QE *Pro* Scientific-grade Spectrometer

Installation and Operation Manual

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Offices: **Ocean Optics, Inc. World Headquarters**
830 Douglas Ave., Dunedin, FL, USA 34698
Phone 727.733.2447
Fax 727.733.3962
8 a.m.– 6 p.m. (Mon-Fri) ET

E-mail: **Info@OceanOptics.com** **(General sales inquiries)**
Orders@OceanOptics.com **(Questions about orders)**
TechSupport@OceanOptics.com **(Technical support)**

A HALMA GROUP COMPANY

Additional Offices:

Ocean Optics Asia

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

Phone **86.21.5206.8686**
Fax **86.21.5206.8686**
E-Mail **asiasales@OceanOptics.com**

Ocean Optics EMEA

Sales and Support Center
Geograaf 24, 6921 EW DUIVEN, The Netherlands

Phone **31-26-3190500**
Fax **31-26-3190505**
E-Mail Info@OceanOptics.eu

Regional Headquarters
Maybachstrasse 11
73760 Ostfildern
Phone **49-711 34 16 96-0**
Fax **49-711 34 16 96-85**
E-Mail Sales@OceanOptics.eu

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About This Manual

Document Purpose and Intended Audience

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

What's New in this Document

This version of the *QE Pro Scientific-grade Spectrometer, Installation and Operation Manual* updates information for the QE *Pro* utility.

Document Summary

Chapter	Description
Chapter 1: *Introduction*	Contains descriptive information about the QE *Pro* Spectrometer and how sampling works. It also provides a list of system requirements, interface options, and shipment components.
Chapter 2: *Installing the QE Pro*	Provides installation and configuration instructions.
Chapter 3: *Troubleshooting*	Contains recommended steps to isolate and correct common problems.
Appendix A:*Calibrating the Wavelength of the QE Pro*	Provides instructions for calibrating the QE *Pro* Spectrometer.
Appendix B: *Specifications*	Contains technical specifications and connector pinouts for the QE *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. Or, use the **Search by Model Number** field at the bottom of the web page.

- Detailed instructions for OceanView Spectrometer Operating Software is located at: **http://www.oceanoptics.com/technical/OceanViewI&O.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 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.*

- **http://www.oceanoptics.com/technical/engineeringdocs.asp**

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://www.oceanoptics.com/warranty.asp**

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.

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 on 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

The Ocean Optics QE *Pro* Spectrometer is a scientific-grade spectrometer that is ideal for researchers and industrial customers. Its broadband sensitivity, from UV to NIR, makes it suitable for a wide range of applications, while its high sensitivity and thermo electric cooler enable effective measurements at very low light levels. The QE *Pro* also has the highest dynamic range of any fiber optic CCD spectrometer in its class.

Two LEDs are provided to monitor spectrometer and TEC operation. The QE *Pro* operates from power provided from a separate +5VDC power supply.

Ocean Optics QE *Pro* High-Sensitivity Fiber Optic Spectrometer

The QE *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 from 40°C below ambient up to 50°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 60 minutes, which greatly enhances the detection limit in low-light level applications. The back-illuminated detector has enhanced 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 18-bit A/D Converter delivers a dynamic typical range of ~85,000:1 and a signal-to-noise ratio of 1000:1 (at full signal).

Replaceable slits are offered for added convenience.

The QE *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 QE *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.

A +5 VDC external power supply is required to operate the spectrometer. This power supply is included with your spectrometer.

Models

The QE Pro is custom configurable for your specific application. In addition, the following preconfigured models are offered:

- **QE *Pro*-ABS** – For absorbance, reflection, irradiance and transmission measurements with a wavelength range of 200 – 950 nm
- **QE *Pro*-FL** – For fluorescence measurements with a wavelength range of 350 – 1100 nm
- **QE *Pro*-Raman** – for 785 nm Raman analysis with a wavelength range of 780 – 1100 nm (preset for 785 Raman)

Features

- Hamamatsu S7031-1006S Detector:
  - Typical dynamic range ~85,000:1
  - Peak QE: 90%
  - Back-thinned for enhanced UV sensitivity
  - Integration times from 8 ms to 60 minutes
  - TE Cooled
- Scientific-grade Optical Bench:
  - Symmetrical Crossed Czerny Turner
  - 101mm focal length
  - F number : f/4
  - Interchangeable slits
  - 14 gratings (H1 – H14); HC1
  - 6 slit widths, plus no slit in SMA or FC bulkhead
- Communications
  - USB 2.0 Full Speed
  - RS232 up to 460K Baud
- Thermo Electric Cooler (TEC)
  - Software-controlled set-point

