



USB2000 Fiber Optic Spectrometer

Installation and Operation Manual

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1 USB2000 Introduction

The following chapter contains introductory information about the USB2000 Spectrometer, shipment information, and spectrometer connectivity.

Product Overview

The USB2000 Spectrometer connects to a notebook or desktop PC via USB port or serial port. When connected to the USB port of a PC, the USB2000 draws power from the host PC, eliminating the need for an external power supply.



Figure 1-1: Ocean Optics USB2000 Fiber Optic Spectrometer

System Requirements

You can use the USB2000's USB connectivity with any PC that meets the following requirements:

- Windows 98/Me/2000/XP operating system (or Windows CE 2.11 or later for palm-sized PCs)
- Ocean Optics OOIBase32 software application installed and configured for use with the USB2000 (OOIPS2000 software if using a palm-sized PC). Consult the "Configuring the USB2000 in OOIBase32" section of *Chapter 3: Installing the USB2000* for specific configuration instructions.

Alternately, the USB2000 has a serial port for connecting to PCs, PLCs, and other devices that support the RS-232 communication protocol. However, this connection method requires an external power supply to power the USB2000.

EEPROM Utilization

An EEPROM memory chip in each USB2000 contains wavelength calibration coefficients, linearity coefficients, and a serial number unique to each individual spectrometer. The OOIBase32 software application reads these values directly from the spectrometer, enabling the ability to "hot-swap" spectrometers between PCs without entering the spectrometer coefficients manually on each PC.

USB2000 Introduction

About OOIBase32

OOIBase32 is the latest generation of operating software for all Ocean Optics spectrometers and is available free to all customers. OOIBase32 is a user-customizable, advanced acquisition and display program that provides a real-time interface to a variety of signal-processing functions. With OOIBase32, you have the ability to perform spectroscopic measurements (such as absorbance, reflectance, and emission), control all system parameters, collect and display data in real time, and perform reference monitoring and time acquisition experiments.

Note: When using a palm-sized PC, you will use the OOIPS2000 software instead of OOIBase32. The functionality of OOIPS2000 is similar to OOIBase32, but it is specifically for the palm-sized PC.

Sampling System Overview

Ocean Optics fiber optic spectrometer systems consist of low-cost, modular data acquisition components. A typical USB2000-based sampling system contains four core elements:

- USB2000 Spectrometer
- OOIBase32 operating software
- Light source
- Sampling optics (varying, depending on application requirements)

How Sampling Works

The following list explains the function of Ocean Optics sampling components in the sampling process:

1. The user stores reference and dark measurements to correct for instrument response variables.
2. The light from the light source transmits through an optical fiber to the sample.
3. The light interacts with the sample.
4. Another optical fiber collects and transmits the result of the interaction to the spectrometer.
5. The spectrometer measures the amount of light and transforms the data collected by the spectrometer into digital information.
6. The spectrometer passes the sample information to OOIBase32.
7. OOIBase32 compares the sample to the reference measurement and displays processed spectral information.

Modular Sampling Accessories

Ocean Optics offers a complete line of spectroscopic accessories for use with the USB2000. Most of our spectroscopic accessories have SMA connectors for application flexibility. Accordingly, changing the sampling system components is as easy as unscrewing a connector and replacing an accessory.

2 USB2000 Specifications

This chapter contains information on spectrometer operation, specifications, and system compatibility. It also includes accessory connector pinout diagrams and pin-specific information.

How the USB2000 Works

The following diagram illustrates the movement of light through the optical bench of the USB2000 Spectrometer. You can customize the items marked with an asterisk (*) when ordering the USB2000.

Note: The optical bench has no moving parts that can wear or break. Ocean Optics secures all components in place permanently at the time of manufacture.

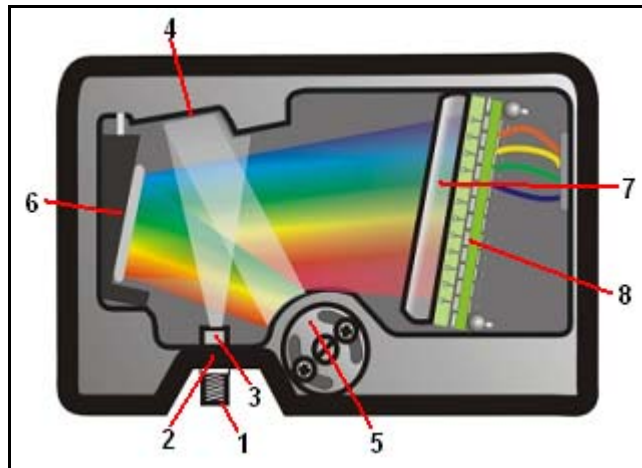


Figure 2-1: USB2000 Spectrometer with Components

The USB Component Table on the following page explains the function of each numbered component in the USB2000 Spectrometer diagram (Figure 2-1).

