



## QE65 Pro Scientific-grade Spectrometer Installation and Operation Manual



For Products: QE65Pro  
Document: 220-12200-000-02-201603

A HALMA COMPANY

## AMERICAS & WORLD HEADQUARTERS

---

**Phone:** +1 727-733-2447

**Fax:** +1 727-733-3962

**Sales:** info@oceanoptics.com

**Orders:** orders@oceanoptics.com

**Support:** techsupport@oceanoptics.com

### **Ocean Optics, Inc.**

830 Douglas Ave.  
Dunedin, FL 34698  
USA

### **Manufacturing & Logistics**

4301 Metric Dr.  
Winter Park, FL 32792  
USA

## EUROPE, MIDDLE EAST & AFRICA

---

**Phone:** +31 26-319-0500

**Fax:** +31 26-319-0505

**Email:** info@oceanoptics.eu

Germany : +49 711-341696-0

UK : +44 1865-811118

France : +33 442-386-588

### **Sales & Support**

Geograaf 24  
6921 EW Duiven  
The Netherlands

### **Manufacturing & Logistics**

Maybachstrasse 11  
73760 Ostfildern  
Germany

## ASIA

---

**Phone:** +86 21-6295-6600

**Fax:** +86 21-6295-6708

**Email:** asiasales@oceanoptics.com

Japan & Korea: +82 10-8514-3797

### **Ocean Optics Asia**

666 Gubei Road  
Kirin Tower Suite 601B  
Changning District  
Shanghai  
PRC, 200336

---

**www.oceanoptics.com**

---

### **Copyright © 2012 Ocean Optics, Inc.**

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, by any means, electronic, mechanical, photocopying, recording, or otherwise, without written permission from Ocean Optics, Inc.

This manual is part of an order and subject to the condition that it shall not, by way of trade or otherwise, be lent, re-sold, hired out or otherwise circulated without the prior consent of Ocean Optics, Inc. in any form of binding or cover other than that in which it is published.

### **Trademarks**

All products and services herein are the trademarks, service marks, registered trademarks or registered service marks of their respective owners.

### **Limit of Liability**

Every effort has been made to make this manual as complete and as accurate as possible, but no warranty or fitness is implied. The information provided is on an "as is" basis. Ocean Optics, Inc. shall have neither liability nor responsibility to any person or entity with respect to any loss or damages arising from the information contained in this manual.

---

# Table of Contents

About This Manual.....	iii
Document Purpose and Intended Audience.....	iii
Document Summary.....	iii
Product-Related Documentation.....	iii
Upgrades.....	iv
<b>Chapter 1: Introduction .....</b>	<b>1</b>
Product Overview .....	1
Features .....	2
System Requirements .....	3
EEPROM Utilization .....	3
How Sampling Works.....	4
Modular Sampling Accessories.....	4
Interface Options .....	4
Shipment Components .....	5
Other Accessories Available .....	5
Breakout Box .....	5
<b>Chapter 2: Installing the QE65 Pro .....</b>	<b>7</b>
Overview .....	7
QE65 Pro Installation.....	7
USB Mode .....	7
Serial Port Mode.....	8
QE65 Pro Configuration.....	8
Connect Spectroscopic Accessories.....	8
External Triggering Options .....	8
<b>Chapter 3: Troubleshooting .....</b>	<b>11</b>
Overview .....	11
QE65 Pro Connected to Computer Prior to Software Installation .....	11
Windows Operating Systems .....	11
Remove the Unknown Device from Windows Device Manager .....	11

Remove Improperly Installed Files.....	12
Mac Operating Systems .....	12
Linux Operating Systems .....	12
<b>Appendix A: Calibrating the Wavelength of the QE65 Pro .....</b>	<b>13</b>
Overview .....	13
About Wavelength Calibration .....	13
Calibrating the Spectrometer .....	14
Preparing for Calibration.....	14
Calibrating the Wavelength of the Spectrometer .....	14
Saving the New Calibration Coefficients: USB Mode .....	16
<b>Appendix B: Specifications.....</b>	<b>17</b>
Overview .....	17
How the QE65 Pro Works.....	17
QE65 Pro Components Table .....	18
QE65 Pro Specifications.....	19
CCD Detector Specifications .....	19
QE65 Pro Spectrometer Specifications .....	19
System Compatibility .....	20
30-Pin Accessory Connector Pinout .....	20
30-Pin Accessory Connector Pinout Diagram .....	21
30-Pin Accessory Connector – Pin Definitions and Descriptions.....	21
30-Pin J2 Accessory Connector - Part Numbers.....	23
QE65 Pro 15-Pin Accessory Cable Pinout .....	24
<b>Index .....</b>	<b>25</b>