    - LED indicator to show when the TEC is stable and accurate
    - Temperature stability: <0.1ºC
    - Continuous TEC setpoint control from 40ºC below ambient up to 50 ºC
- GPIO
    - Single strobe
    - Continuous strobe
    - 10 user-programmable digital I/O pins
    - SPI/I2C for controlling peripherals
- Nonvolatile storage
    - Wavelength calibration coefficients
    - Linearity correction coefficients
    - Absolute irradiance calibration (optional)
- Buffering
- Triggering (4 modes)
- Resets
    - Watchdog timer for reliability
    - Hardware power recycle via reset pin or software command
- Kensington® security slot
- LEDs for feedback on TEC readiness and general spectrometer health
- Software support:
    - OceanView
    - OmniDriver
    - SeaBreeze
- CE certification

System Requirements

You can use the QE *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 Ocean Optics Software*.

Alternately, the QE *Pro* has a serial port for connecting to PCs and PLCs. However, this connection method requires an external power supply to power the QE *Pro*, the Breakout Box, and a serial cable.

EEPROM Utilization

Nonvolatile memory in each QE *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 Ocean Optics 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 in this example:

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 Ocean Optics software.
7. Ocean Optics 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 QE *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 QE *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.

Computer Interface	Operating System Requirements	Part Needed	Description of Part
Computer via USB Port	OceanView: Windows XP/7/8 or Vista (32-bit only) for PC, OS X version 10.5 Intel or later for Mac, or any version released for an x86 or amd64 platform since 2010 for Linux	USB-CBL-1 (included)	Cable that connects from USB port on QE *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 QE *Pro* to serial port on desktop or notebook PC; comes with 5 VDC power supply (required when connecting to serial port)

Shipment Components

- QE *Pro* Spectrometer
- USB-CBL-1
- + 5VDC power supply

The following information and documentation also ships with the QE *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. Your spectrometer operating software 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** 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' QE *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.

Note

Be aware when using the Breakout Box that the signals for hardware flow control (handshaking) are not connected in the QE *Pro*.

Chapter 2

Installing the QE *Pro*

Overview

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

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

QE *Pro* Installation

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

USB Mode

This section contains instructions for connecting the QE *Pro* in USB mode. To connect the QE *Pro* to a computer via the USB port, the computer must be running a Windows XP/7/8 or Vista (32-bit only), Mac OS X (10.5 or later), or Linux (x86 or amd64 platform since 2010) operating system.

► *Procedure*

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

1. Install the spectrometer operating software on the destination computer.

Caution

Do NOT connect the spectrometer to the computer until you install the spectrometer operating software. Follow the instructions below to properly connect and configure your system.

2. Plug the +5 VDC power supply into the QE *Pro*.
3. Locate the USB cable (USB-CBL-1) provided with the QE *Pro*.
4. Insert the square end of the cable into the side of the QE *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 QE *Pro*, the software installs the QE *Pro* drivers. If the drivers do not successfully install (or if you connected the QE *Pro* to the computer before installing the software), consult *Chapter 3: Troubleshooting*.

Serial Port Mode

► *Procedure*

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

1. Plug the 5 VDC external power supply into an outlet and connect it to the QE *Pro*.
2. Connect the serial cable adapter block to the appropriate pins of the QE *Pro*'s 30-Pin Accessory Connector.
3. Connect one end of the 9-pin serial cable to the adapter block on the QE *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 QE *Pro* (some PCs may not have numbered ports; handheld PCs typically have only one serial port).

LED Operation

The QE *Pro* features two status LEDs:

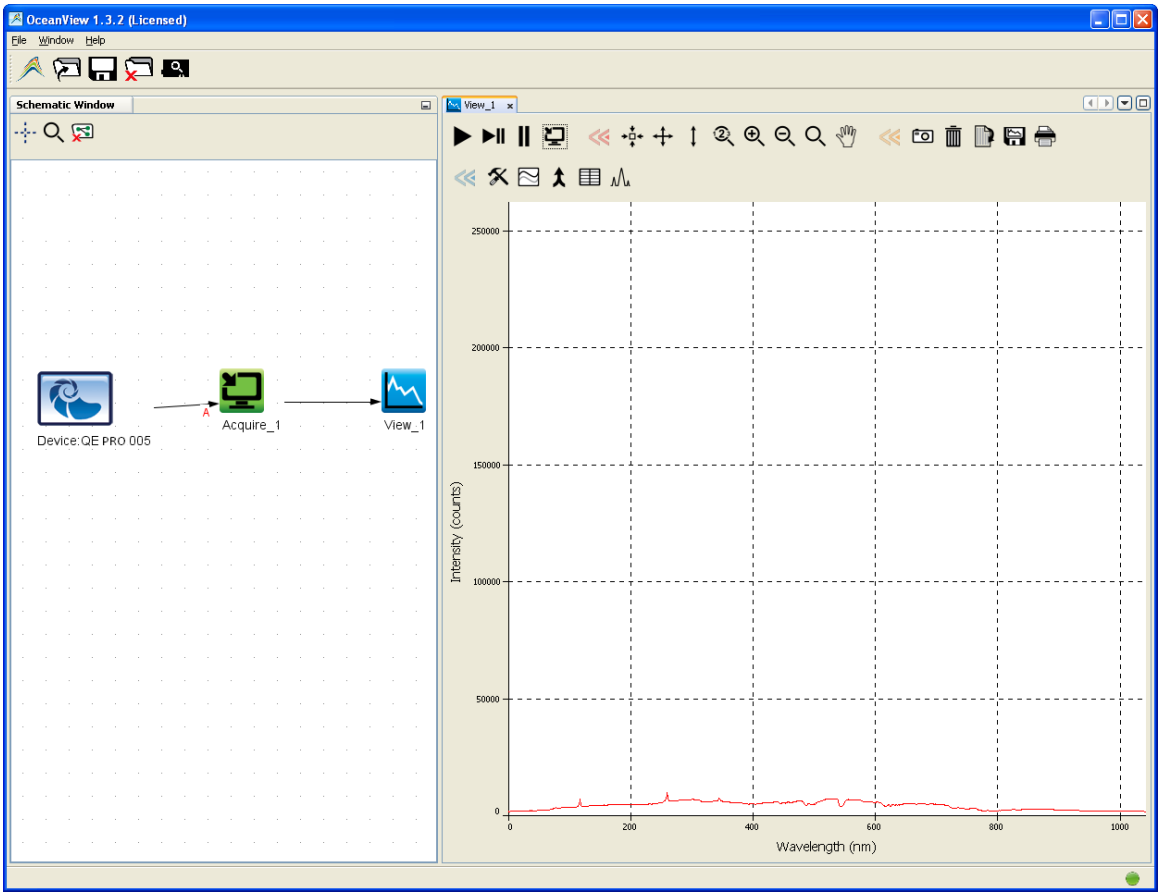
LED Position	Meaning
Top LED	Monitors Spectrometer status: • Off – spectrometer does not have power • Flashing orange – spectrometer is booting • Steady green – spectrometer is ready
Bottom LED	Monitors TEC status: • Off: The TEC system is off. • Orange: The TEC has not yet stabilized at its given setpoint. • Green: The TEC is stable (has been within 1°C of the setpoint for at least 15 seconds).

Configuring the QE *Pro*

The *QE Pro* can be used with OceanView software when connected to the USB port. If you have followed the previous steps and started your spectrometer operating software, 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.

