



## **NIR Near Infrared Fiber Optic Spectrometers**

# **Installation and Operation Manual**

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# About This Manual

## Document Purpose and Intended Audience

This document provides you with instructions to get your system up and running. In addition to the NIR Spectrometer installation and operation instructions, this manual also includes information for locating the SpectraSuite installation instructions (see [Product-Related Documentation](#) below).

## What's New in this Document

This version of the *NIR Near Infrared Fiber Optics Spectrometers Installation and Operation Manual* adds SpectraSuite information and updates the contact list. It also includes information about our service packages available for NIR spectrometers.

## Document Summary

Chapter	Description
Chapter 1: <a href="#">Introduction</a>	Introduces the product features. Also contains a list of items included in the shipment.
Chapter 2: <a href="#">Installing the NIR Spectrometer</a>	Contains information for installing and configuring your NIR Spectrometer. These instructions include information on using your NIR Spectrometer with the spectrometer operating software.
Chapter 3: <a href="#">Troubleshooting</a>	Contains typical problems and suggested resolutions.
Appendix A: <a href="#">Calibrating the Wavelength of the NIR Spectrometer</a>	Contains instructions for calibrating your NIR Spectrometer.
Appendix B: <a href="#">Specifications</a>	Contains technical specifications for the NIR Spectrometer and the NIR Detector.
Appendix C: <a href="#">NIR256-2.5<math>\mu</math>m Sensitivity</a>	Provides some additional sensitivity specifications for the NIR256-2.5 Spectrometer.

## 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>

You can also access operating instructions for Ocean Optics products on the *Software and Technical Resources* CD included with the system.

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

## 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.

## Service

Our Total Technical Service protection plans protect your spectrometer for one year for any contingency - no matter what the circumstances, including total loss. Under these plans, Ocean Optics will repair or replace your instrument with no deductible or any other out-of-pocket expense required from you. NIR service plans include the following:

- **TTS-NIR:** Protects your Ocean Optics NIR spectrometer for any contingency for 1 year. Provides for full spectrometer replacement, if necessary. Limited to 1 full replacement per year.
- **TTS-NIR-E:** This special plan for Ocean Optics NIR spectrometers not previously covered protects for any contingency for 1 year. Provides for full spectrometer replacement, if necessary. Limited to 1 full replacement per year. This coverage starts 30 days after purchasing the plan.

# Introduction

## Product Description

The NIR (Near Infrared) Fiber Optic Spectrometer connects to a notebook or desktop PC via a USB port. It requires an external +5VDC power supply (USB-CBL-PS) to power the spectrometer's high-performance InGaAs array detector. The NIR Spectrometer and the 16-bit A/D converter share a single housing, forming a small-footprint plug-and-play system.

The NIR Spectrometer can connect via the USB port to any PC that uses a Windows 98/Me/2000/XP operating system and has spectrometer operating software installed and configured for use with your NIR Spectrometer. Furthermore, the NIR Spectrometer has a serial port for interfacing to PCs, PLCs, and other devices that support the RS-232 communication protocol.

An EEPROM memory chip in each NIR Spectrometer contains wavelength calibration coefficients, linearity coefficients, and the serial number unique to each spectrometer. Ocean Optics OOIBase32 or SpectraSuite spectrometer operating software reads these values from the spectrometer, which allows "hot-swapping" of spectrometers among multiple PCs.

As with all other Ocean Optics user-configured spectrometers, you can choose from six slit sizes and hundreds of fiber optic accessories (such as light sources, probes, and optical fibers) to create the system just right for your application.



## About the Modular Approach

Ocean Optics fiber optic spectrometer systems are based on low-cost, modular data acquisition principles. A typical NIR Spectrometer system contains four basic elements:

- The NIR Spectrometer
- The Ocean Optics spectrometer operating software
- A light (excitation source)
- A variety of sampling optics (depending on application need)

The light (excitation source) sends light through an optical fiber to the sample. The light interacts with the sample, and the results of that interaction are collected and transmitted through another optical fiber to the spectrometer. The spectrometer measures the amount of light and transforms the data collected by the spectrometer into digital information. Finally, the spectrometer passes that information to the operating software.

### Software

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](#)).

OOIBase32 software has been discontinued, but still functions with the NIR spectrometers. Consult the OOIBase32 manual for hardware requirements when using OOIBase32 (see [Product-Related Documentation](#)).