USB2000 Component Table

Ocean Optics permanently secures all components in the USB2000 at the time of manufacture. Only Ocean Optics Technicians can replace interchangeable components, where noted.

Item	Name	Description
1	SMA Connector	The SMA Connector secures the input fiber to the spectrometer. Light from the input fiber enters the optical bench through this connector.
2	Slit*	The Slit is a dark piece of material containing a rectangular aperture, which is mounted directly behind the SMA Connector. The size of the aperture regulates the amount of light that enters the optical bench and controls spectral resolution. You can also use the USB2000 without a Slit . In this configuration, the diameter of the fiber connected to the USB2000 determines the size of the entrance aperture. Only Ocean Optics technicians can change the Slit .
3	Filter*	The Filter is a device that restricts optical radiation to pre-determined wavelength regions. Light passes through the Filter before entering the optical bench. Both bandpass and longpass filters are available to restrict radiation to certain wavelength regions. Only Ocean Optics technicians can change the Filter .
4	Collimating Mirror	The Collimating Mirror focuses light entering the optical bench towards the Grating of the spectrometer. Light enters the spectrometer, passes through the SMA Connector, Slit, and Filter, and then reflects off the Collimating Mirror onto the Grating.
5	Grating*	The Grating diffracts light from the Collimating Mirror and directs the diffracted light onto the Focusing Mirror. Gratings are available in different groove densities, allowing you to specify wavelength coverage and resolution in the spectrometer. Only Ocean Optics technicians can change the Grating .
6	Focusing Mirror	The Focusing Mirror receives light reflected from the Grating and focuses the light onto the CCD Detector or L2 Detector Collection Lens (depending on the spectrometer configuration).
7	L2 Detector Collection Lens*	The L2 Detector Collection Lens (optional) attaches to the CCD Detector. It focuses light from a tall slit onto the shorter CCD Detector elements. The L2 Detector Collection Lens should be used with large diameter slits or in applications with low light levels. It also improves efficiency by reducing the effects of stray light. Only Ocean Optics technicians can add or remove the L2 Detection Collection Lens .
8	CCD Detector (UV or VIS)	The CCD Detector collects the light received from the Focusing Mirror or L2 Detector Collection Lens and converts the optical signal to a digital signal. Each pixel on the CCD Detector responds to the wavelength of light that strikes it, creating a digital response. The spectrometer then transmits the digital signal to the OOIBase32 application.

USB2000 Specifications

The following sections provide specification information for the CCD Detector in the USB2000, as well as the USB2000 Spectrometer itself.

CCD Detector Specifications

Detector:	Sony ILX511 linear silicon CCD array
Number of elements:	2048 pixels
Pixel size:	14 μm x 200 μm
Pixel well depth:	62,500 electrons
Signal-to-noise ratio:	250:1 (at full signal)
A/D resolution:	12 bit
Dark noise:	2.5 RMS counts
Corrected linearity:	>99.8%

USB2000 Spectrometer Specifications

Dimensions:	89.1 mm x 63.3 mm x 34.4 mm
Weight:	190 g (without cable)
Power consumption:	90 mA @ 5 VDC
Detector range:	200-1100 nm
Detector:	2048-element linear silicon CCD array
Gratings:	14 gratings; UV through Shortwave NIR
Entrance aperture:	5, 10, 25, 50, 100 or 200 mm wide slits or fiber (no slit)
Order-sorting filters:	Installed longpass and bandpass filters
Focal length:	f/4, 42 mm (input); 68 mm (output)
Optical resolution:	~0.3-10.0 nm FWHM (depending on grating and size of entrance aperture)
Dynamic range:	2×10^8 (system); 2000:1 for a single scan
Stray light:	<0.05% at 600 nm; <0.10% at 435 nm; <0.10% at 250 nm
Sensitivity (estimate):	400 nm – 90 photons/count; 600 nm – 41 photons/count; 800 nm – 203 photons/count
Fiber optic connector:	SMA 905 to single-strand optical fiber (0.22 NA)
Data transfer rate:	Full scans into memory every 13 milliseconds
Integration time:	3 milliseconds to 65 seconds
Fiber optic connector:	SMA 905 to single-strand optical fiber (0.22 NA)
Operating systems:	Windows 98/Me/2000/XP when using the USB interface on a desktop or notebook PCs Any 32-bit Windows operating system when using the serial port on desktop or notebook PCs Windows CE 2.11 and above when using the serial port on palm-sized PCs