Configuring QE *Pro* in OceanView

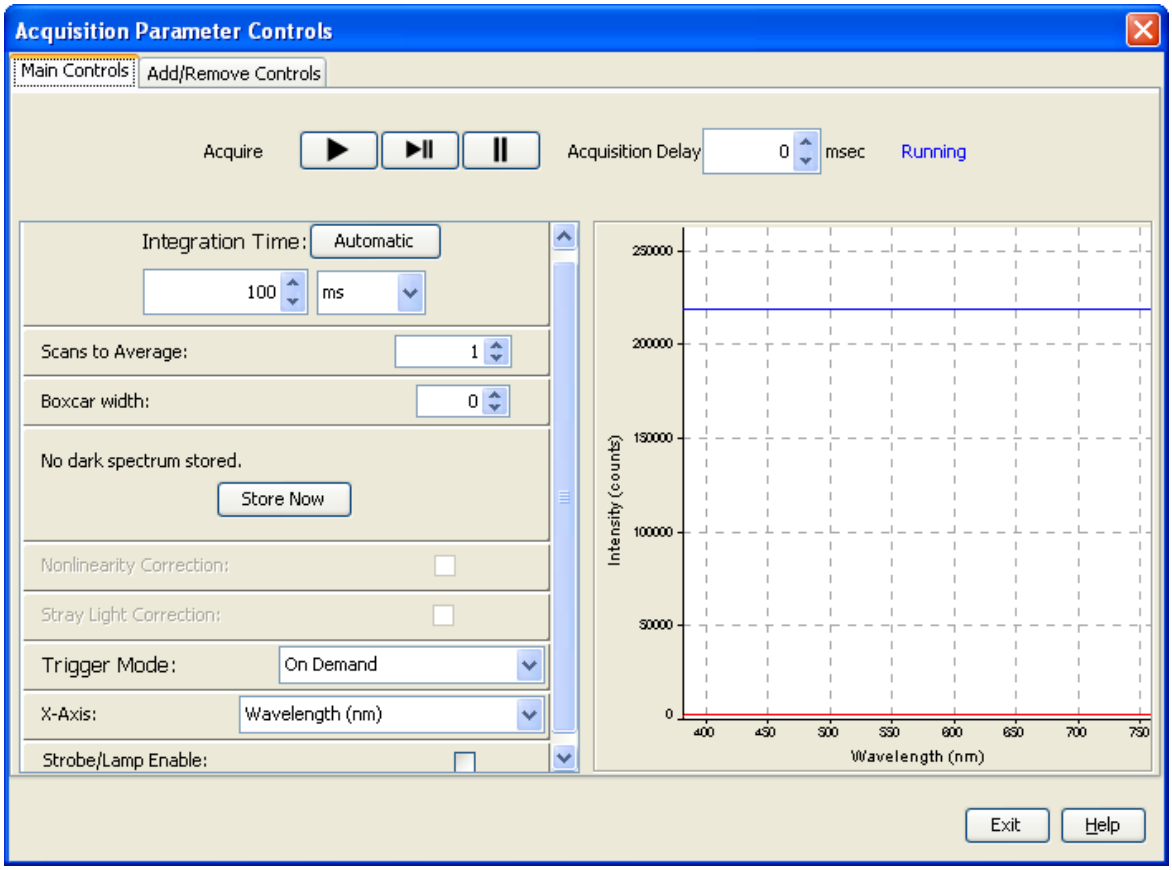
If you have followed the previous steps and started OceanView, your spectrometer appears in the Schematic and Graph Views:



QE *Pro* in OceanView

OceanView QE *Pro* Acquisition Controls

In OceanView, the Acquisition Parameter Controls allow you to set the desired parameters for QE *Pro*.