---

# About This Manual

## Document Purpose and Intended Audience

This document provides the user of the QE65 Pro Spectrometer with instructions for setting up, calibrating and performing experiments with their spectrometer.

## What's New in this Document

This version of the *QE65 Pro Scientific-grade Spectrometer Installation and Operation Manual* updates the specifications.

## Document Summary

Chapter	Description
Chapter 1: <a href="#">Introduction</a>	Contains descriptive information about the QE65 Pro Spectrometer and how sampling works. It also provides a list of system requirements, interface options, and shipment components.
Chapter 2: <a href="#">Installing the QE65 Pro</a>	Provides installation and configuration instructions.
Chapter 3: <a href="#">Troubleshooting</a>	Contains recommended steps to isolate and correct common problems.
Appendix A: <a href="#">Calibrating the Wavelength of the QE65 Pro</a>	Provides instructions for calibrating the QE65 Pro Spectrometer.
Appendix B: <a href="#">Specifications</a>	Contains technical specifications and connector pinouts for the QE65 Pro 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.

Document for...	Document Location
OceanView software	<a href="http://oceanoptics.com///wp-content/uploads/OceanViewIO.pdf">http://oceanoptics.com///wp-content/uploads/OceanViewIO.pdf</a>

Document for...	Document Location
SpectraSuite software	<a href="http://oceanoptics.com///wp-content/uploads/SpectraSuite.pdf">http://oceanoptics.com///wp-content/uploads/SpectraSuite.pdf</a>
HR-4 Breakout Box	<a href="http://oceanoptics.com///wp-content/uploads/HR-4-Breakout-Box.pdf">http://oceanoptics.com///wp-content/uploads/HR-4-Breakout-Box.pdf</a>
External triggering for firmware versions below 3.0	<a href="http://oceanoptics.com///wp-content/uploads/External-Triggering-Options.pdf">http://oceanoptics.com///wp-content/uploads/External-Triggering-Options.pdf</a>
External triggering for firmware versions 3.0 and above	<a href="http://oceanoptics.com///wp-content/uploads/External-Triggering-Options_Firmware3.0andAbove.pdf">http://oceanoptics.com///wp-content/uploads/External-Triggering-Options_Firmware3.0andAbove.pdf</a>

Ocean Optics offers a Glossary of spectroscopy terms to help you further understand your state-of-the-art products and how they function, located at: <http://oceanoptics.com/glossary/>.

## 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.

## Warranty

Our 3-Year Warranty covers Ocean Optics miniature fiber optic spectrometers, light sources and sampling accessories – regardless of the application – from manufacturing defects. It also covers fibers and probes for a full 12 months: <http://oceanoptics.com/services/exclusive-3-year-warranty/>.

This comprehensive warranty ensures you of the highest level of craftsmanship and reliability for years to come. No other manufacturer offers such a solid guarantee of quality and reliability.

The Ocean Optics 3-Year Warranty applies to Ocean Optics equipment (excluding OEM configurations) purchased on or after July 1, 2010. The warranty covers parts and labor needed to repair manufacturing defects that occur during the warranty period. We also will cover the costs of shipping warranty-related repairs from our customers to Ocean Optics and from us to our customers.

## ISO Certification

Ocean Optics, the industry leader in miniature photonics, has been certified for ISO 9001:2008 certification applicable to the design and manufacture of electro-optical equipment since 2009.

---

 **WARNING**


**This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.**

---

---

**FCC COMPLIANCE**

**This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which the user will be required to correct the interference at his own expense.**

 **WARNING:** The authority to operate this equipment is conditioned by the requirement that no modifications will be made to the equipment unless the changes or modifications are expressly approved by the manufacturer.