5 Sample Experiments

The following sections contain information on conducting sample experiments using the USB2000 and OOIBase32. For information on experiments with OOIPS2000, consult the OOIPS2000 Operating Instructions.

Preparing for Experiments

Follow the steps below to configure the USB2000 and OOIBase32 for experiments:

1. Double-check that you have correctly installed the USB2000, installed OOIBase32, and configured the light source and other sampling optics.
2. Open the OOIBase32 application, select **Spectrometer | Configure** from the menu bar, and double-check that **A/D Interface** settings are correct.
3. Check your spectrometer setup configurations in OOIBase32:

Locate the Wavelength Calibration Data sheet that came with the USB2000. Select **Spectrometer | Configure** from the menu and choose the **Wavelength Calibration** page. For each spectrometer channel in the system, enable the channel and make sure the First Coefficient, Second Coefficient, Third Coefficient and Intercept correspond to those of the system.

4. Adjust the acquisition parameters using the **Acquisition Parameters** dialog bar or select **Spectrum | Configure Data Acquisition** from the menu.

If you have followed the previous steps and started OOIBase32, the spectrometer is already acquiring data. Even with no light in the spectrometer, there should be a dynamic trace displayed in the bottom of the graph. If you allow light into the spectrometer, the graph trace should rise with increasing light intensity. This means the software and hardware are correctly installed.

Once you install the hardware, configure the software, and establish your sampling system, you are ready to take measurements.

There are four basic optical measurements from which to choose:

- Absorbance
- Transmission
- Reflection
- Relative irradiance

The type of measurement you will take determines the configuration of the sampling optics for your system. Furthermore, your choice of reference and data analysis determines how the OOIBase32 presents the results.

Note: For each measurement, you must first take a reference and dark spectrum. After you take a reference and a dark spectrum, you can take as many measurement scans as needed. However, if you change any sampling variable (integration time, averaging, smoothing, angle, temperature, fiber size, etc.), you must store a new dark and reference spectrum.

Sample Experiments

Application Tips

If the signal you collect is saturating the spectrometer (intensity greater than 4000 counts), you can decrease the light level on scale in scope mode by:

- Decreasing the integration time
- Attenuating the light going into the spectrometer
- Using 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
- Using a larger diameter fiber
- Removing any optical filters

Absorbance Experiments

Absorbance spectra are a measure of how much light a sample absorbs. For most samples, absorbance is linearly related to the concentration of the substance. OOIBase32 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_λ is the sample intensity at wavelength λ , D_λ is the dark intensity at wavelength λ , R_λ is the reference intensity at wavelength λ .

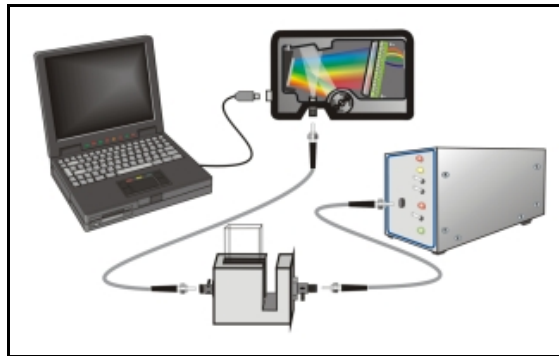


Figure 6-1: Typical absorbance setup. The light source (far right) sends light via an input fiber into a cuvette in a cuvette holder (bottom center). The light interacts with the sample. The output fiber carries light from the sample to the spectrometer (top center), which is connected to the PC (far left).

Absorbance is also proportional to the concentration of the substance interacting with the light (this is known as Beer's Law). Common absorption applications include the quantification of chemical concentrations in aqueous or gaseous samples.

