HR2000+ High-speed Fiber Optic Spectrometer

Installation and Operation Manual
Document Number 294-00000-000-02-201012

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About This Manual

Document Purpose and Intended Audience

This document provides the user of HR2000+ Spectrometer with instructions for setting up, calibrating and performing experiments with their spectrometer.

What's New in this Document

This version of the HR2000+ High-speed Fiber Optic Spectrometer, Installation and Operation Manual updates information for the new triggering options for firmware versions 3.0 and above.

Document Summary

Chapter	Description
Chapter 1: *Introduction*	Contains descriptive information about the HR2000+ Spectrometer and how sampling works. It also provides a list of system requirements, interface options, and shipment components.
Chapter 2: *Installing the HR2000+*	Provides installation and configuration instructions.
Chapter 3: *Troubleshooting*	Contains recommended steps to isolate and correct common problems.
Appendix A: *Calibrating the Wavelength of the HR2000+*	Provides instructions for calibrating the HR2000+ Spectrometers.
Appendix B: *Specifications*	Contains technical specifications and connector pinouts for the HR2000+ Spectrometers.

Product-Related Documentation

You can access documentation for Ocean Optics products by visiting our website at **http://www.oceanoptics.com**. Select *Technical → Operating Instructions*, then choose the appropriate document from the available drop-down lists. Or, use the **Search by Model Number** field at the bottom of the web page.

- Detailed instructions for SpectraSuite Spectrometer Operating Software are located at: **http://www.oceanoptics.com/technical/SpectraSuite.pdf**.
- Detailed instructions for the OOIBase32 Spectrometer Operating Software are located at: **http://www.oceanoptics.com/technical/ooibase32.pdf**

- Detailed instructions for the Breakout Box are located at:
  http://www.oceanoptics.com/technical/HR4_breakout.pdf.

- Detailed instructions for External Triggering for firmware versions below 3.0 are located at:
  http://www.oceanoptics.com/technical/external-triggering.pdf.

- Detailed instructions for External Triggering for firmware versions 3.0 and above are located at:
  http://www.oceanoptics.com/technical/external-triggering2.pdf.

Engineering-level documentation is located on our website at *Technical → Engineering Docs*.

You can also access operating instructions for Ocean Optics products from the *Software and Technical Resources* CD that ships with the product.

Upgrades

Occasionally, you may find that you need Ocean Optics to make a change or an upgrade to your system. To facilitate these changes, you must first contact Customer Support and obtain a Return Merchandise Authorization (RMA) number. Please contact Ocean Optics for specific instructions when returning a product.

Introduction

Product Overview

The HR2000+ High-Speed Miniature Fiber Optic Spectrometer provides optical resolution as good as 0.035 nm (FWHM). The HR2000+ is responsive from 200-1100 nm, but the specific range and resolution depends on your grating and entrance slit selections. With its capability of transferring 1ms spectra continuously, the HR2000+ is the fastest spectrometer available from Ocean Optics.

The HR2000+ is perfect for applications where fast reactions need to be monitored and high resolution is necessary, such as chemistry and biochemistry applications.

Data programmed into a memory chip on each HR2000+ includes wavelength calibration coefficients, linearity coefficients, and the serial number unique to each spectrometer. Our spectrometer operating software simply reads these values from the spectrometer — a feature that enables hot swapping of spectrometers among PCs.

The HR2000+ Spectrometer connects to a notebook or desktop PC via USB port or serial port. When connected to the USB port of a PC, the HR2000+ draws power from the host PC, eliminating the need for an external power supply.
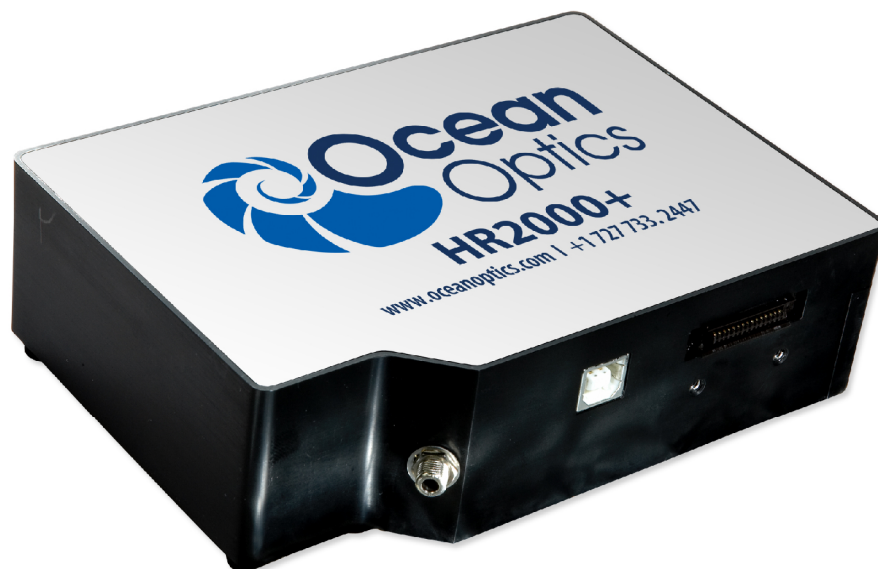
Ocean Optics HR2000+ High-speed Fiber Optic Spectrometer

System Requirements

You can use the HR2000+'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 handheld PCs)
- Ocean Optics SpectraSuite or OOIBase32 software application installed and configured for use with the HR2000+. See *Chapter 2: Installing the HR2000+* for specific configuration instructions.