---





---

# Chapter 1

# Introduction

## Product Overview

Ocean Optics has taken its best scientific-grade spectrometer, the QE65000, and enhanced its optical bench to provide unmatched performance to improve response in the UV and shortwave NIR regions. The Ocean Optics QE65 Pro Spectrometer produces lower stray light and provides superior dynamic range and high sensitivity for low-light level applications such as fluorescence, Raman analysis and DNA sequencing.



### **Ocean Optics QE65 Pro High-Sensitivity Fiber Optic Spectrometer**

The QE65 Pro features a Hamamatsu low-etaloning, back-thinned FFT-CCD detector with a 2-D arrangement of pixels (1044 horizontal x 64 vertical) that is responsive from 200-1100 nm and has a peak quantum efficiency of ~90% (with a QE of 65% at 250 nm). The detector's columns are binned, or summed, inside the detector prior to the readout process, thereby minimizing readout noise. Additionally, the detector can be cooled down to  $-15^{\circ}\text{C}$  with the onboard TE-Cooler to reduce dark noise. The reduction of noise and dark signal allows integration times of the spectrometer (analogous to the shutter speed of a camera) of up to 15 minutes, which greatly enhances the detection limit in low-light level applications. The back-illuminated detector has great response in the UV. The inherent UV response eliminates the need for UV-sensitive detector coatings that can be difficult to apply consistently from batch to batch.

The combination of the spectrometer's low-noise detector and 16-bit A/D Converter delivers a dynamic range of 25000:1 (for a single acquisition) and a signal-to-noise ratio of 1000:1 (at full signal).

Replaceable slits are offered for added convenience.

The QE65 Pro's onboard module has 10 user-programmable digital I/O lines for interfacing to other equipment; and a pulse generator for triggering other devices. You can use the I/Os to flash a lamp, stop/start a process, and send a message/alarm during the spectrometer's integration period. The spectrometer's operating parameters can be controlled through software. In fact, wavelength calibration coefficients unique to each spectrometer are programmed into a memory chip right on the spectrometer.

The QE65 Pro's high-speed electronics have been designed for considerable flexibility in connecting to various modules and external interfaces, including PCs, PLCs and other embedded controllers, through USB 2.0 or RS-232 communications. Its USB 2.0 interface enables full spectral scans into memory every 7 milliseconds.

The QE65 Pro operates via USB interface. A +5 VDC external power supply is required for the TE Cooler (TEC) and to operate the spectrometer via an RS-232 interface. This power supply is included with your spectrometer.

## Features

- Hamamatsu S7031-1006S Detector
  - Peak QE: 90% at peak; 65% at @ 250 nm
  - Back-thinned for good UV sensitivity
  - MPP operation for low noise
  - TE Cooled
- Spectrometer Design
  - Symmetrical Crossed Czerny Turner
  - 101mm focal length
  - 14 gratings across UV-NIR; HC-1 composite grating for broad wavelength coverage
  - 6 slit widths ranging from 50 to 200  $\mu\text{m}$
- Electrical Performance
  - 16 bit, 500KHz A/D converter
  - Integration times from 8ms to ~15min
- Embedded microcontroller allows programmatic control of all operating parameters and standalone operation
  - USB 2.0 480Mbps (high-speed) & 12Mbps (full speed)
  - RS232 115Kbaud
  - Multiple communication standards for digital accessories (SPI, I2C)
- Onboard Pulse Generator
  - 2 programmable strobe signals for triggering other devices
  - Software control of nearly all pulse parameters
- Onboard GPIO
  - 10 user-programmable digital I/Os

- EEPROM storage for
  - Wavelength Calibration Coefficients
  - Linearity Correction Coefficients
  - Absolute Irradiance Calibration (optional)
- Plug-n-play interface for PC applications
- 30-pin connector for interfacing to external products

## System Requirements

You can use the QE65 Pro's USB connectivity with any PC that meets the following requirements:

- Microsoft Windows – Windows 2000/XP/7; 32-bit and 64-bit and Windows Vista (32-bit only)
- Apple Macintosh – version 10.5 Intel or later
- Linux – Any version released for an x86 or amd64 platform since 2010

Alternately, the QE65 Pro has a serial port for connecting to PCs, PLCs, and other devices with a Windows 32-bit operating system that support the RS-232 communication protocol. However, this connection method requires an external power supply to power the QE65 Pro, the Breakout Box, and a serial cable.

