over the WS-1. For best results, use our Reflection Probe Holder to keep the reflection probe firmly at a 45° angle.
2. Take the reference reading by clicking the **Store Reference Spectrum** icon on the toolbar or selecting **File | Store Reference Spectrum**.

Specifications

Reflectance material:	Spectralon
Reflectivity:	>99%
Wavelength range:	200 nm - 2.5 μm *
Reflective area diameter:	1.25"

* With an Ocean Optics spectrometer, the use of the WS-1 is limited to 200-1100 nm.

Sampling Optics: ISP-REF Integrating Sphere

The **ISP-REF INTEGRATING SPHERE** is an illuminated sampling optic that couples via optical fiber to Ocean Optics miniature fiber optic spectrometers to measure reflectance (from 360-1000 nm) of solid objects or emission (from 200-1100 nm) of spectral sources. The ISP-REF Integrating Sphere has a transfer optic assembly for restricting the fiber viewing angle, a 0.4" aperture sample port, and a built-in light source (tungsten halogen) with 12-volt DC adapter.

Application Tips

- The Integrating Sphere has two primary functions: 1) to provide even surface illumination for reflectance measurements, such as determining the color of flat surfaces; and 2) to collect light and funnel it to an optical fiber for emission experiments, such as measuring the spectral properties of an LED.
- The ISP-REF Integrating Sphere is small and compact -- it's just 2.11" x 2.25" x 3.25" (LWH) and weighs less than 1 pound -- yet is durable enough for use outside the laboratory. All instrument electronics -- including the lamp, which can be replaced by simply removing two screws -- are mounted into the bottom section of the unit.
- The reflectivity value obtained by calculating the difference between the inclusion and exclusion of specular reflection is a direct measurement of the gloss of the surface. For an excellent explanation of diffuse and specular reflectance, and of the use of integrating spheres, see "Nonstandard Spectroscopic Measurements," *Spectroscopy*, June 1997.
- The color temperature of the Tungsten Halogen lamp is 3100K.
- The sphere is made from Spectralon, a white diffusing material that provides a highly Lambertian reflecting surface. A simple switch allows users to manipulate the sampling optic for the inclusion (I) or exclusion (E) of specular reflectance.

Operation

1. Locate the on/off switch on the front of the lamp. The "1" position is the on position. The "0" position is the off position. Turn the lamp on.
2. Locate the shutter switch. It is located on the back of the sphere. The "I" (for includes) position means that the resulting reflection measurement includes both specular and diffuse reflections. The "E" (for excludes) position means that the resulting reflection measurement excludes specular reflection (the user will only obtain diffuse reflection measurements). Move the switch to the mode necessary for your application.

Using the Optical Fiber Ports

- The ISP-REF Integrating Sphere has SMA connectors for two optical fibers. The connector, or port marked "S" (for sample) is used to couple an optical fiber to the spectrometer to measure the reflection from a flat surface.
- The second port, marked "R" (for reference), offers two features not available with most other integrating spheres. One function of the R port is to couple an optical fiber to a second channel in the spectrometer. This channel can be used to monitor the Integrating Sphere's built-in tungsten halogen lamp, which provides even surface illumination. The other function of the R port is for the coupling of an optical fiber to collect light. This may be advantageous for applications involving the collection of a wide-angle beam of light, especially where the beam is much larger than the size of the entrance optics.

Specifications

Spectral range (of illumination source):	~360-1000 nm
Dimensions:	2.11" x 2.25" x 3.25" (LWH)
Sphere diameter:	1.5"
Sample port aperture:	0.4"
Sphere material:	Spectralon
Reflectance measurements:	specular included or excluded
Bulb life:	900 hours
Bulb color temperature:	3100K
Connector:	SMA 905

Fiber Optic Probes and Accessories

Ocean Optics fiber optic probes can be coupled to our miniature fiber optic spectrometers and light sources to create a variety of optical-sensing systems. Each probe consists of silica-core, silica-clad optical fiber (0.22 NA) and a sampling optic, and are available for UV-VIS (high OH content) or VIS-NIR (low OH content) applications. All standard fiber optic probes are 2 meters in length and have SMA terminations. Custom probe assemblies are also available.

Fiber Optic Probes and Accessories: R200 Reflection Probes

R200 REFLECTION PROBES couple to Ocean Optics miniature fiber optic spectrometers and light sources to create small-footprint optical-sensing systems for fluorescence and reflection measurements. Ocean Optics offers several variations on the Reflection Probe:

- The **R200-7 REFLECTION PROBE** consists of a bundle of 7 optical fibers -- 6 illumination fibers around 1 read fiber -- each of which is 200 μm in diameter. A 3.0" x 0.25" stainless steel ferrule houses the fiber bundle. Other options of this standard probe assembly include the R400-7, which has a bundle of optical fibers 400 μm in diameter, and the RP200-7, which has a 3.0" x 0.25" plastic ferrule to house the fiber bundle. The RP200-7 is useful where a stainless steel ferrule may not be suitable, such as some applications involving corrosive samples.
- For reflection experiments across the UV-VIS-Shortwave NIR (200-1100 nm), users can specify the **R200-MIXED**. The R200-MIXED consists of fourteen 200 μm -diameter optical fibers -- 6 UV/VIS and 6 VIS/NIR illumination fibers, plus 1 UV/VIS fiber and 1 VIS/NIR read fiber. In addition, the R200-MIXED has a 3.0" x 0.25" stainless steel ferrule to house its fiber bundles, and couples easily to a dual-channel spectrometer in which each channel is set for a different wavelength range.
- Also available is the **R200-REF**, which consists of an R200-7 Reflection Probe and an additional fiber optic to monitor an illumination source such as our LS-1 Tungsten Halogen Light Source. The R200-REF is useful when a reflection experiment either does not allow the user to take frequent reference scans or requires an illumination source with an unstable spectral output.
- One other option is the **R200-ANGLE REFLECTION PROBE**, which has a bundle of seven 200 μm fibers -- 6 illumination fibers around 1 read fiber -- and a 3.0" x 0.25" stainless steel ferrule with a 45° window. This angled window removes the effects of specular reflection when the probe is immersed in dense liquids and powders.

Caution!

- ⚠ The distance from the probe tip to the sample directly affects the signal. For quantitative results, the distance and angle must be held constant.
- ⚠ Handle with care. Dropping the probe may cause permanent damage.

Operation

The reflection probe consists of a 6-fiber leg that should be coupled to the light source, and a single-fiber leg that goes to the spectrometer.

1. Inspect the ends of the fiber legs. The hole in the SMA connector is noticeably larger in the illumination leg than the hole in the spectrometer leg. Also, the spectrometer leg should have colored bands.
2. Install the illumination leg in the light source.
3. Install the spectrometer leg in the spectrometer.
4. Using the RPH-1 Reflection Probe Holder or some other holding device, point the probe at the surface to be measured.