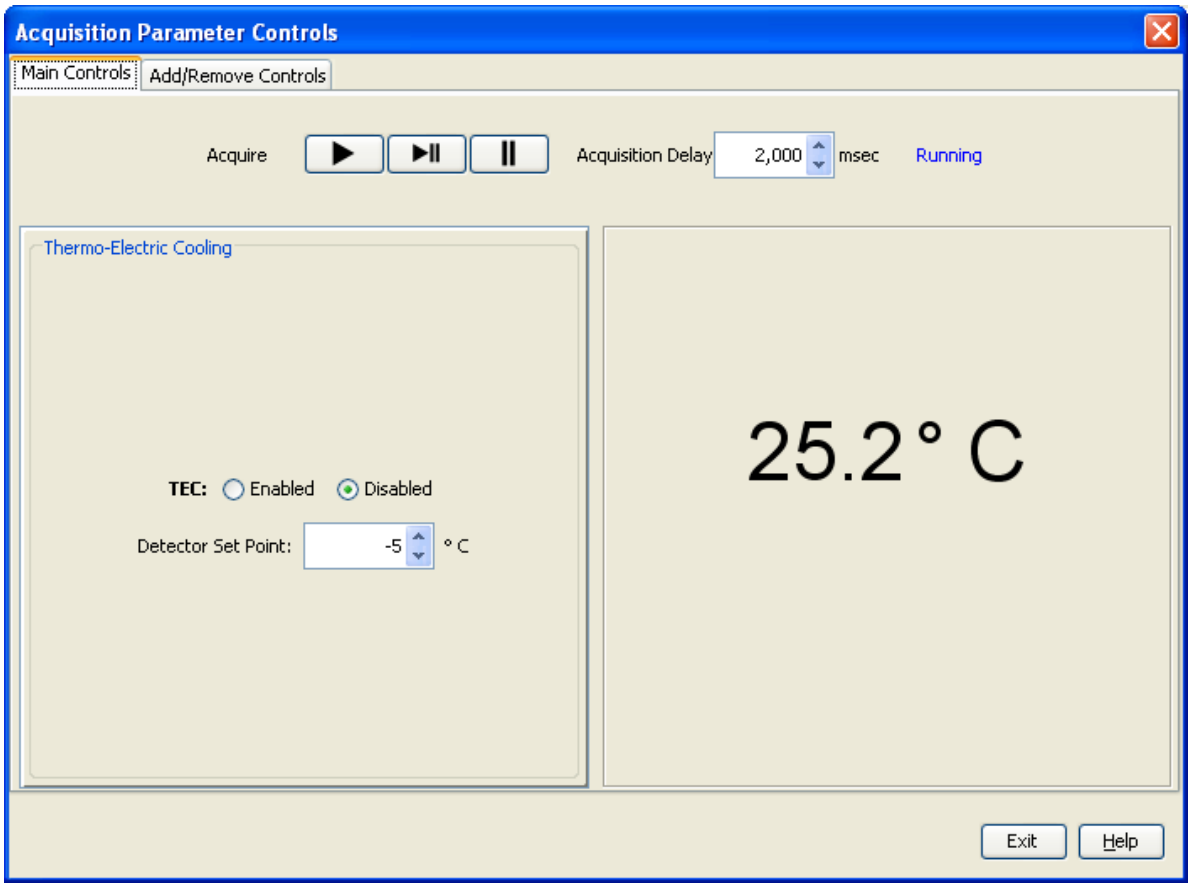


TE Cooler

► *Procedure*

To control the TE Cooler,

1. Right-click on the QE *Pro* in the Schematic View.
2. Select **New Acquisition | Thermo-Electric Cooling**.



Buffering

► *Procedure*

To control buffering,

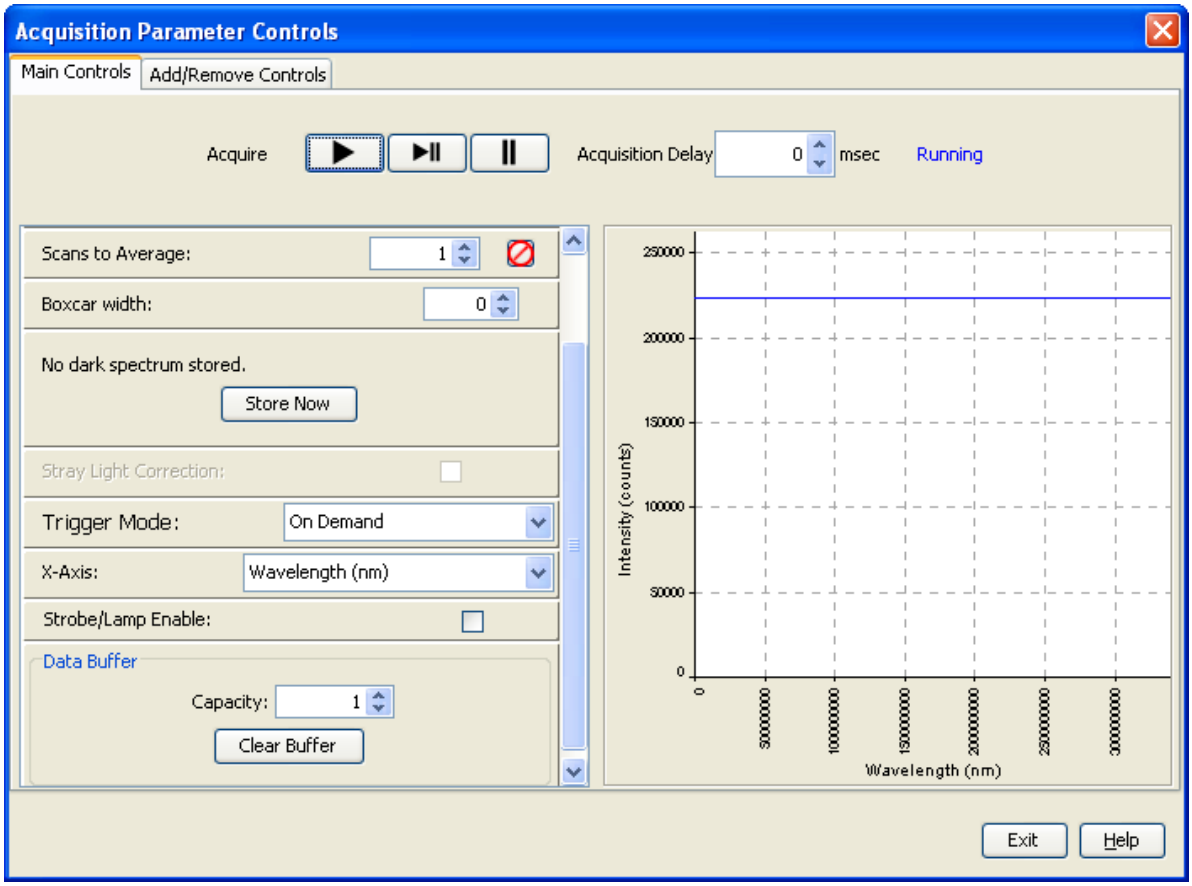
1. Right-click on the QE *Pro* in the Schematic View.
2. Select **New Acquisition | Data Buffer**.