### Accessories

Ocean Optics also offers a complete line of spectroscopic accessories to use with the NIR Spectrometer. Most spectroscopic accessories have SMA connectors for application flexibility. Thus, changing the sampling system is as easy as unscrewing a connector and adding a new component or accessory. A partial list of Ocean Optics spectroscopic accessories includes light sources, sampling holders, filter holders, flow cells, fiber optic probes and sensors, collimating lenses, attenuators, diffuse reflectance standards, integrating spheres and an extensive line of optical fibers.

This modular approach, where components are easily mixed and matched, offers remarkable applications flexibility. You can select from hundreds of products to create distinctive systems for an almost endless variety of optical-sensing applications.



# Interface Options

Because the NIR Spectrometer has both a USB and a serial port, you can connect the NIR Spectrometer to a desktop or notebook PC via a USB port or to a desktop or notebook PC via a serial port.

Computer Interface	Operating System Requirements	Cable Needed	Description of Cable
Desktop or Notebook PC via USB Port	Windows 98/Me/2000/XP	USB-CBL-1 (included)	Cable connects from USB port on NIR Spectrometer to USB port on desktop or notebook PC
Desktop or Notebook PC via Serial Port	Any 32-bit Windows operating system	ADC-USB-SER (not included)	Cable connects from serial port on NIR Spectrometer to serial port on desktop or notebook PC

# Items Included with Shipment

Important information and documentation accompany your NIR Spectrometer upon shipment. This includes:

- ❑ Packing List – The packing list is located inside a plastic bag attached to the outside of the shipment box (the invoice is mailed separately). The items listed on the packing slip include all of the components in the order, including customized items installed in the spectrometer, such as the slit. The packing list also includes important information, such as the shipping and billing addresses, as well as any components on back order.
- ❑ Wavelength Calibration Data Sheet – Each spectrometer is shipped with a Wavelength Calibration Data Sheet that contains information unique to your spectrometer. SpectraSuite Operating Software 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).

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### Note

Please save the Wavelength Calibration Data Sheet for future reference.

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- ❑ Software and Resources Library CD – Each spectrometer order comes with Ocean Optics’ *Software and Resources Library* CD. This disc contains all Ocean Optics software and manuals for software operation, spectrometers, and spectroscopic accessories. Documentation is provided in Portable Document Format (PDF). You need Adobe Acrobat Reader version 6.0 or higher to view these files. Adobe Acrobat Reader is included on the CD.

Passwords for software applications can be found on the back of the *Software and Resources Library* CD package.



# Installing the NIR Spectrometer

## Overview

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

If you have already connected the NIR Spectrometer to the PC prior to installing the software, consult Chapter 3: [Troubleshooting](#) for information on correcting a corrupt NIR Spectrometer installation.

Once you have properly installed the spectrometer, refer to either the SpectraSuite or OOIBase32 operating instructions for information on taking measurements.

## NIR Spectrometer Installation

This section contains instructions for connecting the NIR Spectrometer via both USB and serial modes.

### USB Mode

Follow the steps in this section to interface the NIR Spectrometer via the USB port to a desktop or notebook PC.

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

#### ► **Procedure**

1. Install spectrometer operating software on the destination computer, and then reboot the system.
2. Plug the +5VDC wall adapter (USB-CBL-PS) into an electrical outlet, then connect the power cord to the 2.5 mm power jack (older versions may have a 1.3 mm power jack) on the rear of the NIR Spectrometer.
3. Locate the USB cable (USB-CBL-1) that came with the NIR Spectrometer.

## 2: Installation

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4. Insert the square end of the cable into the rear of the NIR Spectrometer, and then insert the rectangular end into the USB port of the computer.

If the software was installed prior to connecting the NIR Spectrometer, the **Add New Hardware Wizard** appears and installs the NIR Spectrometer drivers. If the drivers do not successfully install, or if you connected the NIR Spectrometer to the computer before installing the software, consult Chapter 4: [Troubleshooting](#).

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### Note

Windows XP users may encounter a **Hardware Installation** warning window regarding Windows XP driver testing. Click the **Continue Installation** button at this screen, as this is an expected warning.

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## Serial Port Mode

To use the serial port capacity of the NIR Spectrometer, the PC must be running a 32-bit version of the Windows operating system.

### ► Procedure

Follow the steps below to connect the NIR Spectrometer to the PC via serial port:

1. Connect one end of the serial cable to the RS-232 connector on the rear of the NIR Spectrometer, and then connect the other end to a serial port on the PC.
2. Note the serial port number (also called COM Port) on the PC to which the NIR Spectrometer is connected (some PCs may not have numbered ports).
3. Plug the +5VDC wall adapter (USB-CBL-PS) into an electrical outlet, then connect the power cord to the 2.5 mm power jack (older versions may have a 1.3 mm power jack) on the rear of the NIR Spectrometer.