Specifications

Fiber core diameter:	200 μm or 400 μm
Fiber core/cladding:	silica
Fiber bundle:	6 illumination fibers around 1 read fiber
Numerical aperture:	0.22
Optimization:	UV/VIS (200-750 nm) and VIS/NIR (450-1000 nm)
Ferrule:	Stainless steel or plastic
Ferrule dimensions:	3.0" x 0.25"
Terminations:	SMA 905
Sheathing:	Blue PVC with Kevlar reinforcement
Temperature range:	-20° C to 80° C
Probe assembly length:	2 meters (breakout is halfway); custom probes are also available

Fiber Optic Probes and Accessories: RPH-1 Reflection Probe Holder

The **RPH-1 REFLECTION PROBE HOLDER** is an anodized aluminum platform with machined holes at 45° and 90° to hold our R200 Reflection Probes or other 0.25" O.D. probes during reflection measurements. Common applications include measuring the reflection properties of mirrors and anti-reflection coatings, and measuring the visual properties of color in paints, graphic arts, plastics, and food products.

Operation

Reflection is the return of radiation by a surface, without a change in wavelength. The reflection may be:

- Specular, in which the angle of incidence is equal to the angle of reflection. If taking specular reflection measurements, position the reflection probe in the 90° aperture of the RPH-1.
- Diffuse, in which the angle of incidence is not equal to the angle of reflection. If taking diffuse reflection measurements, position the reflection probe in the 45° aperture of the RPH-1.

Every surface returns both specular and diffuse reflections. Some surfaces may return mostly specular reflection, others more diffuse reflection. The glossier the surface, the more specular the reflection.

Specular Reflectance Measurements

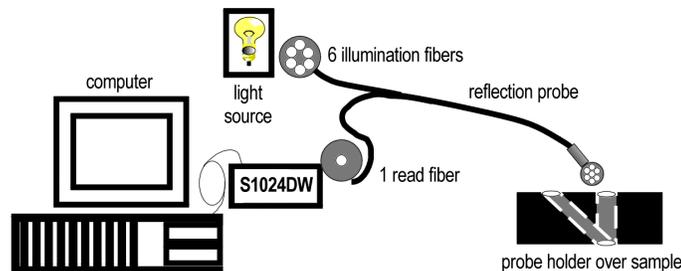
For a specular reflection measurement, attach the illumination leg of your reflection probe to a light source, and the read leg to the spectrometer. Place the end of the probe in the 90° aperture of the RPH-1. Use the cap screw on the holder to secure the probe at the desired distance from the sample.

1. First, take a reference spectrum. Make sure nothing is blocking the light path going to your reference. Place the reflection probe/probe holder over a first-surface mirror. Take the reference reading.
2. Next, take a dark spectrum. Completely block the light path going to your sample. Do not turn off the light source. Take the dark reading.
3. Finally, take your reflection measurement. Make sure the sample is in place and nothing is blocking the light going to your sample. If using OOIBase32, click on the **Transmission** icon to take your spectrum. (The Transmission Mode uses the same formula for transmission and reflection measurements.)

Diffuse Reflectance Measurements

For a diffuse reflection measurement, attach the illumination leg of your reflection probe to a light source, and the read leg to the spectrometer. Place the end of the probe in the 45° aperture of the RPH-1. Use the cap screws on the holder to secure the probe at the desired distance from the sample.

1. First, take a reference spectrum. Make sure nothing is blocking the light path going to your reference. Place the reflection probe/probe holder over a diffuse standard. Take the reference reading.
2. Next, take a dark spectrum. Completely block the light path going to your sample. Do not turn off the light source. Take the dark reading.
3. Finally, take your reflection measurement. Make sure the sample is in place and nothing is blocking the light going to your sample. If using OOIBase32, click on the **Transmission** icon to take your spectrum. (The Transmission Mode uses the same formula for transmission and reflection measurements.)



A typical configuration for a reflection experiment.

Fiber Optic Probes and Accessories: T200 Transmission Probes

T200 TRANSMISSION DIP PROBES couple to our spectrometers and light sources to create small-footprint optical-sensing systems for measuring transmission in chemical solutions and other liquids. The standard T200 has 1 illumination fiber and 1 read fiber and a 0.25" outer diameter stainless steel ferrule. The probes come with either a fixed or removable tip (2-mm, 5-mm or 10-mm path length removable tips).

Caution!

- ⚠ Handle with care. Dropping the instrument may cause permanent damage.
- ⚠ Bubbles will interfere with your readings. Regularly inspect the sample region for bubbles.

Operation

The T200 Transmission Dip Probe consists of two identical fibers in a bifurcated assembly. A plano-convex lens shapes the light coming out of the illumination fiber. The light is transmitted through the sample, hits the mirror, reflects off the mirror, and interacts with the sample again before being transmitted back through the probe via the read fiber. Because the light travels through the sampling region twice, the optical pathlength is actually twice the length of the sample aperture. The transmission cell is used to measure absorbance of the fluid that fills the sample compartment between the fibers and the mirror, which is a UV-enhanced aluminum, second-surface mirror.

1. Connect one leg of the probe to the light source and connect the other leg to the spectrometer. It does not matter which leg of the probe is connected to the light source or spectrometer.
2. In order to achieve the best signal, use an Allen wrench to loosen the set screw on the inner fiber barrel assembly and slide it up and down to change the intensity of the light returned until a signal in Scope Mode reaches approximately 3500 counts. The position of the inner barrel has been optimized at the time of manufacture for aqueous media applications using a 10 mm tip. If your application requires measuring gases you will have to move the inner barrel for maximum throughput.
3. Immerse the probe in distilled water or the solvent of your choice and take a reference spectra.
4. Remove the probe from the reference material, block the light path going to the spectrometer and take a dark spectrum. (Do not turn the light off.)
5. Make sure the light path is clear, place the probe in your sample solution and take your sample spectra.

To replace the probe tip, simply unscrew the probe tip and screw in either a 2-mm path length, 5-mm path length, or 10-mm path length replaceable tip for the Transmission Dip Probe.