Alternately, the HR2000+ has serial port adaptability 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 HR2000+, the Breakout Box (HR4-BREAKOUT), and a serial cable.

EEPROM Utilization

An EEPROM memory chip in each HR2000+ contains wavelength calibration coefficients, linearity coefficients, and a serial number unique to each individual spectrometer. The 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.

About SpectraSuite

SpectraSuite is the latest generation of operating software for all Ocean Optics spectrometers. It is a completely modular, Java-based spectroscopy software platform that operates on Windows, Macintosh and Linux operating systems. The software can control any Ocean Optics USB spectrometer and device, as well as any other manufacturer's USB instrumentation using the appropriate drivers.

SpectraSuite is a user-customizable, advanced acquisition and display program that provides a real-time interface to a variety of signal-processing functions. With SpectraSuite, 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. Consult the SpectraSuite manual for hardware requirements when using SpectraSuite (see

Product-Related Documentation).

Sampling System Overview

How Sampling Works

Ocean Optics components function in a sampling system as follows:

1. The user stores reference and dark measurements to correct for instrument response variables.
2. The light 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 SpectraSuite.

7. SpectraSuite 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 HR2000+. 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.

Interface Options

The HR2000+ has both USB and serial port connectors (with the use of an adapter), enabling you to connect the spectrometer to a desktop or notebook PC via a USB port.

Computer Interface	Operating System Requirements	Part Needed	Description of Part
Desktop or Notebook PC via USB Port	Windows 98/Me/ 2000/XP	USB-CBL-1 (included)	Cable that connects from USB port on HR2000+ to USB port on desktop or notebook PC
Desktop or Notebook PC via Serial Port	Any 32-bit Windows operating system	HR4-BREAKOUT (not included)	Adapter block that enables connection from serial port on HR2000+ to serial port on desktop or notebook PC; comes with 5 VDC power supply (required when connecting to serial port). User must supply own software.

Breakout Box

Ocean Optics also offers the Breakout Box (HR4-BREAKOUT), a passive module that separates the signals from their 30-pin port to an array of standard connectors and headers, enabling easy access to a variety of features found in Ocean Optics' HR2000+ Spectrometer. In addition to the accessory connector, the breakout box features a circuit board based on a neutral breadboard pattern that allows custom circuitry to be prototyped on the board itself.

Shipment Components

The following information and documentation ships with the HR2000+ Spectrometer:

❑ **Packing List**

The packing list is inside a plastic bag attached to the outside of the shipment box (the invoice arrives separately). It lists all items in the order, including customized components in the spectrometer (such as the grating, detector collection lens, and slit). The packing list also includes the shipping and billing addresses, as well as any items on back order.

❑ **Spectrometer Installation Instructions**

A sheet of paper that contains the information that you need to get your spectrometer system up and running. Further information can be found on the Ocean Optics *Software and Resources Library* CD (see below).

❑ **Wavelength Calibration Data Sheet**

Each spectrometer is shipped with a Wavelength Calibration Data Sheet that contains information unique to your spectrometer. SpectraSuite reads this calibration data from your spectrometer when it interfaces to a PC via the USB port. Any other interface requires that you manually enter the calibration data in OOIBase32 (select **Spectrometer | Configure | Wavelength Calibration** tab). See the OOIBase32 documentation for more information (refer to *Product-Related Documentation* for instructions on accessing OOIBase32 documentation).

Note

Please save the Wavelength Calibration Data Sheet for future reference.

❑ **Software and Technical Resources CD**

Each order ships with the Ocean Optics *Software and Technical Resources* CD. This disc contains software, operating instructions, and product information for all Ocean Optics software, spectrometers, and spectroscopic accessories. You must have Adobe Acrobat Reader version 6.0 or higher to view these files. Ocean Optics includes the Adobe Acrobat Reader on the *Software and Technical Resources CD*.

Ocean Optics software requires a password during the installation process. You can locate passwords for the other software applications on the back of the *Software and Resources Library* CD package.

Chapter 2

Installing the HR2000+

Overview

You must install the software application prior to connecting the HR2000+ Spectrometer to the PC. The software installation installs the drivers required for HR2000+ installation. If you do not install the software first, the system will not properly recognize the HR2000+.