## EEPROM Utilization

An EEPROM memory chip in each QE65 Pro contains wavelength calibration coefficients, linearity coefficients, and a serial number unique to each individual spectrometer. The OOI software application reads these values directly from the spectrometer, enabling the ability to “hot-swap” spectrometers between computers without entering the spectrometer coefficients manually on each computer.

## About OceanView Software

OceanView 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.

OceanView is a user-customizable, advanced acquisition and display program that provides a real-time interface to a variety of signal-processing functions. With OceanView, 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 OceanView manual for hardware requirements when using OceanView (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 the spectrometer operating software.
7. The software 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 QE65 Pro. 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 QE65 Pro has both USB and serial port connectors (with the use of an adapter), enabling you to connect the spectrometer to a desktop or notebook computer via a USB port or serial port. However, you must create custom software if using the serial port. OceanView software is available if you are connecting via the USB port.

Computer Interface	Operating System Requirements	Part Needed	Description of Part
Computer via USB Port	<p>OceanView: Microsoft Windows – Windows 2000/XP/7; 32-bit and 64-bit and Windows Vista (32-bit only)</p> <p>Apple Macintosh – version 10.5 Intel or later</p> <p>Linux – Any version released for an x86 or amd64 platform since 2010</p>	USB-CBL-1 (included)	Cable that connects from USB port on QE65 Pro to USB port on desktop or notebook PC
Desktop or Notebook PC via Serial Port	Any 32-bit or 64-bit Windows operating system	HR4-BREAKOUT (not included)	Adapter block that enables connection from serial port on QE65 Pro to serial port on desktop or notebook PC; comes with 5 VDC power supply (required when connecting to serial port)

# Shipment Components

- ❑ QE65 Pro Spectrometer
- ❑ + 5VDC power supply

The following information and documentation also ships with the QE65 Pro 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.

- ❑ **Wavelength Calibration Data Sheet**

Each spectrometer is shipped with a Wavelength Calibration Data Sheet that contains information unique to your spectrometer. OceanView reads this calibration data from your spectrometer when it interfaces to a computer via the USB port.

---

### Note

Please save the Wavelength Calibration Data Sheet for future reference.

---

## Other Accessories Available

Visit us at [www.OceanOptics.com](http://www.OceanOptics.com) for a complete list of products available for all of your spectroscopy needs.

- ❑ **Slits**
- ❑ **Fibers**
- ❑ **Light Sources**
- ❑ **Integrated Sampling Systems**
- ❑ **Cuvettes**
- ❑ **Filter Holders**
- ❑ **Lithium Ion Battery Pack**
- ❑ **HR4-BREAKOUT Breakout Box**

## Breakout Box

Ocean Optics also offers the Breakout Box (HR4-BREAKOUT), a passive module that separates the signals from their 22-pin port to an array of standard connectors and headers, enabling easy access to a variety of features found in Ocean Optics' QE65 Pro 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.



# Installing the QE65 Pro

## Overview

You must install the operating software application prior to connecting the QE65 Pro Spectrometer to the computer. The Ocean Optics spectrometer operating software installs the drivers required for the QE65 Pro spectrometer installation. If you do not install the software first, the system will not properly recognize the QE65 Pro.

If you have already connected the QE65 Pro to the computer prior to installing the operating software, consult *Chapter 3: [Troubleshooting](#)* for information on correcting a corrupt QE65 Pro installation.

## QE65 Pro Installation

This section contains instructions for connecting the QE65 Pro via both USB and serial modes.

---

### Caution

**Ensure that TEC power is always applied (using OceanView software) before USB power.**

---

## USB Mode

This section contains instructions for connecting the QE65 Pro in USB mode. To connect the QE65 Pro to a computer via the USB port, the computer must be running a Windows 2000/XP/7 or Vista (32-bit), Mac OS X or Linux operating system.