Follow the steps below to take an absorbance measurement using OOIBase32:

1. Place OOIBase32 in scope mode by clicking the scope mode icon on the toolbar or selecting **Spectrum | Scope Mode** from the menu bar.
2. Ensure that the entire signal is on scale. The intensity of the reference signal should peak at about 3500 counts. If necessary, adjust the integration time until the intensity is approximately 3500 counts.

(Continued)

Sample Experiments

3. Place a sample of the solvent into a cuvette and take a reference spectrum. You must take a reference spectrum before measuring absorbance.

Note: Do not put the sample itself in the path when taking a reference spectrum, only the solvent.

Click the **Store Reference** spectrum icon on the toolbar or select **Spectrum | Store Reference** from the menu bar to store the reference. This command merely stores a reference spectrum in memory. You must select **File | Save | Reference** from the menu bar to permanently save the spectrum to disk.

4. Block the light path to the spectrometer. Then, take a dark spectrum by clicking the **Store Dark Spectrum** icon on the toolbar or by selecting **Spectrum | Store Dark** from the menu bar. This command merely stores a dark spectrum in memory. You must select **File | Save | Dark** from the menu to permanently save the spectrum to disk.

Note: If possible, do not turn off the light source when taking a dark spectrum. If you must turn off your light source to store a dark spectrum, allow enough time for the lamp to warm up again before continuing your experiment. After the lamp warms up again, store a new reference (Step 3).

You must take a dark spectrum before measuring absorbance.

5. Put the sample in place and ensure that the light path is clear. Then, take an absorbance measurement by clicking on the **Absorbance Mode** icon on the toolbar or selecting **Spectrum | Absorbance Mode** from the menu. To permanently save the spectrum to disk, click the **Save** icon on the toolbar or select **File | Save | Processed** from the menu bar.

Note: If you change any sampling variable (integration time, averaging, smoothing, angle, temperature, fiber size, etc.), you must store a new dark and reference spectrum.

Transmission Experiments

Transmission is the percentage of energy passing through a sample relative to the amount that passes through the reference. Transmission Mode also displays the portion of light *reflected* from a sample, since transmission and reflection measurements use the same mathematical calculations. The transmission is expressed as a percentage (% T_λ) relative to a standard substance (such as air). OOIBase32 calculates % T_λ (or % R_λ) with the following equation...

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

...where S_λ is the sample intensity at wavelength λ , D_λ is the dark intensity at wavelength λ , R_λ is the reference intensity at wavelength λ .

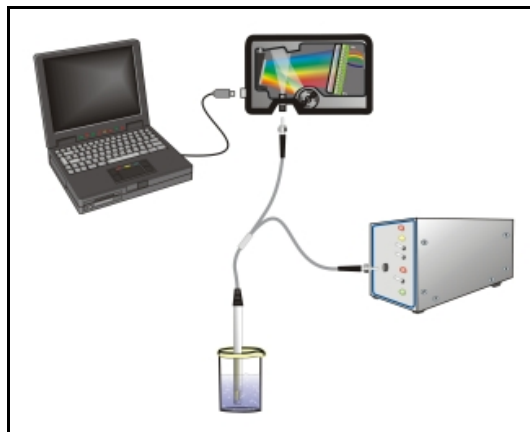


Figure 6-2: Typical transmission setup. The light source (far right) sends light via the input leg of a transmission probe into a container (bottom center). The light interacts with the sample. The output leg of the transmission probe carries the information to the spectrometer (top center), which transmits the information to the PC (far left).

Common transmission applications include measuring light through solutions, optical filters, optical coatings, and other optical elements (such as lenses and fibers).

Perform the following steps to take a transmission measurement using OOIBase32:

1. Place OOIBase32 in scope mode by clicking the **Scope Mode** icon on the toolbar or by selecting **Spectrum | Scope Mode** from the menu bar.
2. Ensure that the entire signal is on scale. The intensity of the reference signal should peak at about 3500 counts. If necessary, adjust the integration time until the intensity is approximately 3500 counts.

(Continued)

Sample Experiments

6. Place a sample of the solvent into a cuvette and take a reference spectrum. You must take a reference spectrum before measuring transmission.

Note: Do not put the sample itself in the path when taking a reference spectrum, only the solvent.

Click the **Store Reference** spectrum icon on the toolbar or select **Spectrum | Store Reference** from the menu bar to store the reference. This command merely stores a reference spectrum in memory. You must select **File | Save | Reference** from the menu bar to permanently save the spectrum to disk.