If you have already connected the HR2000+ to the PC prior to installing the software, consult *Chapter 3: Troubleshooting* for information on correcting a corrupt HR2000+ installation.

HR2000+ Installation

To connect the HR2000+ to a PC via the USB port, the PC must be running the Windows 98/ME/2000/XP operating system.

Note

The USB port on a PC can power up to five HR2000+ spectrometer channels. Systems with more than five channels require a powered USB hub.

► *Procedure*

Follow the steps below to connect the HR2000+ to a PC via the USB port:

1. Install SpectraSuite on the destination computer.
2. Locate the USB cable (USB-CBL-1) provided with the HR2000+.
3. Insert the square end of the cable into the side of the HR2000+.
4. Insert the rectangular end of the cable into the USB port of the PC.

If you installed SpectraSuite prior to connecting the HR2000+, SpectraSuite installs the HR2000+ drivers. If the drivers do not successfully install (or if you connected the HR2000+ to the PC before installing SpectraSuite), consult *Chapter 3: Troubleshooting*.

If you have followed the previous steps and started SpectraSuite, 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.

Note the spectrometer(s) that you have installed are listed in the Data Sources pane.

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

Configuring the HR2000+ with OOIBase32

Once you install the HR2000+ with OOIBase32 software, you must configure OOIBase32's **Configure Spectrometer** options so that OOIBase32 recognizes the HR2000+ Spectrometer. Consult the *OOIBase32 Spectrometer Operating Software Operating Instructions* for detailed instructions on configuring the spectrometer in OOIBase32 (see *Product-Related Documentation*).

The following sections contain instructions on initially configuring the HR2000+ the first time you start OOIBase32. Additional features are available for this spectrometer. See the *OOIBase32 Spectrometer Operating Software Operating Instructions* for detailed information on these HR2000+ features.

Operator and Serial Number Dialog Box

The **Operator and Serial Number** screen prompts you to enter a user name and software serial number into OOIBase32. Some data files created by OOIBase32 during sampling procedures use this information in the file headers.
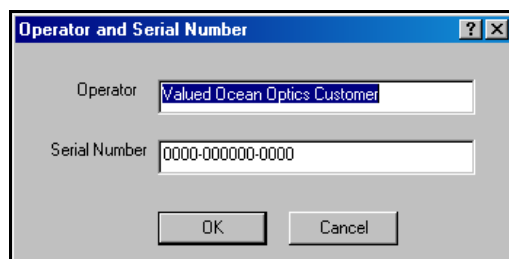
Default Spectrometer Configuration File

The **Default Spectrometer Configuration File** screen prompts you to select a spectrometer configuration (.SPEC) file for use with the HR2000+. The unique serial number of the HR2000+ precedes the file extension (for example, HR2A0162.SPEC).

Navigate to the OOIBase32 installation directory and select the spectrometer configuration file.
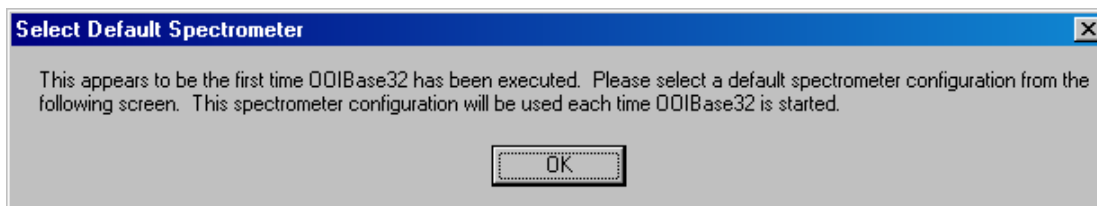
Configure Hardware Screen

The **Configure Hardware** screen prompts you to enter spectrometer-specific information into OOIBase32 the first time you run the program. Typically, you need only enter this information the first time you run OOIBase32. However, you can alter the hardware configuration at any time using the **Spectrometer Configuration** screen. Select **Spectrometer | Configure** from the OOIBase32 menu bar to access the **Spectrometer Configuration** screen.
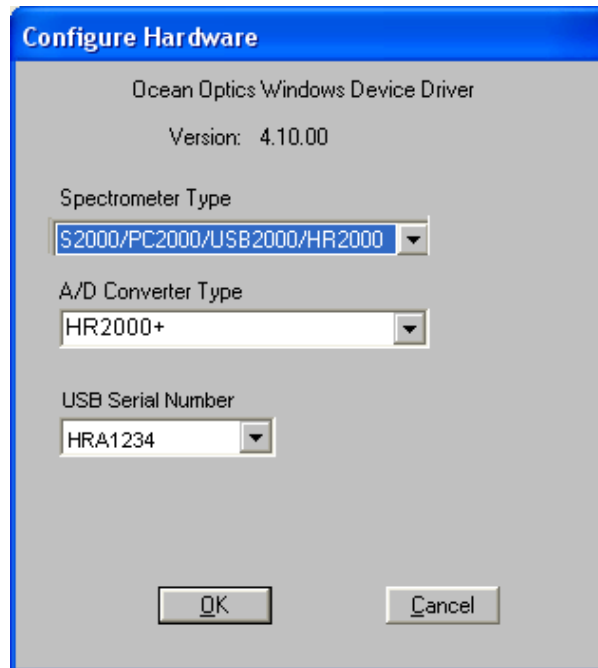
► *Procedure*