The NIR Spectrometer is now connected to the PC's serial port.

---

### Note

Connecting the spectrometer to the PC's serial port requires that you manually enter the calibration coefficients from the Wavelength Calibration Data Sheet into OOIBase32 software (select **Spectrometer** | **Configure** | **Wavelength Calibration** tab). See the OOIBase32 documentation for more information (refer to [Product-Related Documentation](#) for instructions on accessing OOIBase32 documentation).

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# Configuring the NIR Spectrometer

The NIR spectrometer can be used with either SpectraSuite or OOIBase32 software when connected to the USB port. The configuration process differs, depending on whether you are running SpectraSuite or OOIBase32 software.

## Configuring the NIR Spectrometer in SpectraSuite

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.

## Configuring the NIR Spectrometer in OOIBase32

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

# Connect Spectroscopic Accessories

To find operating instructions on NIR Spectrometer-compatible products such as light sources, sampling chambers, probes, fibers or any other Ocean Optics spectroscopic accessories, check the *Software and Technical Resources* CD or the Ocean Optics website at:

<http://www.oceanoptics.com/Technical/OperatingInstructions.asp>.

Chapter 1: [Introduction](#) contains a list of NIR Spectrometer-compatible products. You can find information related to these products on <http://www.oceanoptics.com/>.

# External Triggering Options

You can trigger the NIR Spectrometer using the External Software Triggering option through the 15-pin accessory connector on the spectrometer. Only the External Software Trigger mode is available with the NIR Spectrometer.

The External Triggering Options document contains instructions on configuring External Triggering with the NIR Spectrometer. The External Triggering Options document is located at the following web site:

<http://www.oceanoptics.com/technical/externaltriggering.PDF>

## 2: Installation

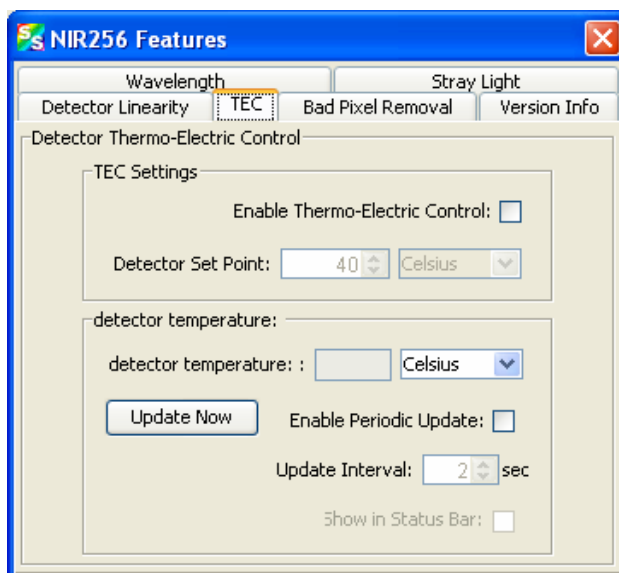
If you do not have web access, you can retrieve this document from the Software and Technical Resources CD included with your spectrometer shipment.

# NIR Controls

There are a number of controls for the NIR Spectrometer that are available in through the spectrometer operating software. The software differs as to where these controls are located.

## SpectraSuite NIR Spectrometer Features

Select Spectrometer | Spectrometer Features, then select the TEC tab to display the NIR Spectrometer controls.



Control	Description
Enable Thermo-Electric Control	Check this box to enable (recommended setting for laboratory conditions) or uncheck to disable the thermoelectric cooler.
Detector Set Point	Enter the target temperature of the NIR Spectrometer detector as follows: <ul style="list-style-type: none"> <li>NIR512: Minimum is <math>-10\text{ }^{\circ}\text{C}</math>, Recommended is <math>-5\text{ }^{\circ}\text{C}</math></li> <li>NIR256: Minimum is <math>-15\text{ }^{\circ}\text{C}</math>, Recommended is <math>-10\text{ }^{\circ}\text{C}</math></li> </ul> The TEC and fans will operate until the detector reaches this temperature.
Detector temperature	Displays the current temperature of the detector in the NIR Spectrometer.

Control	Description
Enable Periodic Update	Check this box to enable periodic update of the NIR detector temperature controls.
Update Interval	If you enabled periodic updates, enter the interval period (in seconds).
Show in Status Bar	Check this box to display the detector temperature in the status bar.

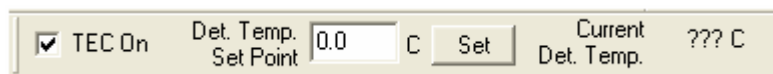
## NIR Toolbar in OOIBase32

The NIR toolbar in OOIBase32 allows you to control a variety of options on the NIR Spectrometer. These options are also applicable to the NIR256.