### ► Procedure

Follow the steps below to connect the QE65 Pro to a computer via the USB port:

1. Install the spectrometer operating software on the destination computer.
2. If you intend to run the TE Cooler, plug the +5 VDC power supply into the QE65 Pro.
3. Locate the USB cable (USB-CBL-1) provided with the QE65 Pro.
4. Insert the square end of the cable into the side of the QE65 Pro.
5. Insert the rectangular end of the cable into the USB port of the PC.

If you installed the spectrometer operating software prior to connecting the QE65 Pro, the software installs the QE65 Pro drivers. If the drivers do not successfully install (or if you connected the QE65 Pro to the computer before installing the software), consult *Chapter 3: [Troubleshooting](#)*.

## Serial Port Mode

To use the serial port capacity of the QE65 Pro Spectrometer, the PC must be running a 32-bit version of the Windows operating system (or Windows CE 2.11 or higher for handheld PCs).

### ► **Procedure**

Follow the steps below to connect the QE65 Pro to the PC via serial port:

1. Plug the 5 VDC external power supply into an outlet and connect it to the QE65 Pro.
2. Connect the serial cable adapter block to the appropriate pins of the QE65 Pro's 30-Pin Accessory Connector.
3. Connect one end of the 9-pin serial cable to the adapter block on the QE65 Pro, and then connect the other end to a serial port on the PC.
4. Note the number of the serial port (COM Port) to which you connected the QE65 Pro (some PCs may not have numbered ports; handheld PCs typically have only one serial port).

## QE65 Pro Configuration

The QE65 Pro can be used with OceanView software when connected to the USB port.

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

## Connect Spectroscopic Accessories

To find operating instructions for QE65 Pro-compatible products (such as light sources, sampling chambers, and probes), consult the Ocean Optics website at <http://oceanoptics.com/support/technical-documents/>.

## External Triggering Options

You can trigger the QE65 Pro using a variety of External Triggering options through the 30-pin Accessory Connector on the spectrometer.

For QE65 Pro firmware versions below 3.0, see the External Triggering Options document located at <http://oceanoptics.com/wp-content/uploads/External-Triggering-Options.pdf>.



For QE65 Pro firmware version 3.0 and above, see the External Triggering Options document located at [http://oceanoptics.com/wp-content/uploads/External-Triggering-Options\\_Firmware3.0andAbove.pdf](http://oceanoptics.com/wp-content/uploads/External-Triggering-Options_Firmware3.0andAbove.pdf). The triggering document contains instructions for configuring External Triggering options for the QE65 Pro.

---

**Note**

Only the external software triggering option is available when using a handheld computer.

---



# Troubleshooting

## Overview

The following sections contain information on troubleshooting issues you may encounter when using the QE65 Pro Spectrometer.

## QE65 Pro Connected to Computer Prior to Software Installation

### Windows Operating Systems

If you connected your Ocean Optics QE65 Pro device to the computer prior to installing your spectrometer operating software application (OceanView) on a Windows platform, 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://oceanoptics.com//wp-content/uploads/Correcting-Device-Driver-Issues.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.

---

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 QE65 Pro 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.

---

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 QE65 Pro Spectrometer in a Mac operating system, you should not encounter any problems if you installed the spectrometer before the operating software.

## Linux Operating Systems

For Linux operating systems, all you need to do is install the 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.

---

## Appendix A

# Calibrating the Wavelength of the QE65 Pro

## 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 QE65 Pro.

## 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:

$$\lambda_p = I + C_1p + C_2p^2 + C_3p^3$$

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 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.

- A QE65 Pro 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

---

### Note

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

## Calibrating the Wavelength of the Spectrometer

### ► Procedure

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

1. Place the spectrometer operating 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 # <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 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**
- 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

	<u>Coefficients</u>	<u>Standard Error</u>	
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 QE65 Pro onto an EEPROM memory chip in the QE65 Pro.

You can overwrite old calibration coefficients on the EEPROM if you are using the QE65 Pro via the USB port.

### ► Procedure

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

1. Ensure that the QE65 Pro is connected to the PC and that you have closed all other applications.
2. Point your browser to <http://oceanoptics.com/support/software-downloads/> 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 QE65 Pro 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 QE65 Pro.