To configure hardware in USB Mode:

1. Specify S2000 in the **Spectrometer Type** drop-down menu.

2. Specify HR2000+ in the **A/D Converter Type** drop-down menu.

3. Specify the serial number of the HR2000+ under the **USB Serial Number** drop-down menu.

Note

The system pre-fills this drop-down menu with the serial numbers of all discovered HR2000+ Spectrometers.

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4. Click the **OK** button to accept the selected options.

5. The spectrometer should now be able to acquire data and respond to light. Exit and restart OOIBase32 to save configuration data to disk.

Spectrometer Configuration Screen

The Spectrometer Configuration screen prompts you to configure specific channel-level spectrometer information, if necessary.

► *Procedure*

1. Select **Spectrometer | Configure** from the menu and set system parameters.

2. Select the **Wavelength Calibration** tab. OOIBase32 pre-fills the coefficients for the HR2000+ from information on a memory chip in the spectrometer.

3. Verify that the calibration coefficients match the coefficients from the Wavelength Calibration Data Sheet that accompanied the spectrometer. If necessary, modify these values using the USB Programmer utility.

4. Additionally, ensure that you select both the **Master** and **Channel Enabled** boxes.

5. In the **A/D Interface** tab, enter the same values as in the **Configure Hardware** screen. OOIBase32 stores this information for future use once you close the program.

Connect Spectroscopic Accessories

To find operating instructions for HR2000+-compatible products (such as light sources, sampling chambers, and probes), consult the *Software and Technical Resources* CD or the Ocean Optics website at **http://www.oceanoptics.com/technical/operatinginstructions.asp**.

External Triggering Options

You can trigger the HR2000+ using a variety of External Triggering options through the 30-pin Accessory Connector on the spectrometer. For HR2000+ firmware versions below 3.0, see the External Triggering Options document located at **http://www.oceanoptics.com/technical/external-triggering.pdf**. For HR2000+ firmware version 3.0 and above, see the External Triggering Options document located at ???. The triggering document contains instructions for configuring External Triggering options for the HR2000+.

Troubleshooting

Overview

The following sections contain information on troubleshooting issues you may encounter when using the HR2000+ Spectrometer.

HR2000+ Connected to PC Prior to Software Installation

Windows Operating Systems

If you connected your Ocean Optics USB device to the computer prior to installing your Ocean Optics software application, you may encounter installation issues that you must correct before your Ocean Optics device will operate properly.

Follow the applicable steps below to remove the incorrectly installed device, device driver, and installation files.

Note

If these procedures do not correct your device driver problem, you must obtain the *Correcting Device Driver Issues* document from the Ocean Optics website: **http://www.oceanoptics.com/technical/engineering/correctingdevicedriverissues.pdf**.

Remove the Unknown Device from Windows Device Manager

► *Procedure*

1. Open Windows Device Manager. Consult the Windows operating instructions for your computer for directions, if needed.

2. Locate the **Other Devices** option and expand the **Other Devices** selection by clicking on the "+" sign to the immediate left.

Note

Improperly installed USB devices can also appear under the Universal Serial Bus Controller option. Be sure to check this location if you cannot locate the unknown device.

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3. Locate the unknown device (marked with a large question mark). Right-click on the **Unknown Device** listing and select the **Uninstall** or **Remove** option.

4. Click the **OK** button to continue. A warning box appears confirming the removal of the Unknown Device. Click the **OK** button to confirm the device removal.

5. Disconnect the HR2000+ from your computer.

6. Locate the section in this chapter that is appropriate to your operating system and perform the steps in the following *Remove Improperly Installed Files* section.

Remove Improperly Installed Files

► *Procedure*

1. Open Windows Explorer.

2. Navigate to the **Windows | INF** directory.

Note

If the INF directory is not visible, you must disable the Hide System Files and Folders and Hide File Extensions for Known File Types options in Windows Folder Options. Access Windows Folder Options from Windows Explorer, under the **Tools | Folder Options** menu selection.

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3. Delete the **OOI_USB.INF** in the INF directory. If your computer is running either the Windows 2000 or XP operating system, you must also delete the **OOI_USB.PNF** file in the INF directory.

4. Navigate to the **Windows | System32 | Drivers** directory.

5. Delete the **EZUSB.SYS** file.

6. Reinstall your Ocean Optics application and reboot the system when prompted.

7. Plug in the USB device.

The system is now able to locate and install the correct drivers for the USB device.