Specifications

Fiber core diameter:	200 μm
Fiber core/cladding:	Silica
Fiber bundle:	1 illumination fiber and 1 read fiber
Numerical aperture:	0.22
Optimization:	UV/VIS (200-750 nm) and VIS/NIR (450-1000 nm)
Ferrule:	Stainless steel or plastic, 3.75" x 0.25"
Terminations:	SMA 905
Probe assembly length:	2 meters (breakout is halfway); custom probes are also available 1 meter for plastic ferrule option

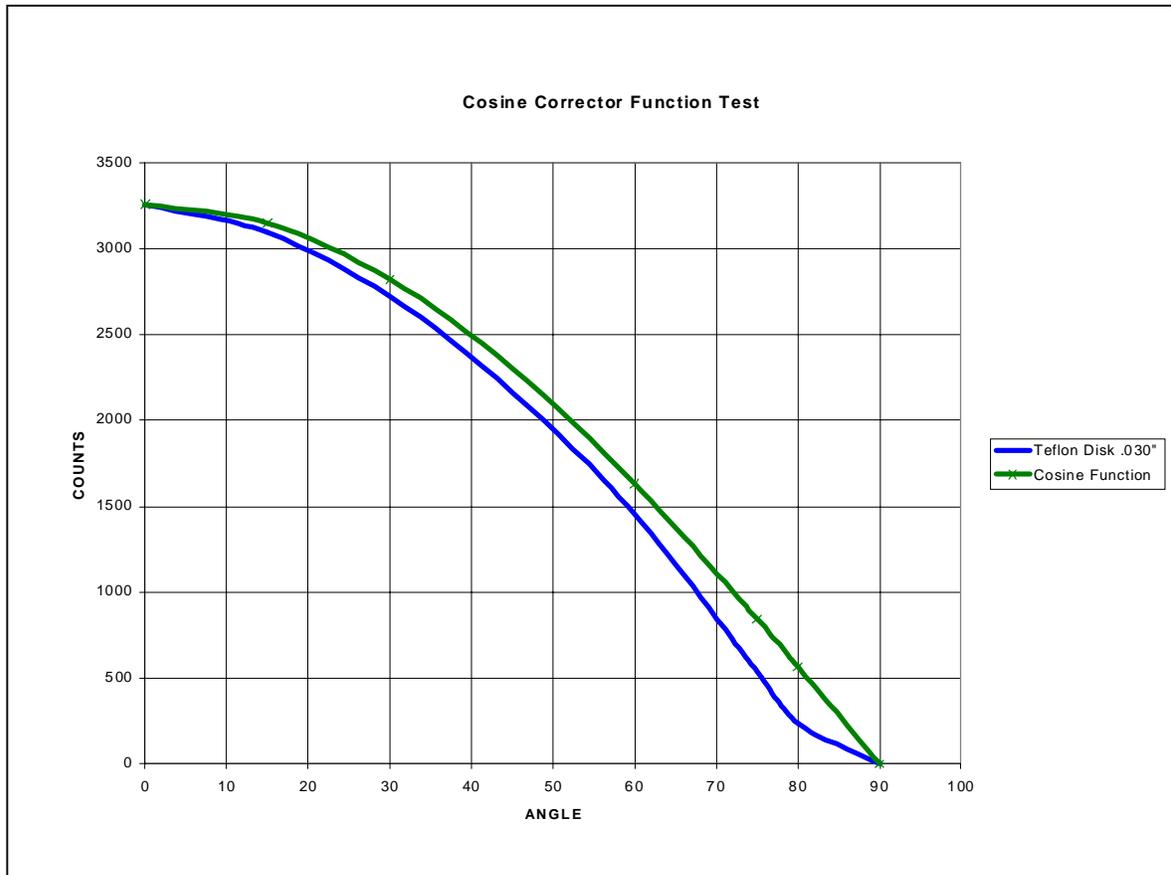
Fiber Optic Probes: CC-3 Cosine-Corrected Irradiance Probes

Cosine-corrected fiber optic irradiance probes are spectroradiometric sampling optics 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. The **CC-3 COSINE CORRECTED IRRADIANCE PROBE**, optimized for applications from 350-1000 nm, has opaline glass diffusing material. The **CC-3-UV COSINE CORRECTED IRRADIANCE PROBE** has Teflon® diffusing material and is optimized for applications from 200 nm - 2 μm.

Application Tips

Each cosine corrector has a 0.25" O.D. barrel with a smooth yet rugged black oxide finish. The diffusing material is a thin disk that sits at the end of the barrel (the Teflon material is 0.30" thick). Both cosine correctors have SMA 905 connectors for convenient coupling to optical fibers. The cosine correctors screw on to the end of any SMA-terminated optical fiber. When coupled to an S1024DW, these cosine correctors can be used to measure UV-A and UV-B solar radiation, environmental light fields, lamps and other emission sources.

CC-3-UV Cosine Corrector -- Function Test



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, light 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 the user 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 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 light is being transmitted. Be sure to use a visible light source when inspecting fibers.
- ⌘ 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: 200⁰C for the fiber, 100⁰C for PVC cabling, 100⁰C 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 quartz or aluminum.

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 that provide mechanical strength, either polyimide or Teflon. Cabling further protects the buffer-coated fiber. Our standard laboratory cabling is blue PVC. Other cabling that is available includes 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 positioned 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, Bulkhead Fittings

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 onto a panel. 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
Gray	300
Red	400
Brown	600
Clear	1000

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

Specifications

Jacket:	<ul style="list-style-type: none"> Acrylate (temperature range -40 to 100° C), for 50 μm fibers Nylon (temperature range -40 to 100° C), for 100 μm, 200 μm, 400 μm, 600 μm and 1000 μm fibers
Sheathing/cabling:	<ul style="list-style-type: none"> 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:	<ul style="list-style-type: none"> UV-VIS (200-750 nm) VIS-NIR (450-1000 nm)
Numerical aperture:	0.22
Recommended minimum bend radius:	<ul style="list-style-type: none"> 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 (above 850 nm) optical fiber.

Experiment Tutorial

Before you begin your experiment, double-check that you have correctly set up your SAD500, installed the operating software, and set up your light source and other sampling optics. Next:

1. Open OOIBase32. Double-check that **A/D Interface** settings correspond to your setup by choosing **Spectrometer | Configure** from the menu.
2. Now check your spectrometer setup configurations in OOIBase32. A Wavelength Calibration Data Sheet is shipped with each spectrometer channel. You will need the numbers on this sheet. Select **Spectrometer | Configure** from the menu and choose the **Wavelength Calibration** page. For each spectrometer channel in your system, enable the channel and enter the First Coefficient, Second Coefficient and Intercept. (Recently, we began calculating third coefficients for all spectrometer systems; however, existing customers will have to enter a zero as their third coefficient.)
3. Adjust your acquisition parameters using the **Acquisition Parameters** dialog bar or the **Configure Data Acquisition** dialog box.
4. Acquiring spectral data from your spectrometer is quite simple. Assuming that you have followed the previous steps and started OOIBase32, your spectrometer is already acquiring data. Even with no light in the spectrometer, you should see a fluctuating trace on the bottom of the graph. If you put light into the spectrometer, you should see the graph trace rise with increasing light intensity. If this occurs, you have correctly installed your hardware and software.
5. Once you installed and configured your hardware and software, and have set up your system, you are ready to take your measurements. There are four basic optical measurements from which to choose: absorbance, transmission, reflection, and relative irradiance measurements. The type of measurements you wish to make determines the configuration of the sampling optics for your system. The choice of reference and data analysis determines how the answer is presented. For each measurement, a reference and dark spectrum must first be made. After taking a reference and a dark spectrum, you may take as many absorbance, transmission, reflection, or relative irradiance measurement scans as you want. However, if at any time any sampling variable changes (integration time, averaging, smoothing, angle, temperature, fiber size, etc.) you *must* store a new dark and reference spectrum.