---

# Appendix B

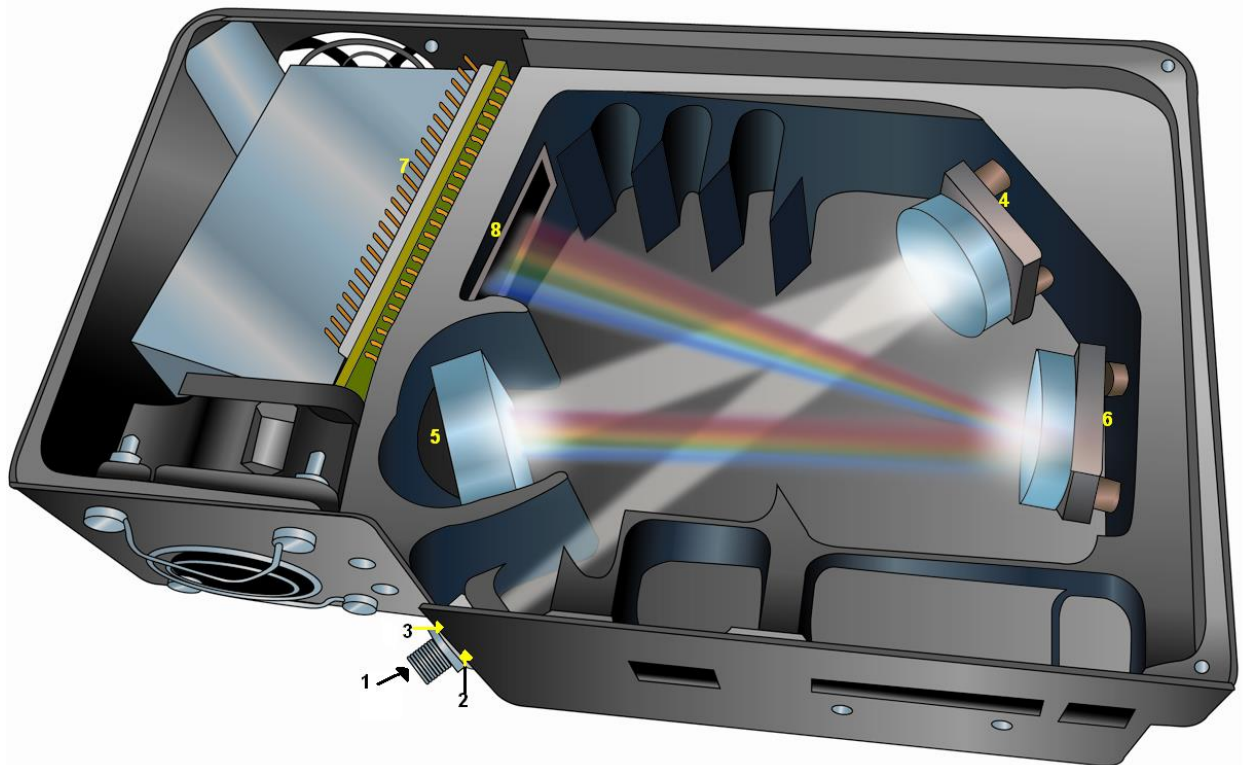
# Specifications

## 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 QE65 Pro Works

Below is a diagram of how light moves through the optical bench of a QE65 Pro 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.



QE65 Pro Spectrometer with Components

## QE65 Pro Components Table

Ocean Optics permanently secures all components in the QE65 Pro 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	<p>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.</p> <p>You can also use the QE65 Pro without a Slit. In this configuration, the diameter of the fiber connected to the QE65 Pro determines the size of the entrance aperture.</p> <p>Only Ocean Optics technicians can change the Slit.</p>
3	Filter	<p>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.</p> <p>Only Ocean Optics technicians can change the Filter.</p>
4	Collimating Mirror	<p>Focuses light entering the optical bench towards the Grating of the spectrometer.</p> <p>Light enters the spectrometer, passes through the SMA Connector, Slit, and Filter, and then reflects off the Collimating Mirror onto the Grating.</p>
5	Grating	<p>Diffraction 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.</p> <p>Only Ocean Optics technicians can change the Grating.</p>
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	Back-thinned Area Detector with TE Cooling	<p>Provides 90% quantum efficiency and bins pixels in a vertical column to acquire light from the entire height of the spectrometer's slit image. This improves light collection and signal-to-noise significantly. This 2D area detector is back-thinned (back-illuminated) and does not require the detector upgrade that is normally applied to other detectors.</p> <p>Only Ocean Optics technicians can add or remove the Detector.</p>
8	Detector with OFLV Filter	Eliminates second-order effects and is used with an HC-1 Grating in a 200-950 nm wavelength system in a QE65 Pro.