Mac Operating Systems

Since there are no device files for the USB2000-FLG Spectrometer in a Mac operating system, you should not encounter any problems if you installed the spectrometer before the SpectraSuite software.

Linux Operating Systems

For Linux operating systems, all you need to do is install the SpectraSuite software, then unplug and replug in the spectrometer. Technically, the driver files for Linux simply give nonprivileged users permission to use newly connected hardware. There isn't any long-term harm to plugging in the device before installing the software.

Older Version of OOIBase32 Installed

If the PC to be used to interface to your HR2000+ already has an older version of OOIBase32 software installed, you must install the latest version of OOIBase32. You can download the latest version of OOIBase32 from the Ocean Optics website at
http://www.oceanoptics.com/technical/softwaredownloads.asp.

You do not need to uninstall previous versions of OOIBase32 when upgrading to the latest version.

Calibrating the Wavelength of the HR2000+

Overview

This appendix describes how to calibrate the wavelength of your spectrometer. 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. Ocean Optics recommends periodically recalibrating the HR2000+.

About Wavelength Calibration

You are going to be solving the following equation, which shows that the relationship between pixel number and wavelength is a third-order polynomial:

$$\lambda_p = I + C_1 p + C_2 p^2 + C_3 p^3$$

Where:

λ = the wavelength of pixel p

I = the wavelength of pixel 0

C_1 = the first coefficient (nm/pixel)

C_2 = the second coefficient (nm/pixel^2)

C_3 = the third coefficient (nm/pixel^3)

R_λ = the reference intensity at wavelength λ

You will be calculating the value for I and the three Cs.

Calibrating the Spectrometer

Preparing for Calibration

To recalibrate the wavelength of your spectrometer, you need the following components:

- A light source capable of producing spectral lines

Note

Ocean Optics' HG-1 Mercury-Argon lamp is ideal for recalibration. If you do not have an HG-1, you need a light source that produces several (at least 4-6) spectral lines in the wavelength region of your spectrometer.

- An HR2000+ spectrometer
- An optical fiber (for spectrometers without a built-in slit, a 50-μm fiber works best)
- A spreadsheet program (Excel or Quattro Pro, for example) or a calculator that performs third-order linear regressions

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Note

If you are using Microsoft Excel, choose **Tools | Add-Ins** and check **AnalysisToolPak** and **AnalysisTookPak-VBA**.

Calibrating the Wavelength of the Spectrometer

► *Procedure*

Perform the steps below to calibrate the wavelength of the spectrometer:

1. Place the software into Scope mode and take a spectrum of your light source. Adjust the integration time (or the A/D conversion frequency) until there are several peaks on the screen that are not off-scale.

2. Move the cursor to one of the peaks and position the cursor so that it is at the point of maximum intensity.

3. Record the pixel number that is displayed in the status bar or legend (located beneath the graph). Repeat this step for all of the peaks in your spectrum.

4. Use the spreadsheet program or calculator to create a table like the one shown in the following figure. In the first column, place the exact or true wavelength of the spectral lines that you used.

   In the second column of this worksheet, place the observed pixel number. In the third column, calculate the pixel number squared, and in the fourth column, calculate the pixel number cubed.

Independent Variable	Dependent Variables			Values Computed from the Regression Output	
True Wavelength (nm)	Pixel #	Pixel #^{2}	Pixel #^{3}	Predicted Wavelength	Difference
253.65	175	30625	5359375	253.56	0.09
296.73	296	87616	25934336	296.72	0.01
302.15	312	97344	30371328	302.40	-0.25
313.16	342	116964	40001688	313.02	0.13
334.15	402	161604	64964808	334.19	-0.05
365.02	490	240100	117649000	365.05	-0.04
404.66	604	364816	220348864	404.67	-0.01
407.78	613	375769	230346397	407.78	0.00
435.84	694	481636	334255384	435.65	0.19
546.07	1022	1044484	1067462648	546.13	-0.06
576.96	1116	1245456	1389928896	577.05	-0.09
579.07	1122	1258884	1412467848	579.01	0.06
696.54	1491	2223081	3314613771	696.70	-0.15
706.72	1523	2319529	3532642667	706.62	0.10
727.29	1590	2528100	4019679000	727.24	0.06
738.40	1627	2647129	4306878883	738.53	-0.13
751.47	1669	2785561	4649101309	751.27	0.19

5. Use the spreadsheet or calculator to calculate the wavelength calibration coefficients. In the spreadsheet program, find the functions to perform linear regressions.

- If using Quattro Pro, look under **Tools | Advanced Math**
- If using Excel, look under **Analysis ToolPak**

6. Select the true wavelength as the dependent variable (Y). Select the pixel number, pixel number squared, and the pixel number cubed as the independent variables (X). After executing the regression, you will obtain an output similar to the one shown below. Numbers of importance are noted.