Application Tips

If the signal you collect is saturating the spectrometer (peaks are off the scale), you can decrease the light level on scale in scope mode by:

- Decreasing the integration time
- Attenuating the light going into the spectrometer
- Switching to a smaller diameter fiber
- Using a neutral density filter with the correct optical density

If the signal you collect has too little light, you can increase the light level on scale in scope mode by:

- Increasing the integration time
- Switching to a larger diameter fiber
- Avoiding the use of any optical filters

Absorbance Experiments

Absorbance spectra are a measure of how much light is absorbed by a sample. Absorbance spectra are formed by radiation that has interacted with a medium. For most samples, absorbance is linearly related to the concentration of the substance. The software calculates absorbance (A_λ) using the following equation:

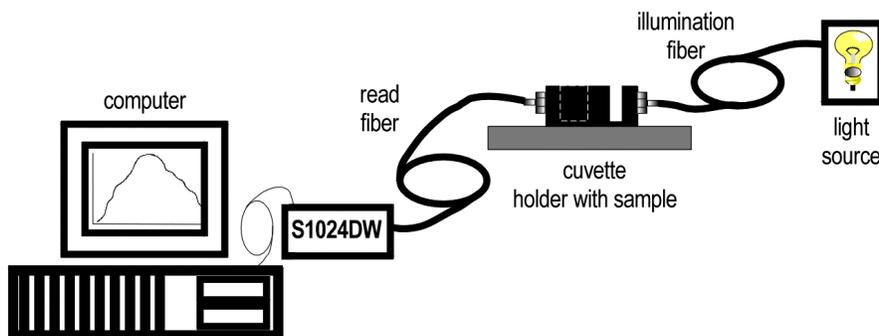
$$A_\lambda = -\log_{10} \left(\frac{S_\lambda - D_\lambda}{R_\lambda - D_\lambda} \right)$$

where S is the sample intensity at wavelength λ , D is the dark intensity at wavelength λ , R is the reference intensity at wavelength λ .

Absorbance can also be expressed as proportional to the concentration of the substance interacting with the light (known as Beer's Law). Common applications include the quantification of chemical concentrations in aqueous or gaseous samples. To take an absorbance measurement:

1. Make sure you are in scope mode, by either clicking the **scope mode** icon on the toolbar, or selecting **Spectrum | Scope Mode** from the menu. Make sure the signal is on scale. The peak intensity of the reference signal should be about 3500 counts. Take a reference spectrum by first making sure nothing is blocking the light path going to your sample. The analyte you want to measure must be absent while taking a reference spectrum. Take the reference reading by clicking the **Store Reference Spectrum** icon on the toolbar or selecting **Spectrum | Store Reference** from the menu.
2. While still in **scope mode**, take a dark spectrum by first completely blocking the light path going to your sample. If possible, do not turn off the light source. Take the dark reading by clicking the **store dark spectrum** icon on the toolbar or selecting **Spectrum | Store Dark** from the menu.
3. Begin an absorbance measurement by first making sure the sample is in place and nothing is blocking the light going to your sample. Then choose the **absorbance mode** icon on the toolbar or select **Spectrum | Absorbance Mode** from the menu. To save the spectrum, click the **save** icon on the toolbar or select **File | Save | Processed** from the menu.

⚠ If at any time any sampling variable changes -- including integration time, averaging, boxcar smoothing, distance from light source to sample, etc. -- you must store a new reference and dark spectrum.



A typical configuration for an absorbance experiment.

Transmission Experiments

Transmission is the percentage of energy passing through a system relative to the amount that passes through the reference. Transmission Mode is also used to show the portion of light *reflected* from a sample. Transmission and reflection measurements require the same mathematical calculations. The transmission is expressed as a percentage (% T_λ) relative to a standard substance (such as air). The software calculates %T (or % R_λ) by the following equation:

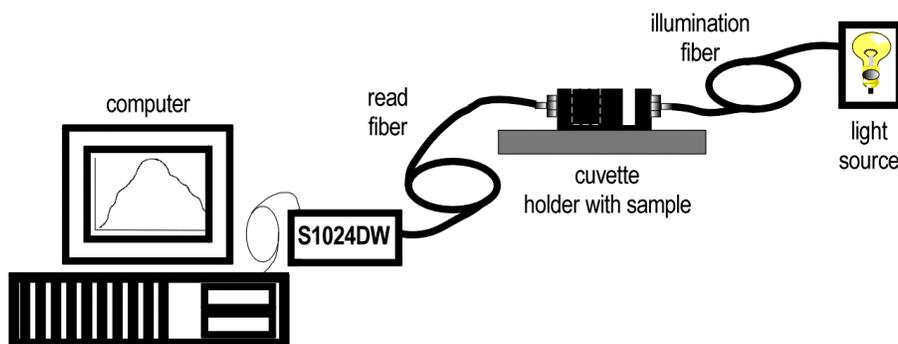
$$\%T_\lambda = \frac{S_\lambda - D_\lambda}{R_\lambda - D_\lambda} \times 100\%$$

where S is the sample intensity at wavelength λ , D is the dark intensity at wavelength λ , R is the reference intensity at wavelength λ .

Common applications include measurement of transmission of light through solutions, optical filters, optical coatings, and other optical elements such as lenses and fibers. To take a transmission measurement:

1. Make sure you are in scope mode, by either clicking the **scope mode** icon on the toolbar, or selecting **Spectrum | Scope Mode** from the menu. Make sure the signal is on scale. The peak intensity of the reference signal should be about 3500 counts. Take a reference spectrum by first making sure nothing is blocking the light path going to your sample. The analyte you want to measure must be absent while taking a reference spectrum. Take the reference reading by clicking the **store reference spectrum** icon on the toolbar or selecting **Spectrum | Store Reference** from the menu.
2. While still in **scope mode**, take a dark spectrum by first completely blocking the light path going to your sample. If possible, do not turn off the light source. Take the dark reading by clicking the **store dark spectrum** icon on the toolbar or selecting **Spectrum | Store Dark** from the menu.
3. Begin a transmission measurement by first making sure the sample is in place and nothing is blocking the light going to your sample. Then choose the **transmission mode** icon on the toolbar or select **Spectrum | Transmission Mode** from the menu. To save the spectrum, click the **save** icon on the toolbar or select **File | Save | Processed** from the menu.

Ⓜ If at any time any sampling variable changes -- including integration time, averaging, boxcar smoothing, distance from light source to sample, etc. -- you must store a new reference and dark spectrum.