### Note

If the NIR512 Toolbar in your version of OOIBase32 does not have the options listed below, you should upgrade your version of OOIBase32 to the latest release.

Visit <http://www.oceanoptics.com/technical/softwaredownloads.asp> to obtain the latest software version.



Control	Description
TEC On	Check this box to enable (recommended setting for laboratory conditions) or uncheck to disable the thermoelectric cooler.
Det. Temp. Set Point	Enter the target temperature of the NIR Spectrometer detector as follows: <ul style="list-style-type: none"> <li>NIR512: Minimum is <math>-10</math> °C, Recommended is <math>-5</math> °C</li> <li>NIR256: Minimum is <math>-15</math> °C, Recommended is <math>-10</math> °C</li> </ul> The TEC and fans will operate until the detector reaches this temperature.
Apply	Click this button to apply the changes made in this toolbar to the NIR Spectrometer.
Current Det. Temp.	Displays the current temperature of the detector in the NIR Spectrometer.





# Troubleshooting

## Overview

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

## NIR Spectrometer Connected to Computer Prior to Operating Software

### Windows Operating Systems

If you connected your NIR Spectrometer to the computer prior to installing your Ocean Optics software application (SpectraSuite or OOIBase32), 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.

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#### 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>.

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## 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.

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### 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 NIR Spectrometer 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.

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### 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 NIR 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.

# Troubleshooting the Serial Port Configuration

Occasionally, you may encounter problems with the serial port connection and/or software. Perform the following procedure to troubleshoot the serial port connection.

► **Procedure**

1. Cycle the power on the NIR Spectrometer and restart the OOIBase32 software. This ensures that the software and the hardware synchronize properly.
2. Determine the serial port (COM port) number:

Operating System	Instructions
Windows 95/98/ME/XP	<ol style="list-style-type: none"> <li>1. Right-click on <b>My Computer</b></li> <li>2. Select <b>Properties</b></li> <li>3. Click the <b>Device Manager</b> tab</li> </ol>

### 3:Troubleshooting

Operating System	Instructions
Windows 2000	<ol style="list-style-type: none"> <li>1. Select <b>Start   Settings   Control Panel   System</b></li> <li>2. Select the <b>Hardware</b> tab</li> <li>3. Click the <b>Device Manager</b> button.</li> </ol>
Windows NT	Select <b>Start   Programs   Administrative Tools (common) NT Diagnostics</b>

3. Double-click on the **Ports (COM & LPT)** option to display COM port numbers. Ensure that no warning icon appears next to the NIR Spectrometer's COM port.
4. Verify that the NIR Spectrometer's COM port is active. If the ports on the PC are not labeled and you do not know the COM port number, use trial-and-error to find the correct COM port. Open OOIBase32 and view the displayed graph. If the correct COM port is selected, you will see a dynamic trace responding to light near the bottom of the graph. If the correct COM port is not selected, you will see a straight line at zero counts.
5. Disable virus protection to ensure timely and complete data transfer (optional – some computers require this step).

## Old Version of OOIBase32 Installed

If the PC to be used to interface to your NIR Spectrometer 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 *Software and Technical Resources* CD or 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 NIR Spectrometer

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.

## 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:

$\lambda$  = 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<sup>2</sup>)

$C_3$  = the third coefficient (nm/pixel<sup>3</sup>)

You will be calculating the value for  $I$  and the three  $C$ s.

## Calibrating the Spectrometer

### Preparing for Calibration

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

## A: Calibrating the Wavelength of the Spectrometer

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- A light source capable of producing spectral lines.  
Ocean Optics' AR-1 Argon lamp or HG-1 Mercury-Argon lamp are ideal for this purpose. If you do not have an AR-1 or HG-1, you will need a spectral line source that produces several (at least 4-6) spectral lines in the wavelength region of your spectrometer.
- The NIR Spectrometer.
- An optical fiber (for spectrometers without a built-in slit, a 50- $\mu\text{m}$  fiber works best).
- A spreadsheet program (Excel or Quattro Pro, for example) or a calculator that performs third-order linear regressions.
- 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 OOIBase32 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 # <sup>2</sup>	Pixel # <sup>3</sup>	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

- Use your spreadsheet or calculator to calculate the wavelength calibration coefficients. In your 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**
- 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 you execute the regression, an output similar to the one shown below is obtained.