Regression Statistics

Multiple R	0.999999831
R Square	0.999999663 ← R Squared
Adjusted R Square	0.999999607
Standard Error	0.125540214
Observations	22

Intercept

	Coefficients	Standard Error	
Intercept	190.473993	0.369047536	First coefficient
X Variable 1	0.36263983	0.001684745	
X Variable 2	-1.174416E-05	8.35279E-07	
X Variable 3	-2.523787E-09	2.656608E-10	Second coefficient

Third coefficient

7. Record the Intercept, as well as the First, Second, and Third Coefficients. Additionally, look at the value for R squared. It should be very close to 1. If not, you have most likely assigned one of your wavelengths incorrectly.

Keep these values at hand.

Saving the New Calibration Coefficients: USB Mode

Ocean Optics programs wavelength calibration coefficients unique to each HR2000+ onto an EEPROM memory chip in the HR2000+.

You can overwrite old calibration coefficients on the EEPROM if you are using the HR2000+ via the USB port. If you are using the HR2000+ via the serial port, consult the *Saving the New Calibration Coefficients: Serial Mode* section later in this appendix.

► *Procedure*

To save wavelength calibration coefficients using the USB mode, perform the following steps:

1. Ensure that the HR2000+ is connected to the PC and that you have closed all other applications.

2. Point your browser to **http://www.oceanoptics.com/technical/softwaredownloads.asp** and scroll down to **Microcode**. Select **USB EEPROM Programmer**.

3. Save the setup file to your computer.

4. Run the **Setup.exe** file to install the software. The **Welcome** screen appears.

5. Click the **Next** button. The **Destination Location** screen appears.

6. Accept the default installation location, or click the **Browse** button to specify a directory. Then, click the **Next** button. The **Program Manager Group** screen appears.

7. Click the **Next** button. The **Start Installation** screen appears.

8. Click the **Next** button to begin the installation. Once the installation finishes, the **Installation Complete** screen appears.

9. Click the **Finish** button and reboot the computer when prompted.

10. Navigate to the **USB EEPROM Programmer** from the Start menu and run the software.

11. Click on the desired HR2000+ device displayed in the left pane of the **USB Programmer** screen.

12. Double-click on each of the calibration coefficients displayed in the right pane of the USB Programmer screen and enter the new values acquired in Steps 5 and 6 of the *Calibrating the Wavelength of the Spectrometer* section in this appendix.

13. Repeat Step 12 for all of the new values.

14. Click on the **Save All Values** button to save the information, and then **Exit** the USB Programmer software.

The new wavelength calibration coefficients are now loaded onto the EEPROM memory chip on the HR2000+.

Saving the New Calibration Coefficients: Serial Mode

If you are connecting the HR2000+ Spectrometer to the serial port of the PC, you need to save the new wavelength calibration coefficients to the **.**SPEC file that OOIBase32 accesses when opened.

Note

You cannot save the calibration coefficients to the EEPROM memory chip on the HR2000+ when using the serial mode.

► *Procedure*

To save Wavelength Calibration Coefficients using the Serial mode, perform the following steps:

1. Open the OOIBase32 application.

2. Select **Spectrometer | Configure** from the OOIBase32 menu bar. The **Configure Spectrometer** screen appears.

3. Select the **Wavelength Calibration** tab to update the wavelength coefficients within OOIBase32.

4. Enter in the new values acquired from Steps 5 and 6 of the *Calibrating the Wavelength of the Spectrometer* section in this appendix.

5. Click the **OK** button to save the information in OOIBase32.

Specifications

Overview

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

How the HR2000+ Works

Below is a diagram of how light moves through the optical bench of an HR2000+ Spectrometer. The optical bench has no moving parts that can wear or break; all the components are fixed in place at the time of manufacture. Items with an asterisk (*) are user-specified.
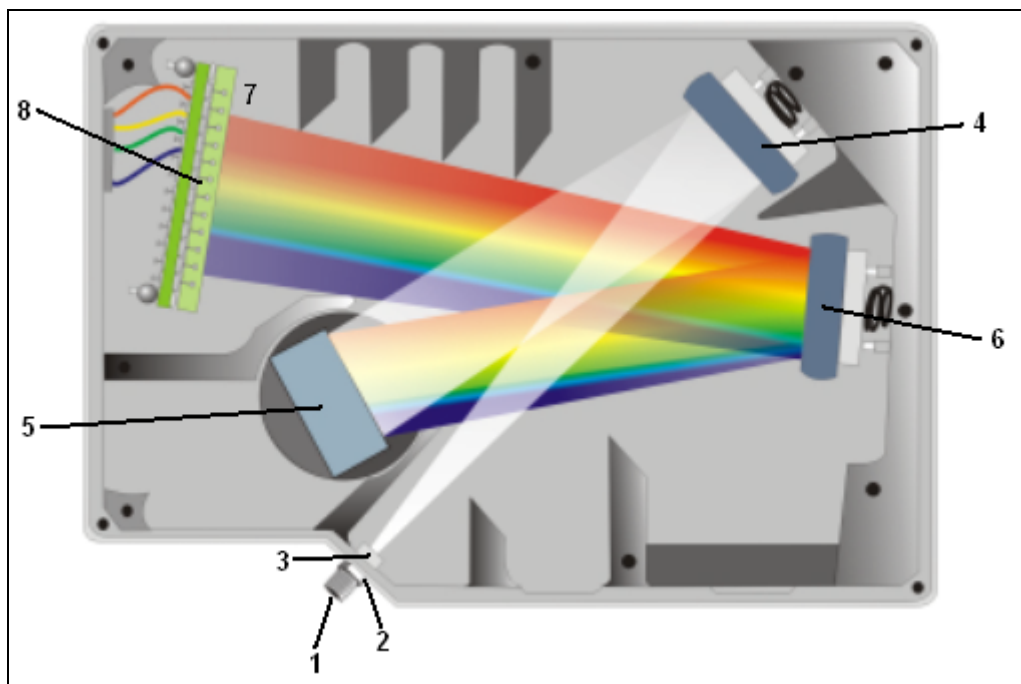
HR2000+ Spectrometer with Components