A typical configuration for a transmission experiment.

Reflection Experiments

Reflection is the return of radiation by a surface, without a change in wavelength. The reflection may be:

- Specular, in which the angle of incidence is equal to the angle of reflection.
- Diffuse, in which the angle of incidence is not equal to the angle of reflection.

Every surface returns both specular and diffuse reflections. Some surfaces may return mostly specular reflection, others more diffuse reflection. The glossier the surface, the more specular the reflection.

Reflection is expressed as a percentage ($\%R_\lambda$) relative to the reflection from a standard substance (such as our WS-1 white reference for a diffuse reflection measurement):

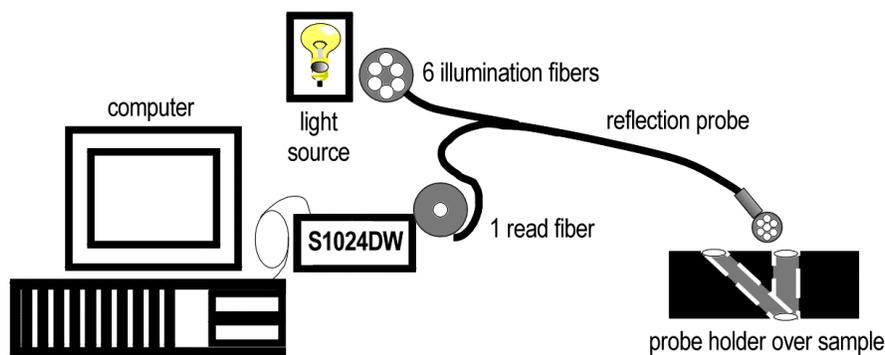
$$\%R_\lambda = \frac{S_\lambda - D_\lambda}{R_\lambda - D_\lambda} \times 100\%$$

where S is the sample intensity at wavelength λ , D is the dark intensity at wavelength λ , R is the reference intensity at wavelength λ .

Common applications include measuring the reflection properties of mirrors, anti-reflection coatings, and measuring the visual properties of the color in paints, graphic arts, plastics, and food products. To take a reflection measurement:

1. Make sure you are in scope mode, by either clicking the **scope mode** icon on the toolbar, or selecting **Spectrum | Scope Mode** from the menu. Make sure the signal is on scale. The peak intensity of the reference signal should be about 3500 counts. Take a reference spectrum by first making sure nothing is blocking the light path going to your sample. The analyte you want to measure must be absent while taking a reference spectrum. Take the reference reading by clicking the **store reference spectrum** icon on the toolbar or selecting **Spectrum | Store Reference** from the menu.
2. While still in **scope mode**, take a dark spectrum by first completely blocking the light path going to your sample. If possible, do not turn off the light source. Take the dark reading by clicking the **store dark spectrum** icon on the toolbar or selecting **Spectrum | Store Dark** from the menu.
3. Begin a reflection measurement by first making sure the sample is in place and nothing is blocking the light going to your sample. Then choose the **transmission mode** icon on the toolbar or select **Spectrum | Transmission Mode** from the menu. The mathematics required to calculate reflection measurements are identical to those necessary to compute a transmission spectrum. To save the spectrum, click the **save** icon on the toolbar or select **File | Save | Processed** from the menu.

Ⓜ If at any time any sampling variable changes -- including integration time, averaging, boxcar smoothing, distance from light source to sample, etc. -- you must store a new reference and dark spectrum.



A typical configuration for a reflection experiment.

Relative Irradiance Experiments

Irradiance is the amount of energy at each wavelength from a radiant sample. In relative terms, it is the fraction of energy from the sample compared to the energy collected from a lamp with a blackbody energy distribution, normalized to 1 at the energy maximum. Relative irradiance is calculated by the following equation:

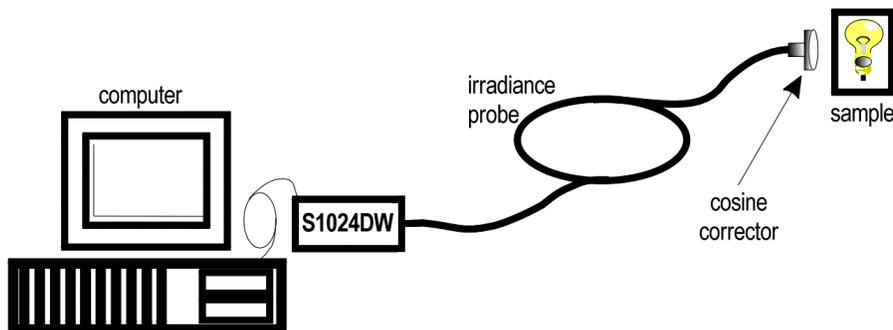
$$I_{\lambda} = B_{\lambda} \left(\frac{S_{\lambda} - D_{\lambda}}{R_{\lambda} - D_{\lambda}} \right)$$

where B_{λ} is relative energy of the reference calculated from the color temperature in Kelvin, S is the sample intensity at wavelength λ , D is the dark intensity at wavelength λ , R is the reference intensity at wavelength λ .

Common applications include characterizing the light output of LEDs, incandescent lamps and other radiant energy sources such as sunlight. Also included in irradiance measurements is fluorescence, in which case the spectrometer measures the energy given off by materials that have been excited by light at a shorter wavelength. To take a relative irradiance measurement:

1. Make sure you are in scope mode, by either clicking the **scope mode** icon on the toolbar, or selecting **Spectrum | Scope Mode** from the menu. Make sure the signal is on scale. The peak intensity of the reference signal should be about 3500 counts. The light source must be a blackbody of known color temperature. Take the reference reading by clicking the **store reference spectrum** icon on the toolbar or selecting **Spectrum | Store Reference** from the menu.
2. While still in **scope mode**, take a dark spectrum by completely blocking the light path. Take the dark reading by clicking the **store dark spectrum** icon on the toolbar or selecting **Spectrum | Store Dark** from the menu.
3. Take a relative irradiance measurement by first positioning the fiber at the light source you wish to measure. Then choose the **irradiance mode** icon on the toolbar or select **Spectrum | Relative Irradiance Mode** from the menu. In the **Reference Color Temperature** dialog box, enter the light source's color temperature in Kelvin and click **OK**. To save the spectrum, click the **save** icon on the toolbar or select **File | Save | Processed** from the menu.

⚠ If at any time any sampling variable changes -- including integration time, averaging, boxcar smoothing, distance from light source to sample, etc. -- you must store a new reference and dark spectrum.