3. Block the light path to the spectrometer. Then, take a dark spectrum by clicking the **Store Dark Spectrum** icon on the toolbar or by selecting **Spectrum | Store Dark** from the menu bar. This command merely stores a dark spectrum in memory. You must select **File | Save | Dark** from the menu to permanently save the spectrum to disk.

Note: If possible, do not turn off the light source when taking a dark spectrum. If you must turn off your light source to store a dark spectrum, allow enough time for the lamp to warm up again before continuing your experiment.

You must take a dark spectrum before measuring transmission.

4. Put the sample in place and verify that the light path is clear. Then, take a transmission measurement by clicking the **Transmission Mode** icon on the toolbar or selecting **Spectrum | Transmission Mode** from the menu bar. To save the spectrum to disk, click the **Save** icon on the toolbar or select **File | Save | Processed** from the menu bar.

Note: If you change any sampling variable (integration time, averaging, smoothing, angle, temperature, fiber size, etc.), you must store a new dark and reference spectrum.

Reflection Experiments

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

- Specular (the angle of incidence is equal to the angle of reflection)
- Diffuse (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, while others may return mostly diffuse reflection. Specular reflection increases proportionately with the amount of gloss on a surface.

Reflection is expressed as a percentage (% R_λ) relative to the reflection from a standard reference substance...

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

...where S_λ is the sample intensity at wavelength λ , D_λ is the dark intensity at wavelength λ , R_λ is the reference intensity at wavelength λ .



Figure 6-3: Typical reflection setup. A light source (far right) sends light via the input leg of a reflection probe onto a sample (bottom center). A reflection probe holder holds the probe in either a 90 or 45-degree angle from the surface. The output leg of the reflection probe carries light from the sample to the spectrometer (top center), which is connected to the PC (far left).

Common reflection applications include measuring the properties of mirrors and coatings. Other applications include measuring the visual properties of the color in paints, plastics, and food products.

Sample Experiments

Perform the following steps to take reflection measurements using OOIBase32:

1. Place OOIBase32 is in scope mode by clicking the **Scope Mode** icon on the toolbar, or by selecting **Spectrum | Scope Mode** from the menu bar.
2. Ensure that the entire signal is on scale. The intensity of the reference signal should peak at about 3500 counts.
3. Take a reference spectrum with the WS-1 Diffuse Reflectance Standard or the STAN-SSH High-reflectivity Reference Standard. You must take a reference spectrum before measuring reflection.

Click the **Store Reference** spectrum icon on the toolbar or select **Spectrum | Store Reference** from the menu bar to store the reference. This command merely stores a reference spectrum in memory. You must select **File | Save | Reference** from the menu bar to permanently save the spectrum to disk.

4. Block the light path to the spectrometer. Then, take a dark spectrum by clicking the **Store Dark Spectrum** icon on the toolbar or by selecting **Spectrum | Store Dark** from the menu bar. This command merely stores a dark spectrum in memory. You must select **File | Save | Dark** from the menu to permanently save the spectrum to disk.

Note: If possible, do not turn off the light source when taking a dark spectrum. If you must turn off your light source to store a dark spectrum, allow enough time for the lamp to warm up again before continuing your experiment.

You must take a dark spectrum before measuring transmission.

5. Put the sample is in place and ensure that the light path is clear. Then, take a reflection measurement by clicking on the **Transmission Mode** icon on the toolbar or selecting **Spectrum | Transmission Mode** from the menu bar (since the mathematical calculations used to calculate transmission and reflection are identical). To save the spectrum to disk, click the **Save** icon on the toolbar or select **File | Save | Processed** from the menu bar.

Note: If you change any sampling variable (integration time, averaging, smoothing, angle, temperature, fiber size, etc.), you must store a new dark and reference spectrum.

Relative Irradiance Experiments

Irradiance is the amount of energy at each wavelength emitted from a radiant sample. In relative terms, it is a comparison of the fraction of energy the sample emits and the energy the sampling system collects from a lamp with a blackbody energy distribution (normalized to 1 at the energy maximum). OOIBase32 calculates relative irradiance with the following equation...

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

...where B_{λ} is the relative energy of the reference (calculated from the color temperature) at wavelength λ , S_{λ} is the sample intensity at wavelength λ , D_{λ} is the dark intensity at wavelength λ , R_{λ} is the reference intensity at wavelength λ .

