QE65000 Scientific-grade Spectrometer

Installation and Operation Manual
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About This Manual

Document Purpose and Intended Audience

This document provides the user of the QE65000 Spectrometer with instructions for setting up, calibrating and performing experiments with their spectrometer.

What's New in this Document

This version of the *QE65000 Scientific-grade Spectrometer Installation and Operation Manual* updates information for external triggering.

Document Summary

Chapter	Description
Chapter 1: *Introduction*	Contains descriptive information about the QE65000 Spectrometer and how sampling works. It also provides a list of system requirements, interface options, and shipment components.
Chapter 2: *Installing the QE65000*	Provides installation and configuration instructions.
Chapter 3: *Troubleshooting*	Contains recommended steps to isolate and correct common problems.
Appendix A: *Calibrating the Wavelength of the QE65000*	Provides instructions for calibrating the QE65000 Spectrometer.
Appendix B: *Specifications*	Contains technical specifications and connector pinouts for the QE65000 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 is located at: **http://www.oceanoptics.com/technical/SpectraSuite.pdf**.
- Detailed instructions for Overture Spectrometer Operating Software are located at: **http://www.oceanoptics.com/technical/Overture.pdf**

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

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

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

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

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

- **http://www.oceanoptics.com/technical/engineering/QE65000%20Addendum.pdf**

- **http://www.oceanoptics.com/technical/engineering/engineering/OEM%20Data%20Sheet%20--%20QE65000.pdf**

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

Upgrades

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

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Chapter 1

Introduction

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Product Overview

The Ocean Optics QE65000 Spectrometer is a novel combination of detector, optical bench and electronics technologies that provide you with a remarkably sensitive system for demanding, low-light level applications such as fluorescence, DNA sequencing and Raman spectroscopy. The QE65000 is Ocean Optics' most sensitive spectrometer, achieving up to 90% quantum efficiency with high signal-to-noise and improved signal processing speed.

Ocean Optics QE65000 High-Sensitivity Fiber Optic Spectrometer

The QE65000 features a Hamamatsu back-thinned detector with a 2-D arrangement of pixels (1044 horizontal x 64 vertical) that is responsive from 200-1100 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 ºC 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 combination of the spectrometer's low-noise detector and 16-bit A/D Converter delivers a dynamic range of 25000:1 and a signal-to-noise ratio of 1000:1.

The QE65000'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.

TheQE65000'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 QE65000 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 S7031-1006 Detector
  - Peak QE: 90% @ 700 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
  - 6 slit widths
- 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
- CE certification

System Requirements

You can use the QE65000's USB connectivity with any computer that meets the requirements for the spectrometer operating software being used (Windows 98/Me/2000/XP, Mac OS X and Linux). See *About Ocean Optics Software*.

Alternately, the QE65000 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 QE65000, the Breakout Box, and a serial cable.

EEPROM Utilization

An EEPROM memory chip in each QE65000 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

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*).

Overture software is available for free for limited spectroscopy operating functionality such as absorbance and transmission measurements (see *Product-Related Documentation*).

OOIBase32 software has been discontinued, but still functions with the QE65000 Spectrometer. Consult the OOIBase32 manual for hardware requirements when using OOIBase32 (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 OOI software.

7. OOI 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 QE65000. 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 QE65000 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. SpectraSuite 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	SpectraSuite: Windows 2000/XP for PC, OS X version 10.0 or later for Mac, or Red Hat 9 or later, Fedora (any version), Debian 3.1 (Sarge), and SUSE (9.0 or later), Centos, and Ubuntu for Linux OOIBase32: Windows 98/Me/ 2000/XP	USB-CBL-1 (included)	Cable that connects from USB port on QE65000 to USB port on desktop or notebook PC
Desktop or Notebook PC via Serial Port	Any 32-bit Windows operating system	HR4-BREAKOUT (not included)	Adapter block that enables connection from serial port on QE65000 to serial port on desktop or notebook PC; comes with 5 VDC power supply (required when connecting to serial port)

Shipment Components

❑ QE65000 Spectrometer
❑ + 5VDC power supply

The following information and documentation also ships with the QE65000 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. Any other interface requires that you manually enter the calibration data in OOIBase32 (select **Spectrometer | Configure | Wavelength Calibration** tab). See the OOIBase32 documentation for more information (refer to *Product-Related Documentation* for instructions on accessing OOIBase32 documentation).