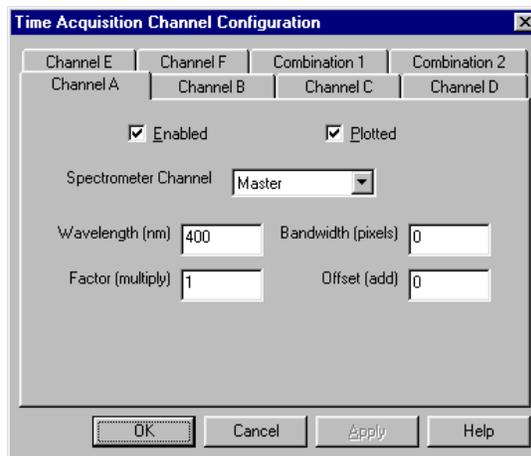


A typical configuration for an irradiance experiment.

Time Acquisition Experiments

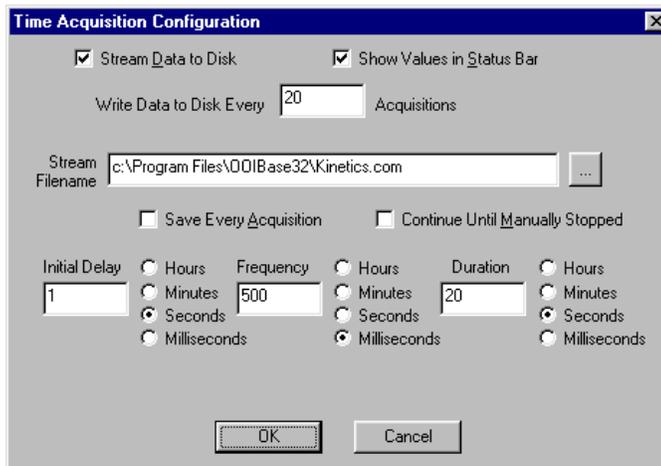
Time acquisition experiments track processes, perform kinetic analyses, and monitor spectral events as a function of time. (See the **OOIBase32 Spectrometer Operating Software Manual** for details.) You can collect as a function of time spectral data from up to 6 single wavelengths (designated as Channels A through F) and up to two mathematical combinations of these wavelengths (designated as Combinations 1 and 2). You can acquire data in any mode. To perform a time series experiment, follow these steps:

1. While in scope mode, store reference and dark spectra, if desired, and choose a view mode, such as absorbance.
2. Access the Time Acquisition Channel Configuration dialog box by selecting **Time Acquisition | Configure | Configure Time Channels** from the menu.
 - Select **Enabled** to set the time acquisition calculation for the wavelength. Without selecting Enabled, the time acquisition process will not calculate data.
 - Enable **Plotted** to see a real time graph of the acquired data in a spectral window.
 - Select a **Spectrometer Channel** for your time acquisition process.
 - In the **Wavelength (nm)** box, specify the analysis wavelength. In the **Bandwidth (pixels)** box, specify the number of pixels averaged around the analysis wavelength.
 - Select a multiplicative **Factor** to apply to the data before it is plotted or stored. Select an additive constant or **Offset** to apply to the data after the factor is applied and before the data is plotted or stored. The equation for the Factor and Offset functions is: $\text{Results} = (\text{Factor} \times \text{Data}) + \text{Offset}$.
3. If desired, configure a time acquisition process for the second single wavelength by selecting the **Channel B** page. To configure a time acquisition process for the third, fourth, fifth, and sixth single wavelengths, select the **Channel C**, **Channel D**, **Channel E**, and **Channel F** pages, respectively, and set the necessary parameters.
4. If desired, configure a time acquisition process for a combination of two time channels by selecting **Combination 1**.
 - Select **Enabled** to set the time acquisition calculation for the wavelength.
 - Enable **Plotted** to see a real-time graph of the acquired data in a spectral window.
 - Specify Time Channel A through F for the **First Channel**.
 - Select the mathematical **Operation** to produce the data for Combination 1.
 - Specify Time Channel A through F for the **Second Channel**.
 - Select a multiplicative **Factor** to apply to the data before it is plotted or stored. Select an additive constant or **Offset** to apply to the data after the factor is applied and before the data is plotted or stored. The equation for the Factor and Offset functions is: $\text{Results} = (\text{Factor} \times \text{Data}) + \text{Offset}$.
5. If desired, configure a time acquisition process for the **Combination 2** page. It is almost identical to the Combination 1 page except that you have the option of choosing Combination 1 for your **First Channel** or **Second Channel**.
6. Click the OK button for the Time Acquisition Channel Configuration dialog box.



7. Access the Time Acquisition Configuration dialog box by selecting **Time Acquisition | Configure | Configure Acquisition** from the menu.

- Enable **Stream Data to Disk** to save time acquisition data.
- Enter a value in the **Write Data to Disk Every X Acquisitions** box to set the frequency for saving data. The smaller this number, the more frequently data is saved. The larger this number, the less frequently data is saved; but entering a large number enhances the performance of the time acquisition process.



At specified time intervals, data from OOIBase32 is stored into time acquisition channels or combination channels. This data can be simply plotted in a spectral window, or streamed to disk, or both. Up to 2048 acquisitions can be displayed in a spectral window. If more than 2048 acquisitions are gathered, only the last 2048 of them will be displayed. To store more than 2048 acquisitions, you must stream the data to disk. Writing data to the disk is a slow process (relative to the speed of some spectral acquisitions) and causes a decrease in system performance. However, writing data to disk more frequently gives a larger margin of safety.

- Enable **Show Values in Status Bar** to see the time acquisition values in the status bar. These values replace the cursor values.
- Name the **Stream Filename** for the time acquisition process. Clicking on the ellipsis to the right of this box opens a file save dialog box allowing you to navigate to a designated folder.
- Enable **Save Every Acquisition** to store data for every spectral acquisition during the time acquisition process.

There are options to either store data for each acquisition, or to collect data only after a specified delay. Several factors affect the minimum time acquisition frequency, including integration time, number of spectrometer channels, samples averaged, and computer speed. If you specify you want data to be stored every 100 milliseconds, the delay will be *at least* 100 milliseconds, but could be much longer depending on your experimental configuration. OOIBase32 spends a large amount of time calculating, rendering and displaying the spectra in a spectral window. You have the option to suspend graph display, which greatly improves performance.

- Enable **Continue Until Manually Stopped** to store data until you manually stop the acquisition process by clicking on the stop icon or selecting **Time Acquisition | Stop**.
- Enter an **Initial Delay** to set the delay before the time acquisition process begins. However, the delay countdown cannot begin until you initiate the time acquisition process by clicking on the start icon or selecting **Time Acquisition | Start** from the menu. Be sure to select **Hours, Minutes, Seconds** or **Milliseconds** immediately to the right of the initial delay entry.
- Enter a value to set the **Frequency** of the data collected in a time acquisition process. Data from a time acquisition is stamped with a time that is accurate to 1 millisecond. Be sure to select **Hours, Minutes, Seconds** or **Milliseconds** immediately to the right of the frequency entry.
- Enter a value to set the **Duration** for the entire time acquisition process. Be sure to select **Hours, Minutes, Seconds** or **Milliseconds** to the right of the duration entry.