Data buffering can also be set using the Acquisition Parameter Controls.

► *Procedure*

To add data buffering controls to the Acquisition Parameter Controls,

1. Click on the **Add/Remove Controls** tab.
2. Select **Data Buffer**. The Data Buffer controls appear on the Main Controls tab.



3. Select the data buffering capacity (the total number of scans the device can store at once).
4. Click **Clear Buffer** to set the buffer to zero and start over.

Connect Spectroscopic Accessories

To find operating instructions for QE *Pro* compatible products (such as light sources, sampling chambers, and probes), visit the Ocean Optics website at **http://www.oceanoptics.com/technical/operatinginstructions.asp**.

External Triggering Options

You can trigger the QE *Pro* using a variety of External Triggering options through the 30-pin Accessory Connector on the spectrometer. See the External Triggering Options document located at **http://www.oceanoptics.com/technical/External-Triggering2.pdf**. The triggering document contains instructions for configuring External Triggering options for the QE *Pro*.

Chapter 3

Troubleshooting

Overview

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

QE *Pro* Connected to Computer Prior to Software Installation

Windows Operating Systems

If you connected your Ocean Optics QE *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://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.

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 QE *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 QE *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 QE *Pro*

Overview

This appendix describes how to calibrate the wavelength of your spectrometer using SpectraSuite spectrometer operating software. 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 QE *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:

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

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)

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.

- A QE *Pro* 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**.

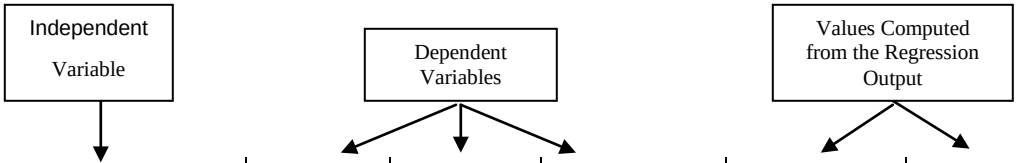
Calibrating the Wavelength of the Spectrometer

► *Procedure*

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

1. Place the spectrometer operating software into Quick View mode in OceanView 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.



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
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

First coefficient
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

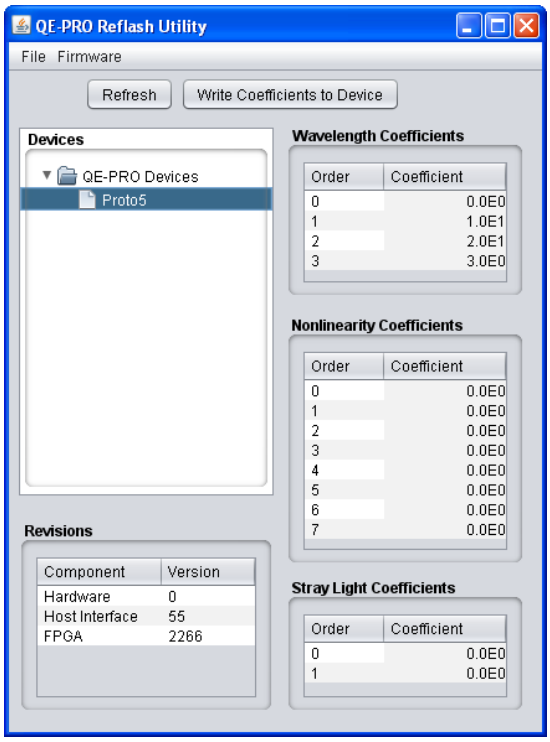
Ocean Optics programs wavelength calibration coefficients unique to each QE *Pro* onto an EEPROM memory chip in the QE *Pro*.

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

► *Procedure*

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

1. Ensure that the QE *Pro* 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 **QE *Pro* Update Utility**.
3. Save the files to your computer and extract them from the zip file.
4. Double-click the **UpdateQE-PRO.jar** file to run the software.
5. Click on the desired QE *Pro* device displayed in the **Devices** pane.