# QE65 Pro Specifications

The following sections provide specification information for the CCD detector in the QE65 Pro, as well as the QE65 Pro Spectrometer itself.

## CCD Detector Specifications

Specification	Value
Detector	Hamamatsu S7031-1006 Low Etaloning
Detector range	200-1100 nm
Pixels	1024 x 58 (1044 x 64 total pixels)
Pixel size	24 $\mu\text{m}^2$
Pixel well depth	300,000 electrons/well, 1.5 m elec/column
Sensitivity	22 electrons/count all $\lambda$ ; 26 photons/count @ 250 nm
Quantum efficiency	90% peak; 65% at 250 nm. See <i>Quantum Efficiency of Detector</i> graph below.

## QE65 Pro Spectrometer Specifications

Specification	Value
Dimensions (LxWxH)	182 mm (7.16 in.) x 110 mm (4.33 in.) x 47 mm (1.85 in.)
Weight	
QE65 Pro	1.18 kg (2.53 lbs.)
Power Supply	0.45 kg (1 lb.)
Temperature	TE Cooler can only cool 40 °C below ambient temperature
Operation	0 °C to +50 °C
Storage	-30 °C to +70 °C
Humidity	0 – 90% noncondensing
Power consumption	
No TE Cooler	500 mA @ 5 VDC
With TE Cooler	3.5A at 5 VDC

## B: Specifications

Specification	Value
Supply Voltage	4.5 – 5.5 V
Power-up Time	< 5 seconds
Signal-to-noise ratio	1000:1 (single acquisition)
Gratings	21 gratings available
Entrance aperture	5, 10, 25, 50, 100 or 200 $\mu\text{m}$ wide slits
OFLV filters	OFLV-QE (200-950 nm); OFLV-QE-250 (250-1000 nm); OFLV-QE-300 (300-1050 nm); OFLV-QE-350
Focal length	f/4, 101.6 mm (input and output)
Optical resolution (FWHM)	Depends on grating and size of entrance aperture
Dark noise	3 RMS counts
Dynamic range	$7.5 \times 10^9$ (over integration range); 25000:1 for a single integration period
Fiber optic connector	SMA 905 to single-strand optical fiber (0.22 NA)
Integration time	8 ms to 15 minutes
Corrected linearity	>99.8%
Thermal stability	$2 \pm 1$ pixel shift from -10 to 50°C
Interfaces	USB 2.0, 480 Mbps (USB 1.1 compatible); RS-232 (3-wire)

## System Compatibility

You can use the QE65 Pro's USB connectivity with any computer that meets the requirements for the spectrometer operating software being used (Windows XP/Vista/Windows 7, Mac OS X and Linux). See [About OceanView Software](#).

Alternately, the QE65 Pro has a serial port for connecting to PCs, PLCs, and other devices with a Windows 32-bit operating system that support the RS-232 communication protocol. However, this connection method requires an external power supply to power the QE65 Pro, the HR4000 Breakout Box, and a serial cable.

## 30-Pin Accessory Connector Pinout

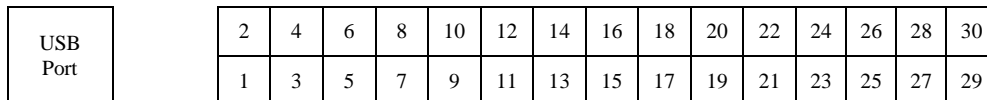
The QE65 Pro features a 30-pin Accessory Connector, located on the side of the unit as shown:



**Location of QE65 Pro 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 QE65 Pro, pin numbering is as follows:



**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 QE65 Pro’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)
4	N/A	N/A	Reserved