8. Click the OK button for the Time Acquisition Configuration dialog box.

9. Initiate the Time Acquisition mode by either clicking on the alarm clock icon in the Time Acquisition toolbar or selecting **Time Acquisition | Activate Time Acquisition** from the OOIBase32 menu. You can then start a time acquisition process by selecting the start icon or by selecting **Time Acquisition | Start** from the menu.

Appendix A: Adjusting the Focus of a Collimating Lens

In order to obtain accurate data, the light entering and exiting a sample by means of a fiber/collimating lens assembly must be well collimated. The following is a description of how to adjust the focus of light so that accurate data is collected by the spectrometer. (All collimating lenses are already adjusted at the time of manufacture such that light emerging from a 200 μm fiber/collimating lens assembly is collimated.)

Adjust the focus of the collimating lens on your light source.

1. Connect the fiber that you are going to use as the illumination fiber in your setup to the light source. Ensure the connection is tight. The male SMA connector of the fiber must be screwed all the way into the female connector of the lamp.
2. Turn on the lamp and inspect the light beam emitted from the other end of the fiber by pointing the fiber at a light-colored object such as a white piece of paper. The distance is not too critical but should be at least 3 inches from the surface. Loosen the set screw on the fiber barrel of the light source with an Allen wrench.
3. After the set screw has been loosened, slide the inner barrel of the collimating lens on the light source until you see an even intensity across the beam spot. The spot of light should be uniform; there should be no fluctuations in intensity and color. There should not be any dimmer rings of light surrounding the center spot.
4. Once the inner barrel is positioned so that a well-focused, uniform spot of light is obtained, tighten the set screw with the Allen wrench. Do not put down the fiber and then tighten the set screw. Try to continue to hold the fiber 3 inches from the surface while you tighten so that if the inner barrel of the collimating lens slips and distorts the spot of light, you will be able to readjust the focus. Now the collimating lens on the light source is correctly coupled to the fiber.

Adjust the focus of the next collimating lens in your setup.

5. For this part of the procedure, the illumination fiber is still connected to the lamp and its collimating lens and the lamp is still on. Now take the second collimating lens in your setup (removed from the illumination side of a cuvette holder, for example) and screw it onto the *other* end of the illumination fiber. Make sure the fiber and the second collimating lens are completely connected. Point this end of the fiber at least 2 meters away from a wall. If the beam spot on the wall is too faint, you may need to dim the room lights.
6. Loosen the set screw that holds the barrel of this second collimating lens in place and slide the barrel until the spot of light focused on the wall has crisp edges. You are looking for the sharpest and cleanest image possible. Tighten the set screw. Do not put the fiber down and then tighten the set screw. Try to continue to hold the fiber with the spot of light focused on the wall while you tighten the set screw so that if the inner barrel of the collimating lens slips and distorts the image while tightening, you will be able to readjust the focus. Now that the second collimating lens has been refocused, remove it from the end of the fiber and install it back into your setup (back into a cuvette holder, for example).

Continue to adjust the focus of the other collimating lenses in your setup.

7. You have completed adjusting the focus of the collimating lenses in the illumination part of your setup. Continue to adjust the focus of the other collimating lenses in your setup. If the read fiber is the same diameter size as the illumination fiber, repeat step 6 with each collimating lens in your setup. If the read fiber is a different diameter size than that of the illumination fiber, you need to remove the illumination fiber from the light source, connect the read fiber to the light source, and repeat step 6 for every collimating lens on the read part of your setup.

Appendix B: S1024DW 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 information.

J1 (D-25) Connectors

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 Out	25
11	Master Clock In	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 (D3)	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) Connectors

Pin	Function
1	Strobe Single Fire
2	Strobe Multiple Fire
3	+5VDC
4	External Hardware Trigger
5	External Synchronization Trigger
6	Analog Channel 7 Input
7	Analog Channel 6 Input
8	External Software Trigger (D3)
9	Analog Channel 1
10	Ground
11	Analog Channel 4
12	Analog Channel 5
13	Digital Out S0 (Strobe Enable or Lamp On/Off)
14	Analog Channel 3
15	Analog Channel 2

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)

F	Inverted Clock 2
E	Inverted Clock 1
D	N/C
C	A/D Trigger
B	Digital In 3 (D3)
A	S1
1	Ground
2	+5 VDC
3	Clock 1
4	Store Clock
5	Clock 2
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 S1024DW 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

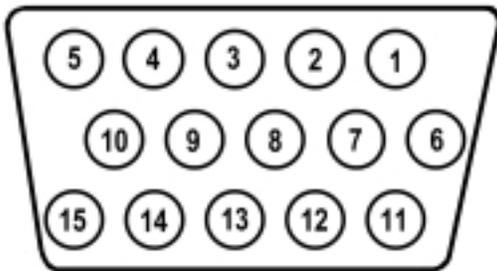
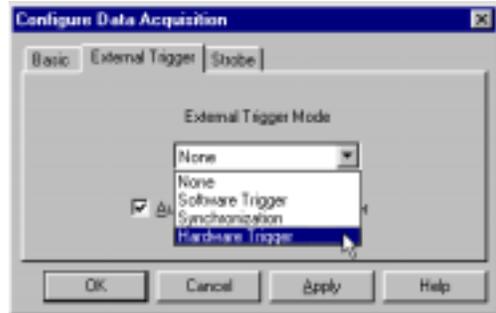
The continuous strobe rate is controlled by the A/D frequency input to the spectrometer and the position of the jumper JP3. The jumper selects a divider for the input clock. To change the jumper it is necessary to remove the S1024DW from its housing.

Jumper Position	Divisor	S1024DW Flash Rate (running @ 200 kHz)
1	Buffered input from D25 pin 20	
2	2^{10}	195 Hz
3	2^{12}	48.8 Hz
4	2^{14}	12.2 Hz
5	2^{16}	3.1 Hz

Appendix C: External Triggering

Our S2000 and S1024DW Spectrometers provide four methods of acquiring data. In the Normal Mode, Ocean Optics spectrometers are “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, three other modes of acquiring data are available. Each mode involves applying an external trigger to the spectrometer before the software receives the data. The length of the integration time and the source for the integration clock depend upon the mode chosen. All other acquisition parameters are set in the software.



J2 (D-SUB-15) Accessory Connector (female)

For each external trigger mode, Pin 3 of the J2 (D-SUB-15) Accessory Connector supplies voltage to the spectrometer. To operate in the Software Mode, the triggering device must be connected to Pin 8 of the J2 (D-SUB-15) Accessory Connector. To operate in the Synchronization Mode, the triggering device must be connected to Pin 5 of the J2 (D-SUB-15) Accessory Connector. And to operate in the Hardware Mode, the triggering device must be connected to Pin 4 of the J2 (D-SUB-15) Accessory Connector.