6. Double-click on each of the calibration coefficients displayed in the **Wavelength Coefficients** pane of the USB Programmer screen and enter the new values acquired in Step 5 of the *Calibrating the Wavelength of the Spectrometer* section in this appendix.
7. Repeat Step 6 for all of the new values.
8. Click on the **Write Coefficients to Device** button to save the information, and then select **File| Exit** to exit the QE *Pro* Reflash Utility software.

The new wavelength calibration coefficients are now loaded onto the EEPROM memory chip on the QE *Pro*.

Appendix B

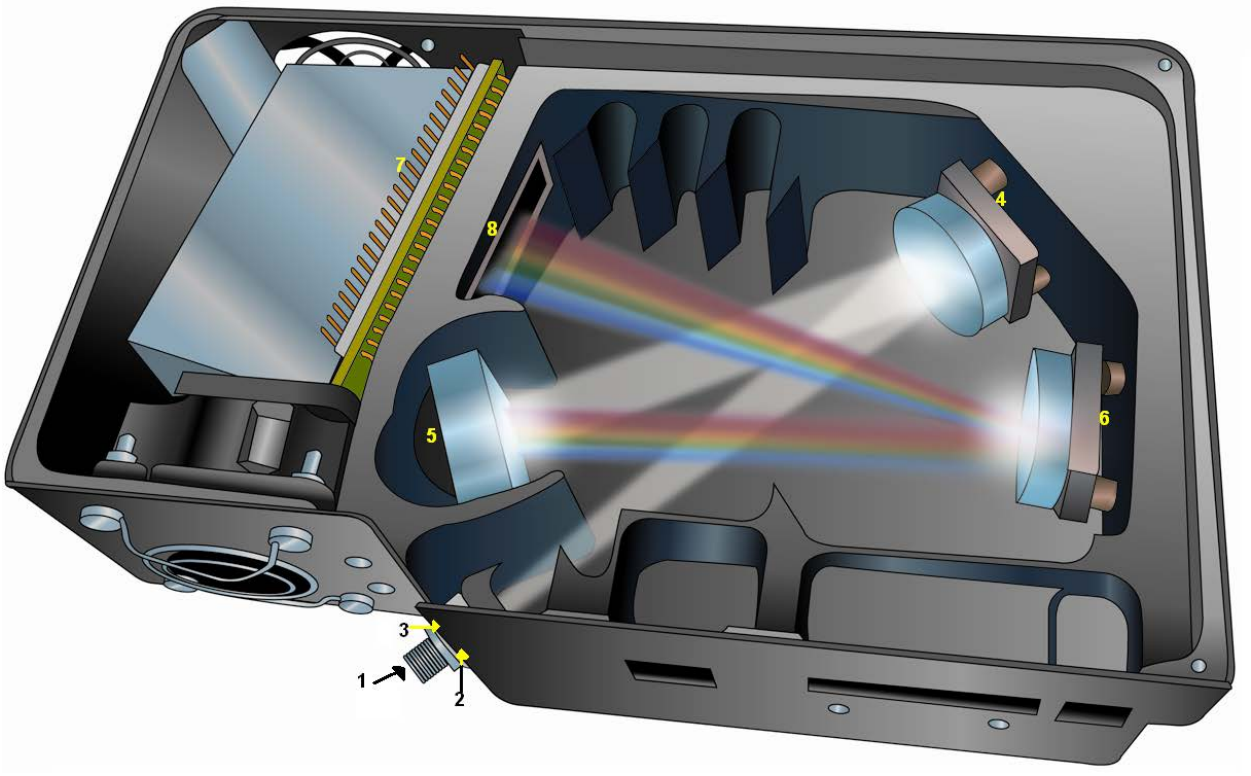
Specifications

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 QE *Pro* Works

Below is a diagram of how light moves through the optical bench of a QE *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.



QE *Pro* Spectrometer with Components

QE *Pro* Components Table

Ocean Optics permanently secures all components in the QE *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	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 QE *Pro* without a Slit. In this configuration, the diameter of the fiber connected to the QE *Pro* 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	Back-thinned Area Detector with TE Cooling	Provides 90% quantum efficiency and bins pixels in a vertical column to acquire light form 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. Only Ocean Optics technicians can add or remove the Detector.
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 QE *Pro*.

QE *Pro* Specifications

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

CCD Detector Specifications

Specification	Value
Detector	Hamamatsu S7031-1006 Low Etaloning
Detector range	185-1100 nm
Pixels	1024 active
Pixel size	24 μm^2
Quantum efficiency	90% peak; 65% at 250 nm. See *Quantum Efficiency of Detector* graph below.