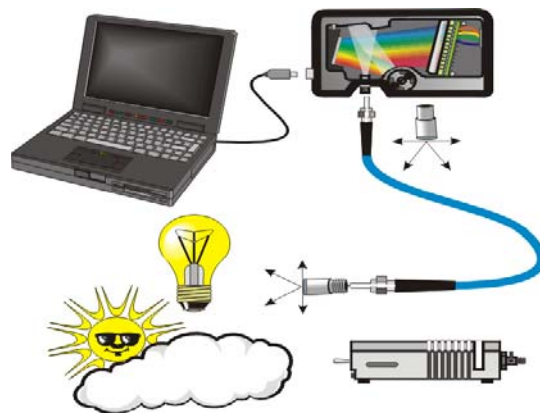


Figure 6-4: Typical Relative Irradiance Setup. A light source with a known color temperature (such as the LS-1or LS-1-LL - lower right) is used to take a reference spectrum. The light to measure (lower left) is accumulated through a CC-3 Cosine Corrector (or FOIS integrating sphere) into an input fiber, which carries the light information to the spectrometer. The spectrometer then transmits the information to the PC, which compares the measured spectra against the reference spectrum, thus removing wavelength-dependent instrument response from the measurement.

Common applications include characterizing the light output of LEDs, incandescent lamps, and other radiant energy sources such as sunlight. Relative irradiance measurements also include fluorescence measurements, which measure the energy given off by materials that have been excited by light at shorter wavelengths.

Sample Experiments

Perform the following steps to take a relative irradiance measurement using OOIBase32:

1. Place OOIBase32 is in scope mode by clicking the **Scope Mode** icon on the toolbar, or by selecting **Spectrum | Scope Mode** from the menu bar.
2. Ensure that the entire signal is on scale. The intensity of the reference signal should peak at about 3500 counts.

Note: The light source must be a blackbody of known color temperature.

3. In the **Reference Color Temperature** dialog box, enter the color temperature of the light source (in Kelvin) and click the **OK** button.
4. Take a reference spectrum using a light source with a black body of a known color temperature, such as the LS-1.

Click the **Store Reference** spectrum icon on the toolbar or select **Spectrum | Store Reference** from the menu bar to store the reference. This command merely stores a reference spectrum in memory. You must select **File | Save | Reference** from the menu bar to permanently save the spectrum to disk.

5. Block the light path to the spectrometer. Then, take a dark spectrum by clicking the **Store Dark Spectrum** icon on the toolbar or by selecting **Spectrum | Store Dark** from the menu bar. This command merely stores a dark spectrum in memory. You must select **File | Save | Dark** from the menu to permanently save the spectrum to disk.

Note: If possible, do not turn off the light source when taking a dark spectrum. If you must turn off your light source to store a dark spectrum, allow enough time for the lamp to warm up again before continuing your experiment.

You must take a dark spectrum before measuring relative irradiance.

6. Position 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 bar.
7. Click the **Save** icon on the toolbar or select **File | Save | Processed** from the menu bar to save the spectrum to disk.

Note: If you change any sampling variable (integration time, averaging, smoothing, angle, temperature, fiber size, etc.), you must store a new dark and reference spectrum.

Time Acquisition Experiments

OOIBase32 allows you to perform time acquisition experiments. Time acquisition experiments track processes, perform kinetic analyses, and monitor spectral events all as a function of time. You can collect, as a function of time, spectral data from up to six single wavelengths (designated as Channels A through F) and up to two mathematical combinations of these wavelengths (designated as Combinations 1 and 2). Additionally, you can acquire data in any mode (transmission, absorbance, etc.).

For more details about this and other OOIBase32 functions, refer to the *OOIBase32 Spectrometer Operating Software Manual*.

Follow the steps below to perform a time series experiment in OOIBase32:

1. Enter scope mode and store a reference spectra and dark spectra.
2. Choose the measurement mode (absorbance, transmission, etc.) and select **Time Acquisition | Configure | Configure Time Channels** from the menu bar to access the Time Acquisition Channel Configuration screen.

Proceed to the Configuring the Time Acquisition Channel Configuration Screen section below.