See *HR2000+ Components Table* on the following page for an explanation of the function of each numbered component in the HR2000+ Spectrometer in this diagram.

HR2000+ Components Table

Ocean Optics permanently secures all components in the HR2000+ at the time of manufacture. Only Ocean Optics technicians can replace interchangeable components, where noted.

Item	Name	Description
1	SMA Connector	Secures the input fiber to the spectrometer. Light from the input fiber enters the optical bench through this connector.
2	Slit	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 HR2000+ without a Slit. In this configuration, the diameter of the fiber connected to the HR2000+ determines the size of the entrance aperture. Only Ocean Optics technicians can change the Slit.
3	Filter	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	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	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	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	An optional component that 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)	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.

HR2000+ Specifications

The following sections provide specification information for the CCD detector in the HR2000+, as well as the HR2000+ Spectrometer itself. HR2000+CG-UV-NIR specifications are listed in *Appendix C:* **Error! Reference source not found.**.

CCD Detector Specifications

Specification	Value
Detector	Sony ILX-511B linear silicon CCD array
No. of elements	2048 pixels
Sensitivity	75 photons per count at 400 nm 41 photons per count at 600 nm
Pixel size	14 µm x 200 µm
Pixel well depth	65 Ke-
Signal-to-noise ratio	250:1 (at full signal)
A/D resolution	14 bit
Dark noise	3.2 RMS counts
Corrected linearity	>99.8%
Maximum pixel rate	Rate at which pixels are digitized is 1 MHz

HR2000+ Spectrometer

Specification	Value
Dimensions	148.6 mm x 104.8 mm x 45.1 mm
Weight	570 g
Power consumption	220 mA @ 5 VDC
Detector	2048-element linear silicon CCD array
Detector range	200-1100 nm
Gratings	14 gratings available

Specification	Value
Entrance aperture	5, 10, 25, 50, 100 or 200 µm wide slits
Order-sorting filters	Installed longpass and bandpass filters
Focal length	f/4, 101 mm
Optical resolution	Depends on grating and size of entrance aperture
Stray light	<0.05% at 600 nm; <0.10% at 435 nm
Dynamic range	2×10^8 (system); 1300:1 for a single acquisition
Fiber optic connector	SMA 905 to single-strand optical fiber (0.22 NA)

Data transfer rate:
   USB 2.0 Port
   Serial Port
	
	Full scans into memory every 1 millisecond
	Full scans into memory every 600 milliseconds

Integration time	1 ms to 65 seconds
Interfaces	USB 2.0, 480 Mbps (USB 1.1 compatible); RS-232 (2-wire); SPI (3-wire); I^2C Inter-Integrated Circuit 2-wire serial bus

Operating systems:
   USB Port
   Serial Port
	
	Windows 2000/XP, Mac OS X, and Linux
	Any 32-bit Windows operating system

Onboard GPIO	10 user-programmable digital I/Os
Analog channels	One 13-bit analog input and one 9-bit analog output

System Compatibility

The following sections provide information on hardware and software requirements for the HR2000+.