**Regression Statistics**

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

	<b><u>Coefficients</u></b>	<b><u>Standard Error</u></b>	
Intercept	190.473993	0.369047536	← first coefficient
X Variable 1	0.36263983	0.001684745	←
X Variable 2	-1.174416E-05	8.35279E-07	← second coefficient
X Variable 3	-2.523787E-09	2.656608E-10	← third coefficient

The numbers of importance are indicated in the above figure.

## A: Calibrating the Wavelength of the Spectrometer

---

7. Record the Intercept as well as the First, Second, and Third Coefficients. Also, look at the value for R squared. It should be *very* close to one. If it is not, you have probably assigned one of your wavelengths incorrectly. Keep these values at hand.

# Saving the New Calibration Coefficients: USB Mode

Wavelength calibration coefficients unique to each NIR Spectrometer are programmed into an EEPROM memory chip on the NIR Spectrometer.

You can save over old calibration coefficients with new ones and the spectrometer operating software can read these coefficients, *but only if you are using the NIR Spectrometer via the USB port*. If you are using the NIR Spectrometer via the serial port, see the [Saving the New Calibration Coefficients: Serial Mode](#) section later in this Appendix.

### ► Procedure

To Save Wavelength Calibration Coefficients Using the USB Mode

1. Ensure that the NIR Spectrometer is connected to the PC and that no other applications are running.
2. Point your browser to <http://www.oceanoptics.com/technical/softwaredownloads.asp> and scroll down to Microcode. Double-click on **USB EEPROM Programmer**.
3. Save the setup file to your computer.
4. Run the **Setup.exe** file to install the software
5. At the **Welcome** screen, click the **Next** button.
6. At the **Destination Location** screen, accept the default or click the **Browse** button to pick a directory. Then, click the **Next** button.
7. Select a Program Manager Group and click the **Next** button. The Start Installation screen appears. Click the **Next** button.
8. Click the **Finish** button when the Installation Complete screen appears.
9. Reboot the computer when prompted.
10. Navigate to USB EEPROM Programmer and open the software.
11. Click on the NIR Spectrometer device, located 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.



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

## Saving the New Calibration Coefficients: Serial Mode

If you are interfacing the NIR Spectrometer to your PC via the serial cable, you need to save the 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 NIR Spectrometer when using the serial mode.

---

### ► Procedure

To save Wavelength Calibration Coefficients using the Serial mode:

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.



---

## Appendix B

# Specifications

## How the Spectrometer Works

Light passes through the NIR Spectrometer through a fixed optical path. The optical bench of the NIR Spectrometer has no moving parts that can wear or break; all the components are fixed in place at the time of manufacture.

The following table describes each component in the NIR Spectrometer. Items marked with an asterisk (\*) can be user-specified (consult an Applications Scientist for more information):

### NIR Spectrometer Component Table

Name	Description
SMA Connector	Light from a fiber enters the optical bench through the SMA connector.
Slit*	Light passes through the installed slit, which acts as the entrance aperture. Entrance slits are rectangular apertures, with the width determining the amount of light entering the optical bench. A slit is permanent and can only be changed by an Ocean Optics technician.  You can also use the NIR Spectrometer without a slit installed. In this case, the diameter of the fiber connected to the NIR Spectrometer determines the size of the entrance aperture.
Installed Filter*	Light passes through a filter installed in the SMA connector. Both bandpass and longpass filters are available to restrict radiation to certain wavelength regions. Filters are permanently installed in the bulkhead of the SMA connector.
Collimating Mirror	Light coming in from the entrance aperture reflects from this mirror, as a collimated beam, toward the grating.
Grating*	Light is diffracted by the fixed grating and directed to the focusing mirror. Instead of the grating rotating (as it does in scanning monochromators and other instruments), the grating in the NIR Spectrometer is fixed in place at the time of manufacture.
Focusing Mirror	Diffracted light hits this second mirror, which reflects and focuses the light on the detector array.

## B: Specifications

Name	Description
InGaAs Detector	Each pixel on the detector responds to the wavelength of light that strikes it. Electronics bring the complete spectrum to the software.