Note

Please save the Wavelength Calibration Data Sheet for future reference.

❑ **Software and Technical Resources CD**

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

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

Other Accessories Available

Visit us at **www.OceanOptics.com** for a complete list of products available for all of your spectroscopy needs.

- ❑ **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' QE65000 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 QE65000

Overview

You must install the operating software application prior to connecting the QE65000 Spectrometer to the computer. The Ocean Optics spectrometer operating software installs the drivers required for the QE65000 spectrometer installation. If you do not install the software first, the system will not properly recognize the QE65000.

If you have already connected the QE65000 to the computer prior to installing the operating software, consult *Chapter 3: Troubleshooting* for information on correcting a corrupt QE65000 installation.

QE65000 Installation

This section contains instructions for connecting the QE65000 via both USB and serial modes.

Caution

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

USB Mode

This section contains instructions for connecting the QE65000 in USB mode. To connect the QE65000 to a computer via the USB port, the computer must be running a Windows 2000/XP, Mac OS X or Linux operating system.

► *Procedure*

Follow the steps below to connect the QE65000 to a computer via the USB port:

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

2. Locate the USB cable (USB-CBL-1) provided with the QE65000.

3. Insert the square end of the cable into the side of the QE65000.

4. Insert the rectangular end of the cable into the USB port of the PC.

5. If you intend to run the TE Cooler, plug the +5 VDC power supply into the QE65000.

If you installed the spectrometer operating software prior to connecting the QE65000, the software installs the QE65000 drivers. If the drivers do not successfully install (or if you connected the QE65000 to the computer before installing the software), consult *Chapter 3:* *Troubleshooting*.

Serial Port Mode

To use the serial port capacity of the QE65000 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 QE65000 to the PC via serial port:

1. Connect the serial cable adapter block to the appropriate pins of the QE65000's 30-Pin Accessory Connector.

2. Connect one end of the 9-pin serial cable to the adapter block on the QE65000, and then connect the other end to a serial port on the PC.

3. Note the number of the serial port (COM Port) to which you connected the QE65000 (some PCs may not have numbered ports; handheld PCs typically have only one serial port).

4. Plug the 5 VDC external power supply into an outlet and connect it to the QE65000.

Configuring the QE65000

The QE65000 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 QE65000 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.

SpectraSuite QE65000 Spectrometer Features

Select **Spectrometer | Spectrometer Features**, then select the TEC tab to display the QE65000 Spectrometer controls.
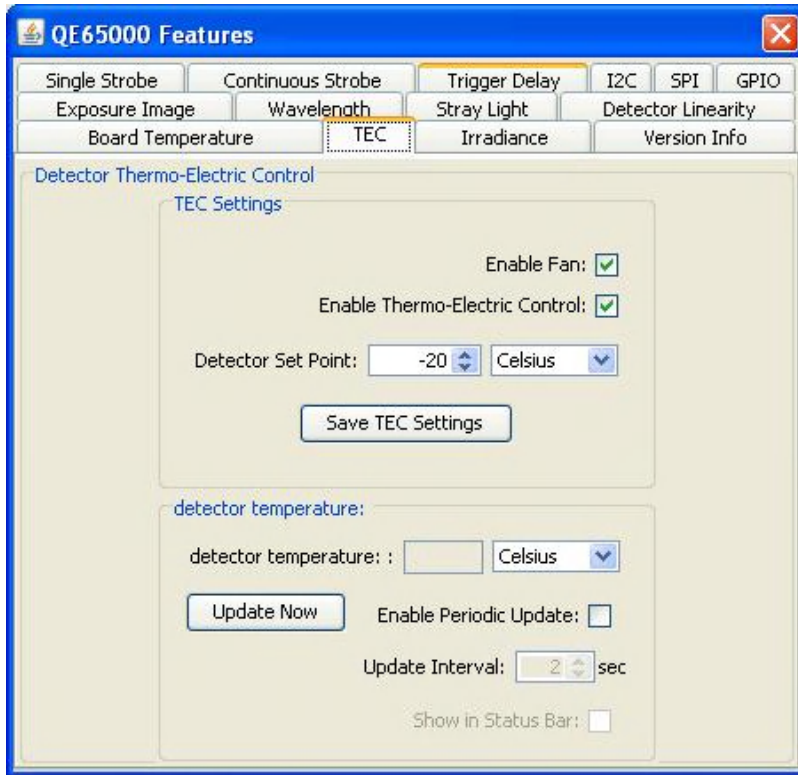
Control	Description
Enable Fan	Check this box to turn on the cooling fan.
Enable Thermo-Electric Control	Check this box to enable (recommended setting for laboratory conditions) or uncheck to disable the thermoelectric cooler. Be sure to always turn on TEC power before applying USB power.
Detector Set Point	Enter the target temperature of the QE65000 Spectrometer detector. The default is -10ºC. The TEC and fans will operate until the detector reaches this temperature.
Detector temperature	Displays the current temperature of the detector in the QE65000 Spectrometer.
Enable Periodic Update	Check this box to enable periodic update of the QE65000 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.