External Software Trigger

In this level-triggered 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 Software Mode, you set the integration time in the software. (It is the only external triggering mode where the integration time is set 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 above 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 on page 61 for pin location.)
3. Set your acquisition parameters in the software via the Acquisition Dialog Bar or the Configure Data Acquisition dialog box. To access the dialog box, click the Data Acquisition icon or select **Spectrum | Configure Data Acquisition** from the menu.
4. Select **Spectrum | Configure Data Acquisition** from the menu. Choose the **External Trigger** page and select **Software Trigger**.
5. To save processed data with each external trigger, enable the **Automatically save file on trigger** box. If you enable this function, you will be presented with a file save dialog box *with each trigger*. To avoid manually naming a file for each trigger, you can enable the **Autoincrement Filenames** function by selecting **File | Autoincrement Filenames | Enabled** from the menu. Choose a base name and starting index for the autoincremented files.
6. Once you select an external trigger mode, it will appear on your computer that your spectrometer is unresponsive. Instead, it is waiting for the trigger. Activate your triggering device. The acquisition parameters, the name of the window acquiring data and the trigger mode are all displayed in the main status bar.

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

External Synchronization Trigger

In this edge-triggered mode, the spectrometer is idle until you apply the initial trigger to the spectrometer. With each trigger, the following occurs:

1. the spectrometer stops taking its current scan and data is transferred to the software
2. the spectrometer begins a new scan
3. the spectrometer integrates until another trigger is applied

In the Synchronization Mode, the integration time is set by the frequency of triggers applied to the spectrometer. The effective integration time is the time between rising edges of signals applied to Pin 5 of the J2 Accessory Connector. All other acquisition parameters are set in the software. The source for the integration clock is the external triggering device itself, such as a periodic TTL signal.

Use the Synchronization Mode if you:

- must synchronize your scans to an external clock source
- are using a lock-in amplifier
- are using a chopper

To Use the Synchronization 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 on page 61 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 5 of the J2 Accessory Connector to your triggering device. (See figure on page 61 for pin location.)
3. Set other acquisition parameters in the software via the Acquisition Dialog Bar or the Configure Data Acquisition dialog box. To access the dialog box, click the Data Acquisition icon or select **Spectrum | Configure Data Acquisition** from the menu.
4. Select **Spectrum | Configure Data Acquisition** from the menu. Choose the **External Trigger** page and select **Synchronization**.

- To save processed data with each external trigger, enable the **Automatically save file on trigger** box. If you enable this function, you will be presented with a file save dialog box *with each trigger*. To avoid manually naming a file for each trigger, you can enable the **Autoincrement Filenames** function by selecting **File | Autoincrement Filenames | Enabled** from the menu. Choose a base name and starting index for the autoincremented files.
- Once you select an external trigger mode, it will appear on your computer that your spectrometer is unresponsive. Instead, it is waiting for the trigger. Activate your triggering device. The acquisition parameters, name of the window acquiring data and trigger mode are displayed in the main status bar.

External Hardware Trigger

In this edge-triggered mode, the spectrometer is idle until you apply a trigger to the spectrometer. With each trigger, the following occurs:

- the spectrometer is cleared and then begins integrating
- the spectrometer integrates for a fixed period of time, determined by the jumpered pins on the spectrometer's circuit board
- the data is transferred to the software
- the spectrometer then sits idle, waiting for the next trigger

In the Hardware Mode, you set the integration time by positioning jumpers over pins on the spectrometer's circuit board. All other acquisition parameters are set in the software. The source for the integration clock is the external triggering device itself. This mode is ideal for use with laser and other short-pulse events.

Use the Hardware Mode if you:

- are using a pulsed excitation or light source in your experiment
- are doing LIF (fluorescence with pulsed excitation) or phosphorescence experiments
- are able to jumper the pins on Jumper Block 4 of the spectrometer's electronic board
- need to synchronize an acquisition with an external event

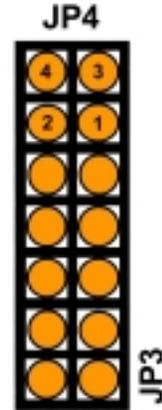
To Use the Hardware Mode:

- 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 on page 61 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.
- Supply a line from Pin 4 of the J2 Accessory Connector to your triggering device. (See figure on page 61 for pin location.)
- To set the integration time, look at the charts below. After finding the A/D converter you are using, choose your integration time. You have four choices.

Integration Time SAD500 (1 MHz Master Clock Freq)	Integration Time Equation	Jumper Block 4 (JP4)	
		Pins 1-2	Pins 3-4
5 ms	$1000/F_m$	open	open
60 ms	$12000/F_m$	open	shorted
300 ms	$60000/F_m$	shorted	open
655 ms	$131070/F_m$	shorted	shorted

F_m = the master clock frequency in Hz (i.e., 200 kHz for the SAD500); shorted = connected; open = disconnected

4. Once you have selected the integration time, note the configuration of the pins in the Jumper Block 4 column of the chart.
5. Remove your spectrometer from its housing. Do not tamper with the optical bench. (If you have more than one channel in your system, you may have to disconnect the channels from one another. The master spectrometer is always on the bottom of a multiple channel system.) In the center of the green circuit board, near the optical bench, find Jumper Block 4, labeled JP4. (See the figure to the right.) Jumper Block 4 consists of the first four pins, which are numbered 1, 2, 3, and 4. Using jumpers, configure the pins to match the integration time you selected.



For example:

- You have an S1024DW and a SAD500 A/D converter
 - Out of your four choices for an integration time, you select 60 milliseconds
 - Pins 1-2 must be open and Pins 3-4 must be shorted
 - Leave Pins 1-2 uncovered and place a jumper over Pins 3-4
6. Set other acquisition parameters such as averaging and boxcar smoothing in the software via the Acquisition Dialog Bar or the Configure Data Acquisition dialog box. To access the dialog box, click the Data Acquisition icon or select **Spectrum | Configure Data Acquisition** from the menu.
 7. Select **Spectrum | Configure Data Acquisition** from the menu. Choose the **External Trigger** page and select **Hardware Trigger**.
 8. To save processed data with each external trigger, enable the **Automatically save file on trigger** box. If you enable this function, you will be presented with a file save dialog box *with each trigger*. To avoid manually naming a file for each trigger, you can enable the **Autoincrement Filenames** function by selecting **File | Autoincrement Filenames | Enabled** from the menu. Choose a base name and starting index for the autoincremented files.
 9. Once you select an external trigger mode, it will appear on your computer that your spectrometer is unresponsive. Instead, it is waiting for the trigger. Activate your triggering device. The acquisition parameters, name of the window acquiring data and trigger mode are displayed in the main status bar.

It is important to note that if you apply triggers faster than the fixed integration time, you will miss acquisitions.