## NIR Detector Specifications

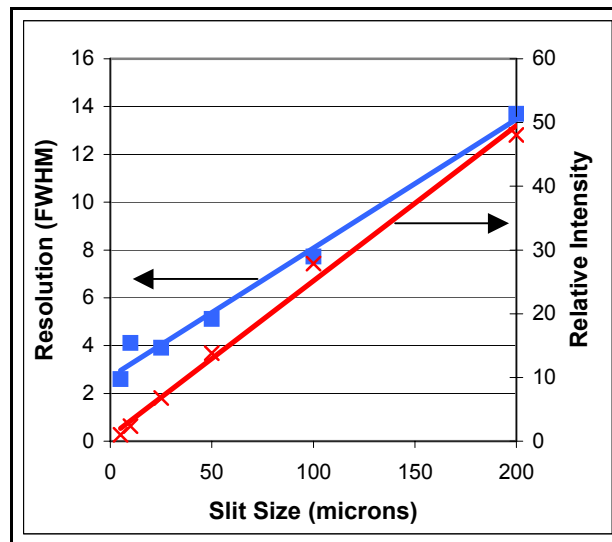
	NIR512	NIR256-2.1	NIR256-2.5
Detector	Hamamatsu G9204 512-element InGaAs cooled array	Hamamatsu G9206 256-element InGaAs cooled array	Hamamatsu G9208 256-element InGaAs cooled array
Number of elements	512 pixels	256 pixels	256 pixels
Detector temperature specifications	Cooling 30 °C below ambient, stable temperature to within $\pm .1$ °C	Cooling 40 °C below ambient, stable temperature to within $\pm .1$ °C	
Responsivity range	0.85 – 1.7 $\mu$ m	0.9 – 2.05 $\mu$ m	0.9 – 2.55 $\mu$ m
Responsivity peak	1.6 $\mu$ m	1.95 $\mu$ m	2.3 $\mu$ m
Pixel size	25 $\mu$ m x 500 $\mu$ m	50 $\mu$ m x 250 $\mu$ m	50 $\mu$ m x 250 $\mu$ m
Pixel well depth	187,000,000 electrons		
Dark signal RMS <sup>1</sup>	<12 counts	<14 counts	<14 counts
Defective pixels <sup>2</sup>	None Max Dark Current = 60pA at 25 °C	2% Max Dark Current = 120pA at -20 °C	5% Max Dark Current = 2000pA at 25 °C
Signal-to-noise ratio	4000:1 at full signal		
Above zero integration Time <sup>3</sup>	1000 msec	N/A	N/A

### Notes:

1. Does not include first or last pixels.
2. Defective Pixels are specified at the specific test conditions.
3. As integration time increases, the dark value of a pixel may decrease. The "Above Zero Integration Time" figure is the maximum integration time at which all pixels have a dark value greater than zero A/D counts. Longer integration times are possible if these pixel values are ignored or interpolated.

# NIR Spectrometer – Slit Size vs. Resolution and Throughput

The following chart illustrates the effect that varying slit sizes have on NIR512 Spectrometer resolution and throughput:

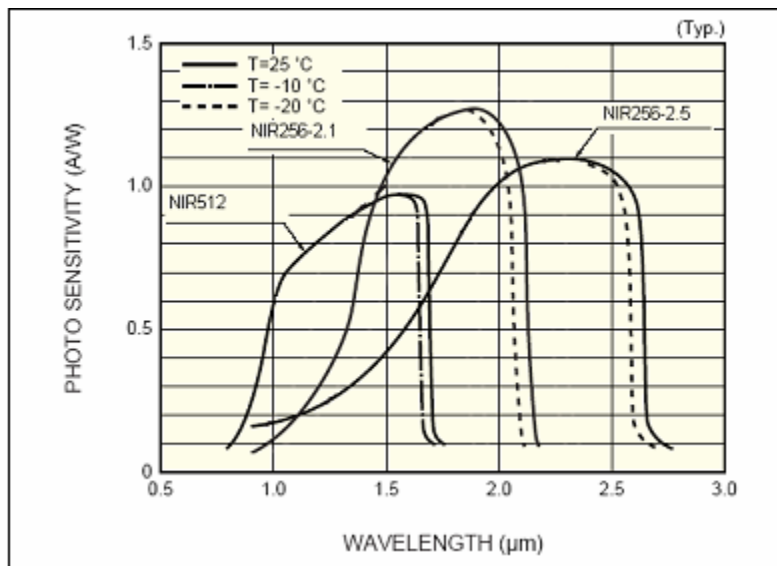


## NIR Spectrometer Specifications

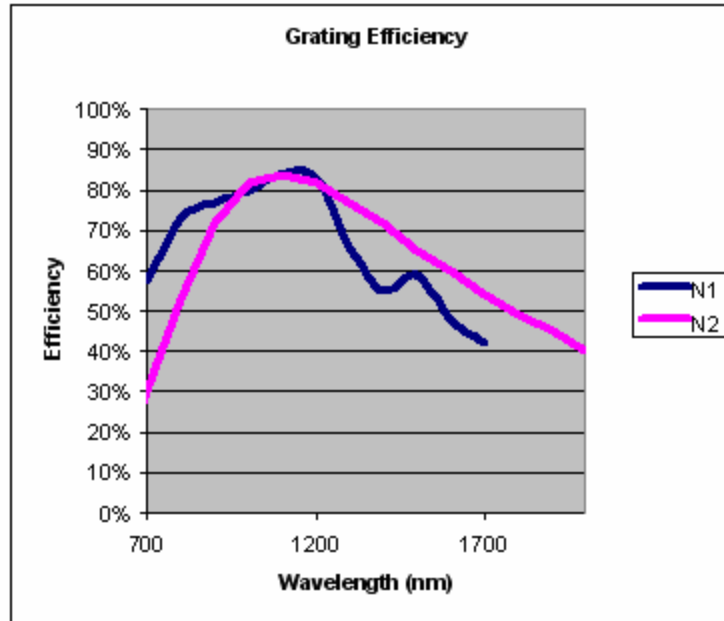
	NIR512	NIR256-2.1	NIR256-2.5
Dimensions	152 mm x 105 mm x 76 mm		
Weight	190 g (without cable)		
Power consumption	2A @ 5V DC	4A @ 5V DC	
Detector range	900 to 1700 nm	900 - 2100 nm with grating N2 1200 - 2100 nm with grating N1	900 nm to 2500 nm
Gratings	N1: 300 lines/mm blazed at 1 $\mu$ m	N2: 150 lines/mm blazed at 1.6 $\mu$ m or N1: 300 lines/mm blazed at 1 $\mu$ m	N2: 150 lines/mm blazed at 1.6 $\mu$ m
Entrance aperture	5, 10, 25, 50, 100, or 200 mm wide slits or fiber (no slit)		
Order-sorting filters	Installed longpass and bandpass filters		

**B: Specifications**

	NIR512	NIR256-2.1	NIR256-2.5
Optical resolution (slit dependent)	4.2 – 14.0 nm FWHM	With Grating N1: 4.5 – 14.0 FWHM With Grating N2: 7.5 – 25.0 nm FWHM	7.5 – 25.0 nm FWHM
Focal length	f/4, 40mm		
Dynamic range	5000:1 for a single scan		
Fiber optic connector	SMA 905 to single-strand optical fiber (0.22 NA)		
A/D converter:	16-bit internal - 500 KHz		
Data transfer rate	Full scans into memory every 10 milliseconds (USB interface)		
Integration time	1 ms – 3 seconds	1 ms – 1 second	1 – 30 milliseconds
Fiber optic connector	SMA 905 to single-strand optical fiber (0.22 NA)		
Operating systems	Windows 98/Me/2000/XP, Mac OS X & Linux - USB interface Any 32-bit Windows operating system – Serial port		



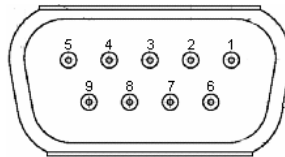
**Spectral Response Curves**



Grating Efficiency Curves

## 9-pin RS-232 Serial Port Pinout

When facing the 9-pin RS-232 Serial Port connector on the NIR Spectrometer, the pins are numbered as:

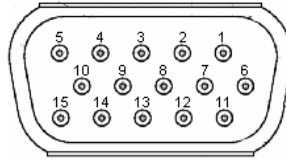


## 9-pin RS-232 Serial Port Connector – Pin Definitions

Pin #	Description
2	RS232 Transmit
3	RS232 Receive
5	Ground

## 15-pin Accessory Connector Pinout

When facing the 9-pin RS-232 Serial Port connector on the NIR Spectrometer, the pins are numbered as:



## 15-pin Accessory Connector – Pin Definitions

Pin #	Description
3	+5V DC
8	External Software trigger pin
10	Ground

## LED Information

The LED on the NIR Spectrometer has two states: Blinking and Solid. A blinking LED indicates that the thermo-electric cooler (TEC) is not active. A solid LED indicates that the TEC is active, which means the TEC is in the process of reaching (or has reached) the set temperature.

The LED indicator is present on Revision C (and higher) NIR Spectrometers. The last letter in your NIR serial number (for example, NIRXXA001 for Revision A) represents the revision code of the spectrometer.

The NIR Spectrometer is designed to keep the internal temperature within 0.1 °C of the set temperature.