Configuring the QE65000 in OOIBase32

Once you install the QE65000, you must configure OOIBase32's **Configure Spectrometer** options so that OOIBase32 recognizes the QE65000 Spectrometer. Consult the *OOIBase32 Spectrometer Operating Software Operating Instructions* for detailed instructions on configuring the spectrometer in OOIBase32 (see *Product-Related Documentation*).

QE65000 Controls in OOIBase32

The QE65000 toolbar in OOIBase32 allows you to control a variety of options on the QE65000 Spectrometer. Click your right mouse button while in the OOIBase32 toolbar to display the QE65000 toolbar.

Note

If 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. Be sure to always turn on TEC power before applying USB power.
Det. Temp. Set Point	Enter the target temperature of the spectrometer detector in the range of 30 to 45 degrees below ambient temperature. The TEC and fans will operate until the detector reaches this temperature. The default is -10ºC. NOTE: This assumes that your spectrometer is in the standard lab environment (no extreme temperatures).
Apply	Click this button to apply the changes made in this toolbar to the QE65000 Spectrometer.
Current Det. Temp.	Displays the current temperature of the detector in the spectrometer.

Connect Spectroscopic Accessories

To find operating instructions for QE65000-compatible products (such as light sources, sampling chambers, and probes), consult the *Software and Technical Resources* CD or the Ocean Optics website at **http://www.oceanoptics.com/technical/operatinginstructions.asp**.

External Triggering Options

You can trigger the QE65000 using a variety of External Triggering options through the 30-pin Accessory Connector on the spectrometer.

For QE65000 firmware versions below 3.0, see the External Triggering Options document located at **http://www.oceanoptics.com/technical/External-Triggering.pdf**.

For QE65000 firmware version 3.0 and above, 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 QE65000.

Note

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

Troubleshooting

Overview

The following sections contain information on troubleshooting issues you may encounter when using the QE65000 Spectrometer.

QE65000 Connected to Computer Prior to Software Installation

Windows Operating Systems

If you connected your Ocean Optics QE65000 device to the computer prior to installing your spectrometer operating software application (SpectraSuite, Overture or OOIBase32) 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.

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Note

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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 QE65000 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

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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 QE65000 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.

Calibrating the Wavelength of the QE65000

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 QE65000.

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 QE65000 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 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.

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
Adjusted R Square	0.999999607
Standard Error	0.125540214
Observations	22

R Squared

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 QE65000 onto an EEPROM memory chip in the QE65000.

You can overwrite old calibration coefficients on the EEPROM if you are using the QE65000 via the USB port.