Compatibility for Desktop or Notebook PCs

To use the HR2000+, you must have a PC that meets the following minimum requirements:

- Operating systems: Windows 2000/XP, Mac OS X, or Linux with USB port; any 32-bit or 64-bit Windows OS with serial port
- Computer interfaces: USB 2.0 @ 480 Mbps; RS-232 (2-wire) @ 115.2 K baud
- Peripheral interfaces: I^2C inter-integrated circuit
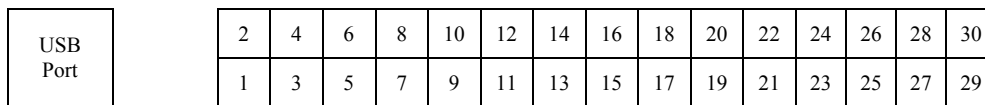
30-Pin Accessory Connector Pinout

The HR2000+ features a 30-pin Accessory Connector, located on the side of the unit as shown:

Location of HR2000+ 30-Pin Accessory Connector

30-Pin Accessory Connector Pinout Diagram

When facing the 30-pin Accessory Connector on the front of the vertical wall of the HR2000+, pin numbering is as follows:

USB Port		2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
		1	3	5	7	9	11	13	15	17	19	21	23	25	27	29

30-Pin Accessory Connector Pinout Diagram

30-Pin Accessory Connector – Pin Definitions and Descriptions

The following table contains information regarding the function of each pin in the HR2000+'s 30-Pin Accessory Connector:

Pin #	Function	Input/Output	Description
1	RS232 Rx	Input	RS232 receive signal – Communicates with a PC over DB9 Pin 3
2	RS232 Tx	Output	RS232 transmit signal – Communicates with a PC over DB9 Pin 2
3	GPIO (2)	Input/Output	General purpose software-programmable, digital input/output (channel number) Reserved
4	V5_SW	Output	Regulated 5 Volt power pin – Supplies 50 mA (maximum)

Pin #	Function	Input/Output	Description
5	Ground	Input/Output	Ground
6	I²C SCL	Input/Output	I²C clock signal for communication to other I²C peripherals
7	GPIO (0)	Input/Output	General purpose software-programmable, digital input/output (channel number) Reserved
8	I²C SDA	Input/Output	I²C data signal for communication to other I²C peripherals
9	GPIO (1)	Input/Output	General purpose software-programmable, digital input/output (channel number) Reserved
10	Ext. Trigger In	Input	TTL input trigger signal – See External Triggering Options document for information.
11	GPIO (3)	Input/Output	General purpose software-programmable, digital input/output (channel number) Reserved
12	V_{CC}, V_{USB}, or $5V_{IN}$	Input or Output	Input power pin for HR2000+ – When operating via USB, this pin can power other peripherals – Ensure that peripherals comply with USB specifications
13	Reserved	Output	Reserved
14	V_{CC}, V_{USB}, or $5V_{IN}$	Input or Output	Input power pin for HR2000+ – When operating via USB, this pin can power other peripherals – Ensure that peripherals comply with USB specifications
15	Reserved	Input	Reserved
16	GPIO (4)	Input /Output	General purpose software-programmable, digital input/output (channel number) Reserved
17	Single Strobe	Output	TTL output pulse used as a strobe signal – Has a programmable delay relative to the beginning of the spectrometer integration period
18	GPIO (5)	Input/Output	General purpose software-programmable, digital input/output (channel number) Reserved
19	Reserved	Output	Reserved
20	Continuous Strobe	Output	TTL output signal used to pulse a strobe – Divided down from the master clock signal
21	SPI Chip Select	Output	SPI Chip/Device Select signal for communication to other SPI peripherals

Pin #	Function	Input/Output	Description
22	GPIO (6)	Input/Output	General purpose software-programmable, digital input/output (channel number) Reserved
23	Analog In (0-5V)	Input	13-bit analog-to-digital input with a 0-5V range. For future use.
24	Analog Out (0-5V)	Output	9-bit programmable output voltage with a 0-5V range
25	Lamp Enable	Output	TTL signal driven Active HIGH when the Lamp Enable command is sent to the spectrometer
26	GPIO (7)	Input/Output	General purpose software-programmable, digital input/output (channel number) Reserved
27	Ground	Input/Output	Ground
28	GPIO (8)	Input/Output	General purpose software-programmable, digital input/output (channel number) Reserved
29	Ground	Input/Output	Ground
30	GPIO (9)	Input/Output	General purpose software-programmable, digital input/output (channel number) Reserved

30-Pin J2 Accessory Connector - Part Numbers

The part numbers for the 30-pin accessory connector on the HR2000+ Spectrometer are as follows:

- The connector is Pak50™ model from 3M Corp. Headed Connector – Part Number **P50–030P1–RR1–TG**.
- The mating connector is Part Number **P50–030S–TGF**.
- Mating the two components requires two 1.27 mm (50 mil) flat ribbon cables (3M 3365 Series is recommended).

If you are customizing your HR2000+ Spectrometer system or configuring External Triggering, you may need these part numbers to complete your setup.

HR2000+ 15-Pin Accessory Cable Pinout

Pin #	Description	Pin #	Description
1	Single_strobe	9	GPIO-9
2	ContStrobe	10	GND_SIGNAL
3	V5_SW	11	SDA
4	ExtTrigIn	12	SCL
5	ExtTrigIn	13	LampEnable
6	GPIO-8	14	A_IN
7	A_OUT	15	GPIO-7
8	ExtTrigIn		

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