Configuring the Time Acquisition Channel Configuration Screen

1. Perform the following steps on the Time Acquisition Channel Configuration screen:
 - a. Select **Enabled** to set the time acquisition calculation for the wavelength. The time acquisition process will not calculate data if you do not select this option for at least
 - b. Select **Plotted** to see a real-time graph of the acquired data in a spectral window.
 - c. Select a **Spectrometer Channel** for the time acquisition process
 - d. Specify the analysis wavelength in the **Wavelength (nm)** box.
 - e. Specify the number of pixels around the analysis wavelength to average in the **Bandwidth (pixels)** box.
 - f. Select a multiplicative factor to apply to the data before plotting or storing. Then, select an additive constant or offset to apply to the data. OOIBase32 applies the additive constant or offset after applying the factor but before plotting or storing data.

The equation for the Factor and Offset functions is:

$$\text{Results} = (\text{Factor} * \text{Data}) + \text{Offset}$$

2. Configure a time acquisition process for the second single wavelength (if desired). Select the Channel B page and repeat Steps 1-3 for Channel B.

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.

(Continued)

Sample Experiments

3. Configure a time acquisition process for a combination of two time channels (if desired) by selecting **Combination 1**.

Perform the steps below to configure a combination:

- g. Select **Enabled** to set the time acquisition calculation for the wavelength.
- h. Enable **Plotted** to see a real-time graph of the acquired data in a spectral window.
- i. Specify Time Channel A through F for the First Channel.
- j. Select the mathematical operation to produce the data for Combination 1.
- k. Specify Time Channel A through F for the Second Channel.
- l. Select a multiplicative factor to apply to the data before plotting or storing. Then, select an additive constant or offset to apply to the data. OOIBase32 applies the additive constant or offset after applying the factor but before plotting or storing data.

The equation for the Factor and Offset functions is:

$$\text{Results} = (\text{Factor} * \text{Data}) + \text{Offset}$$

4. Configure a time acquisition process for the Combination 2 page, if desired. This page is virtually identical to the Combination 1 page, with the exception that you can choose Combination 1 for the first or second channel in Combination 2.
5. Click the **Apply** button to apply the changes, and then click the **OK** button to close the Time Acquisition Channel Configuration screen.

Proceed to the Configuring the Configure Acquisition Screen section below.

Configuring the Time Acquisition Configuration Screen

1. Select **Time Acquisition | Configure | Configure Acquisition** from the menu bar to open the Time Acquisition Configuration screen.
2. Enable **Stream Data to Disk** to save time acquisition data.
3. Enter a value in the **Write Data to Disk Every X Acquisitions** box to set the frequency for data saves. OOIBase32 saves data more frequently if the number is smaller, or less frequently if the number is larger. Entering a large number enhances the performance of the time acquisition process.

Note: At specified time intervals, OOIBase32 stores data into time acquisition channels or combination channels. OOIBase32 can plot the data in a spectral window, or stream the data to disk, or both. OOIBase32 can display up to 2048 acquisitions in a spectral window. If OOIBase32 collects more than 2048 acquisitions, it only displays the last 2048. 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.

4. Enable **Show Values in Status Bar** to see the time acquisition values in the status bar. These values replace the cursor values.
5. 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.

(Continued)

Sample Experiments

6. Enable **Save Every Acquisition** to store data for every spectral acquisition during a time acquisition process (optional).

Note: OOIBase32 has 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 instruct OOIBase32 to store data every 100 milliseconds, the delay between data acquisitions will be 100 milliseconds or more, depending on your experimental configuration. OOIBase32 spends a large amount of time calculating, rendering, and displaying the spectra in a spectral window. You can suspend the graph display, which greatly improves the performance of OOIBase32.

7. Enter an **Initial Delay** to set the delay preceding the time acquisition process. Keep in mind that the delay countdown does not begin until you start the time acquisition process. Be sure to select Hours, Minutes, Seconds, or Milliseconds immediately to the right of the initial delay entry.
8. Enter a value to set the **Frequency** of the data collected in a time acquisition process. OOIBase32 stamps data from a time acquisition with a time accurate to one millisecond. Be sure to select Hours, Minutes, Seconds, or Milliseconds immediately to the right of the frequency entry. You can enable the **Save Every Acquisition** box to store the acquisitions that occur at this frequency. See Step 6 for more information.
9. 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. Click the **OK** button to close the Time Acquisition Configuration dialog box. Then, enable **Continue Until Manually Stopped**, which instructs OOIBase32 to store data until you manually stop the acquisition process (optional).