**B: Specifications**

Pin #	Function	Input/Output	Description
5	Ground	Input/Output	Ground
6	I <sup>2</sup> C SCL	Input/Output	I <sup>2</sup> C clock signal for communication to other I <sup>2</sup> C peripherals
7	GPIO (0)	Input/Output	General purpose software-programmable, digital input/output (channel number)
8	I <sup>2</sup> C SDA	Input/Output	I <sup>2</sup> C data signal for communication to other I <sup>2</sup> C peripherals
9	GPIO (1)	Input/Output	General purpose software-programmable, digital input/output (channel number)
10	Ext. Trigger In	Input	TTL input trigger signal -- See External Triggering Options document for info
11	GPIO (3)	Input/Output	General purpose software-programmable, digital input/output (channel number)
12	V <sub>CC</sub> or 5V <sub>IN</sub>	Input or Output	Input power pin for QE65 Pro – When operating via USB, this pin can power other peripherals – Ensure that peripherals comply with USB specifications (no TEC power)
13	SPI Data Out	Output	SPI Master Out Slave In (MOSI) signal for communication to other SPI peripherals
14	V <sub>CC</sub> or 5V <sub>IN</sub>	Input or Output	Input power pin for QE65 Pro – When operating via USB, this pin can power other peripherals – Ensure that peripherals comply with USB specifications (no TEC power)
15	SPI Data In	Input	SPI Master In Slave Out (MISO) signal for communication to other SPI peripherals
16	GPIO (4)	Input /Output	General purpose software-programmable, digital input/output (channel number)
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)
19	SPI Clock	Output	SPI clock signal for communication to other SPI peripherals
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)
23	N/A	N/A	Reserved
24	N/A	N/A	Reserved
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)
27	Ground	Input/Output	Ground
28	GPIO (8)	Input/Output	General purpose software-programmable, digital input/output (channel number)
29	Ground	Input/Output	Ground
30	GPIO (9)	Input/Output	General purpose software-programmable, digital input/output (channel number)

## 30-Pin J2 Accessory Connector - Part Numbers

The part numbers for the 30-pin accessory connector on the QE65 Pro 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).

## QE65 Pro 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		



---

# Index

## 1

15-pin accessory cable  
pinouts, 24

## 3

30-pin accessory connector  
diagram, 21  
part numbers, 23  
pin definitions, 21

## A

accessories, 5, 8  
Accessories, 4  
accessory connector  
pinout, 20

## B

breakout box, 5

## C

Calibrating, iii, 13  
calibration, 13  
preparing for, 14  
procedure, 14  
calibration coefficients  
saving in USB mode, 16  
CCD Detector, 18  
collimating mirror, 18  
compatibility, 20  
Components Table, 18

## D

Detector Collection Lens, 18  
document  
audience, iii  
purpose, iii  
summary, iii

## E

EEPROM, 3  
External Triggering, 8

## F

filter, 18  
focusing mirror, 18

## G

grating, 18

## I

Installation, 7  
Serial Port mode, 8  
USB mode, 7  
installed filter, 18  
Interface, 4  
ISO certification, iv

## L

L2 Detector Collection Lens, 18  
Lens, 18

**M**

memory chip, 3  
mirror, 18

**O**

OceanView, 3  
Options  
  Interface, 4

**P**

packing list, 5  
power supply (external), 2, 3, 4, 5, 7, 19, 20  
product-related documentation, iii

**Q**

QE65 Pro  
  specifications, 19

**S**

Sampling  
  Accessories, 4  
  System, 4  
Serial Port mode, 8  
setup, 7  
shipment components, 5  
slit, 18  
SMA Connector, 18  
specifications, 17  
  QE65 Pro, 19  
  spectrometer, 19  
spectroscopic accessories, 8  
System Requirements, 3

**T**

TE Cooler, 1, 2, 7, 19  
Triggering, 8  
troubleshooting  
  Linux systems, 12  
  Mac systems, 12  
Troubleshooting, 11

**U**

upgrades, iv  
USB mode, 7  
USB-ADP-PC, 4  
USB-CBL-1, 4

**W**

warranty, iv  
Wavelength Calibration  
  about, 13  
Wavelength Calibration Data File, 5  
Wavelength Calibration Data Sheet, 5  
what's new, iii