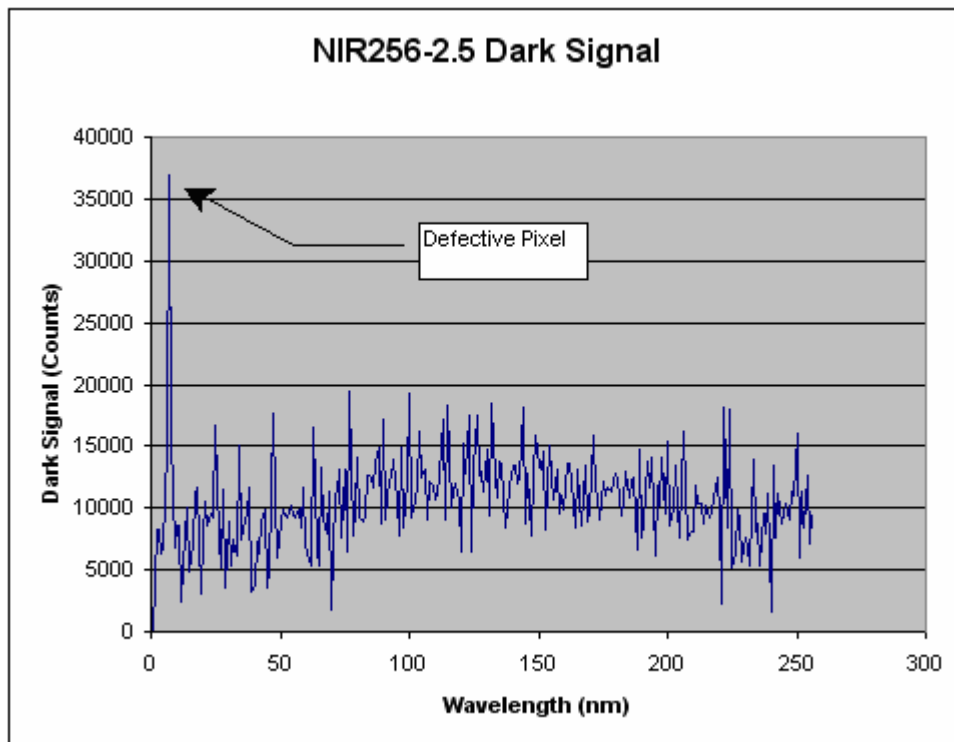


# NIR256-2.5 $\mu\text{m}$ Sensitivity

When configuring a system for operation out to 2.5 $\mu\text{m}$  it is important that you consider the following details:

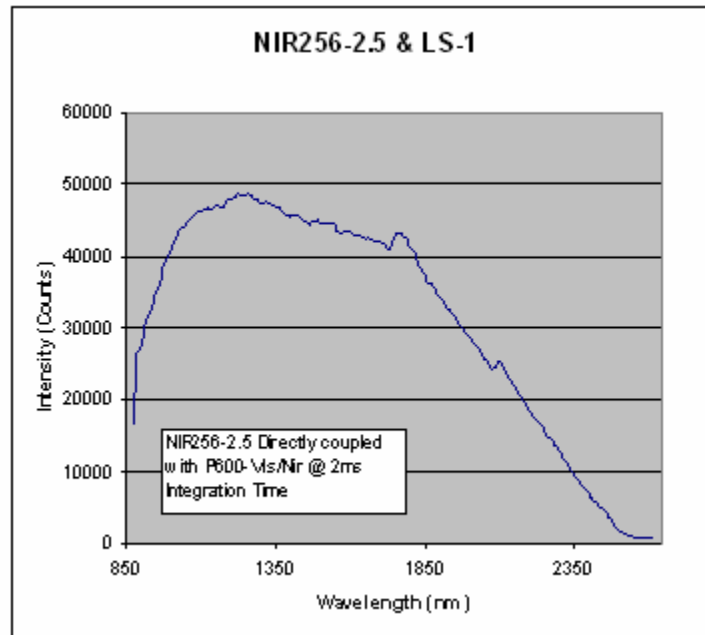
- **Short Integration Times:** For the detector to be sensitive out to 2.5 $\mu\text{m}$ , the detector's band gap energy must be small. Unfortunately, this raises the absolute level of the detectors dark signal. A typical dark signal at 34ms is shown below. While the detector functions at integration times greater than 50ms, this seems to be the realistic limit.
- **Fiber Selection:** For maximum signal intensity, alternative fiber materials should be used for wavelengths greater than 2.2 $\mu\text{m}$ .

The figure below shows a dark signal at 24ms integration time. Full Scale is 65,535 counts. The spectra shows the presence of a defective pixel.



### C: NIR256-2.5 $\mu\text{m}$ Sensitivity

The figure below shows the relative intensity of a NIR256-2.5 Spectrometer with a 25 $\mu\text{m}$  slit directly coupled to an LS-1 Light Source with a 600 $\mu\text{m}$  fiber.



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