QE *Pro* Spectrometer Specifications

Specification	Value
Integration time	8 ms to 60 minutes
Typical dynamic range	~85,000:1
Signal-to-noise ratio	1000:1 (single acquisition)
Readout Noise	2.5 counts RMS (typical)
Stray light	<0.08% at 600 nm; 0.4% at 435 nm
Linearity Corrected	0.5% nonlinearity (max)
f number	f/4
Fiber optic connector	SMA 905 and Ocean Optics FC
Gratings	14 gratings available (H1--H14), HC1 grating
Entrance aperture	5, 10, 25, 50, 100 or 200 µm wide slits (or SMA/FC bulkhead with no slit)

Specification	Value
Optical resolution (FWHM)	Depends on grating and size of entrance aperture
OFLV filters	OFLV-QE (200-950 nm); OFLV-QE-250 (250-1000 nm); OFLV-QE-300 (300-1050 nm); OFLV-QE-350 (350-1100 nm); OFLV-QE-400 (400-1150 nm)
Temperature Operation	TE Cooler can only cool 40 °C below ambient temperature -40 °C to +50 °C
Humidity	≤ 90% noncondensing
Power consumption TEC On @ 40° below ambient TEC Off	 15W (Max) 2.5W (Max, Typical)
Supply Voltage	4.5 – 5.5 V
Power-up Time	7 seconds
Interfaces	USB 2.0, 480 Mbps (USB 1.1 compatible); RS-232 (5-wire)
Dimensions (LxWxH)	182 mm (7.16 in.) x 110 mm (4.33 in.) x 47 mm (1.85 in.)
Weight QE *Pro* Power Supply	 1.15 kg (2.6 lbs.) 0.45 kg (1 lb.)

System Compatibility

You can use the QE *Pro*'s USB connectivity with any computer that meets the requirements for the spectrometer operating software being used (Windows XP/Vista/Windows 7/8, Mac OS X and Linux). See *About Ocean Optics Software*.

Alternately, the QE *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 QE *Pro*, the HR4000 Breakout Box, and a serial cable.

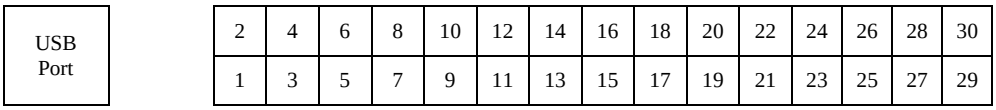
30-Pin Accessory Connector Pinout

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

Location of QE *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 QE *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 QE *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 Input Output
4	-	-	Unused

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 Input Output
8	I2C SDA	Input/Output	I2C data signal for communication to other I2C peripherals
9	GPIO (1)	Input/Output	General Purpose Input Output
10	Ext. Trigger In	Input	CMOS input trigger tolerant from 3-5V
11	GPIO (3)	Input/Output	General Purpose Input Output
12	VOUT	Output	Output power pin for QE *Pro*
13	SPI_MOSI	Output	SPI Master Out Slave In (MOSI) signal for communication to other SPI peripherals
14	VOUT	Output	Output power pin for QE *Pro*
15	SPI MISO	Input	SPI Master In Slave Out (MISO) signal for communication to the other SPI peripherals
16	GPIO (4)*	Input /Output	General Purpose Input Output
17	Single Strobe	Output	CMOS (3.3V) 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 Input Output
19	SPI Clock	Output	SPI clock signal for communication to other SPI peripherals
20	Continuous Strobe	Output	CMOS output signal used to pulse a strobe – Divided down from the master clock signal
21	SPI CS	Output	External SPI chip select (active low)
22	GPIO (6)	Input/Output	General Purpose Input Output
23	RESET	Input	This pin is pulled up to 5V by a 10K internal resistor. Pull down to ground to reset. Leave open for normal operation.
24	RS-232 CTS	Output	RS-232 Clear to Send control logic signal – used to enable or suspend host transmission to the QE *Pro*
25	Lamp Enable	Output	CMOS signal driven Active HIGH when the Lamp Enable

Pin #	Function	Input/Output	Description
			command is sent to the spectrometer
26	GPIO (7)	Input/Output	General Purpose Input Output
27	RS-232 RTS	Input	RS-232 Request To Send control logic signal -- used to enable QE *Pro* transmission to the host
28	GPIO (8)	Input/Output	General Purpose Input Output
29	Ground	Input/Output	Ground
30	GPIO (9)	Input/Output	General Purpose Input Output

30-Pin J2 Accessory Connector - Part Numbers

The part numbers for the 30-pin accessory connector on the QE *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, HR4-CBL-DB15).

HR4-CBL-DB15 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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