► *Procedure*

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

1. Ensure that the QE65000 is connected to the PC and that you have closed all other applications.

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

3. Save the setup file to your computer.

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

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

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

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

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

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

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

11. Click on the desired QE65000 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 QE65000.

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 QE65000 Works

Below is a diagram of how light moves through the optical bench of a QE65000 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.
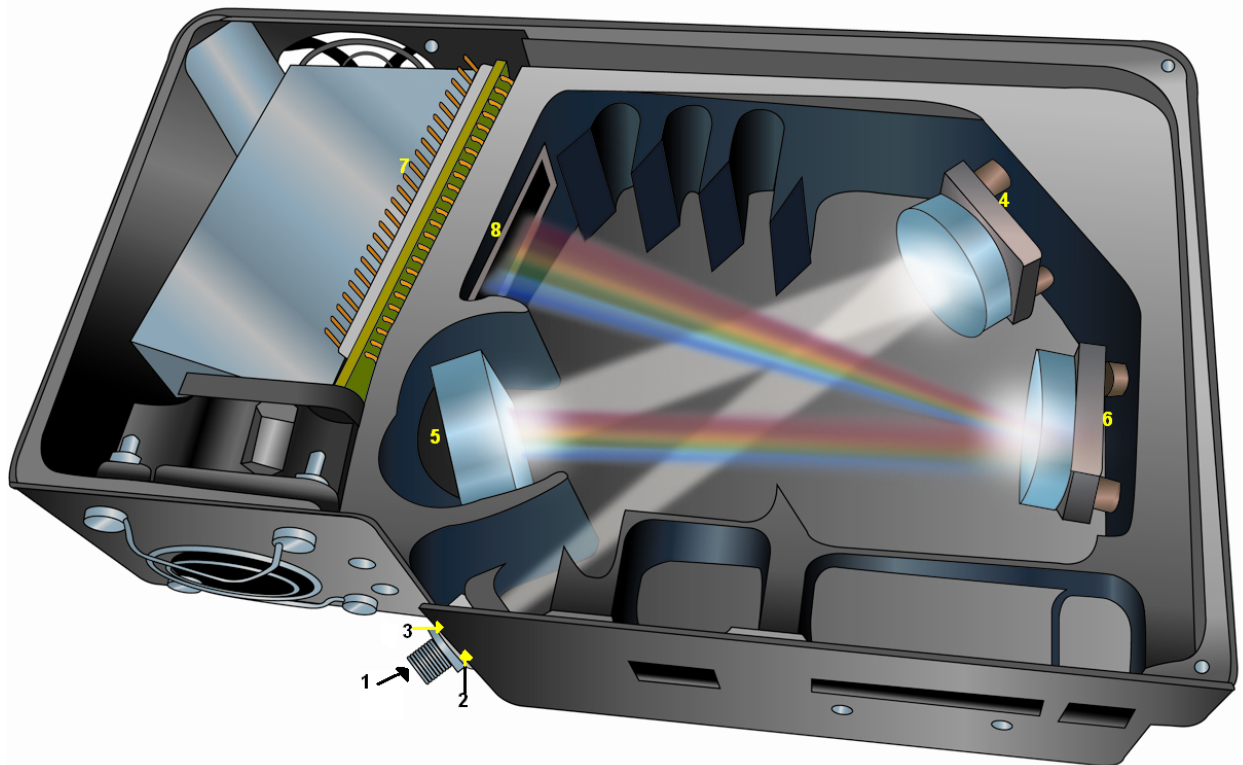
QE65000 Spectrometer with Components

QE65000 Components Table

Ocean Optics permanently secures all components in the QE65000 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 QE65000 without a Slit. In this configuration, the diameter of the fiber connected to the QE65000 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 QE65000.

QE65000 Specifications

The following sections provide specification information for the CCD detector in the QE65000, as well as the QE65000 Spectrometer itself.

CCD Detector Specifications

Specification	Value
Detector	Hamamatsu S7031-1006, back-thinned FFT-CCD
Spectral range	200-1100 nm with window, VUV option available (150nm). VUV option includes purge port and window removal (no TE cooling). 200-925 nm with HC1 grating.
Active area	24.576 x 1.392mm
Pixel size	24.6 µm square
Full Well Capacity	300,000 electrons (vertical), 600,000 typical (horizontal)
Dark Current	4000 e/pixel/sec @ 25 ºC; 200 e/pixel/sec @ 0 ºC
Dark noise	3 RMS counts
Readout noise	1.5 counts RMS (40 electrons)
Linearity Correction	>99.8%
Quantum efficiency	90% at 700 nm peak; 65% at 250 nm. See *Quantum Efficiency of Detector* graph below.
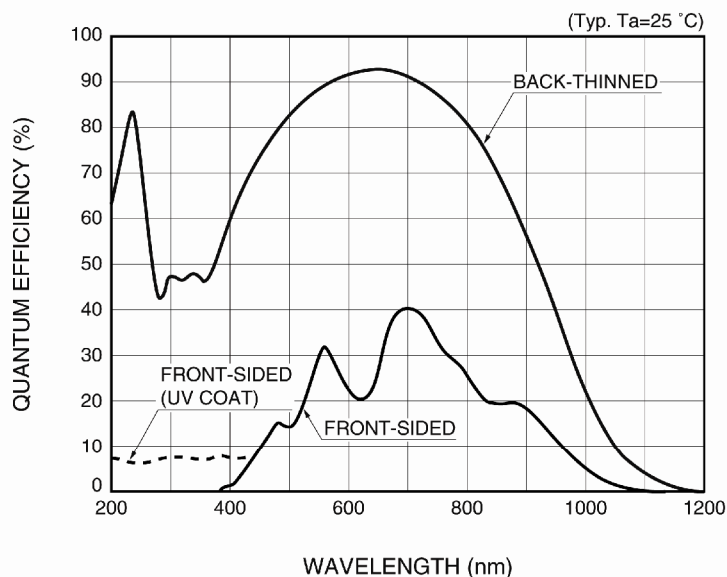
Quantum Efficiency of Detector

QE65000 Spectrometer Specifications

Specification	Value
Dimensions (LxWxH)	182 mm (7.16 in.) x 110 mm (4.33 in.) x 47 mm (1.85 in.)

Weight
  QE65000
  Power Supply
	
	1.18 kg (2.53 lbs.)
	0.45 kg (1 lb.)

Temperature
  Operation
  Storage
	TE Cooler can only cool 40 °C below ambient temperature
	0 °C to +50 °C
	–30 °C to +70 °C

Humidity	0 – 90% noncondensing

Power consumption
  No TE Cooler
  With TE Cooler
	
	500 mA @ 5 VDC
	3.5A at 5 VDC

Supply Voltage	4.5 – 5.5 V
Power-up Time	~ 2s depending on code size
Signal-to-noise ratio	1000:1 (single acquisition)

Specification	Value
Gratings	14 gratings available
Entrance aperture	5, 10, 25, 50, 100 or 200 µm wide slits
Order-sorting filters	6 OF series available
Focal length (input)	f/4, 101 mm
Optical resolution (FWHM)	Depends on grating and size of entrance aperture
Stray light	<0.08% at 600 nm; 0.4% at 435 nm
Dynamic range	7.5×10^9 (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
Interfaces	USB 2.0, 480 Mbps (USB 1.1 compatible); RS-232 (3-wire)

System Compatibility

You can use the QE65000's USB connectivity with any computer that meets the requirements for the spectrometer operating software being used (Windows 2000/XP, Mac OS X and Linux). See *About Ocean Optics Software*.

Alternately, the QE65000 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 QE65000, the HR4000 Breakout Box, and a serial cable.

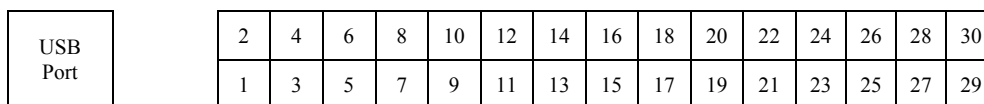# 30-Pin Accessory Connector Pinout

The QE65000 features a 30-pin Accessory Connector, located on the side of the unit as shown:

Location of QE65000 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 QE65000, pin numbering is as follows:

USB Port	

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

30-Pin Accessory Connector Pinout Diagram

30-Pin Accessory Connector – Pin Definitions and Descriptions

The following table contains information regarding the function of each pin in the QE65000'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)

Pin #	Function	Input/Output	Description
4	N/A	N/A	Reserved
5	Ground	Input/Output	Ground
6	I^{2}C SCL	Input/Output	I^{2}C clock signal for communication to other I^{2}C peripherals
7	GPIO (0)	Input/Output	General purpose software-programmable, digital input/output (channel number)
8	I^{2}C SDA	Input/Output	I^{2}C data signal for communication to other I^{2}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$_{CC}$ or 5V$_{IN}$	Input or Output	Input power pin for QE65000 – 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$_{CC}$ or 5V$_{IN}$	Input or Output	Input power pin for QE65000 – 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

Pin #	Function	Input/Output	Description
21	SPI Chip Select	Output	SPI Chip/Device Select signal for communication to other SPI peripherals
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 QE65000 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).

QE65000 15-Pin Accessory Cable Pinout

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

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