



**Torus Concave Grating
Spectrometers**

Installation and Operation Manual



For Products: Torus
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About This Manual

Document Purpose and Intended Audience

This document provides the users of Torus Spectrometers with instructions for setting up, calibrating and performing experiments with their spectrometer.

What's New in this Document

This version of the Torus Spectrometer Installation and Operation Manual updates the specifications.

Document Summary

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

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	http://oceanoptics.com//wp-content/uploads/OceanViewIO.pdf
SpectraSuite software	http://oceanoptics.com//wp-content/uploads/SpectraSuite.pdf
HR-4 Breakout Box	http://oceanoptics.com//wp-content/uploads/HR-4-Breakout-Box.pdf
External triggering for firmware versions	http://oceanoptics.com//wp-content/uploads/External-Triggering-Options.pdf

Document for...	Document Location
below 3.0	
External triggering for firmware versions 3.0 and above	http://oceanoptics.com//wp-content/uploads/External-Triggering-Options_Firmware3.0andAbove.pdf

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, first contact Customer Support to 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.

Compliance

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

The Torus family of spectrometers offers a unique combination of technologies with a concave grating, a powerful 2-MHz analog-to-digital (A/D) converter, programmable electronics, a 2048-element CCD-array detector, and a high-speed USB 2.0 port. Torus is exceptional because it features an aberration-corrected, holographic, toroidal diffraction grating that delivers low stray light, high throughput and excellent thermal stability. This makes this family of spectrometers ideal for a wide range of research and OEM applications such as:

- Detecting trace gas amounts in the atmosphere
- Precision measurement of LEDs, lasers and other light sources
- Absorbance measurement of optically dense solutions
- Fluorescence from solid surfaces
- Medical dosimetry in tissue and other biological media

Our first Torus model is a visible spectrometer (360-825 nm) whose spectral range and low stray light make it especially useful for measuring color, while its increased sensitivity and throughput make it ideal for low light level applications.

The Torus Spectrometer connects to a computer via the USB port or serial port. When connected through a USB 2.0 or 1.1, the spectrometer draws power from the host computer, eliminating the need for an external power supply. The Torus, like all our USB devices, can be controlled by our OceanView software, a Java-based spectroscopy software platform that operates on Windows, Macintosh and Linux operating systems.



Ocean Optics Torus Fiber Optic Spectrometer Typical Set-up

Features

- ❑ Sony ILX511B 2048-element linear silicon CCD array detector
- ❑ Responsive from 360 to 825 nm
- ❑ An optical resolution of ≤ 1.6 nm (FWHM)
- ❑ Integration times from 1 ms to 65 seconds
- ❑ EEPROM storage for
 - Wavelength Calibration Coefficients
 - Linearity Correction Coefficients
 - Absolute Irradiance Calibration (optional)
- ❑ Interchangeable slits
- ❑ Low power consumption of only 250 mA @ 5 VDC
- ❑ 16 bit, 3MHz A/D Converter
- ❑ 4 triggering modes
- ❑ 30-pin connector for interfacing to external products
- ❑ CE Certification
- ❑ RoHS compliant

System Requirements

You can use the Torus' USB connectivity with any computer that meets the following requirements:

- Microsoft Windows – Windows 2000/XP/7; 32-bit and 64-bit and Windows Vista (32-bit only)
- Apple Macintosh – OS X version 10.0 or later
- Linux – Any version released for an x86 or amd64 platform since 2010

EEPROM Utilization

An EEPROM memory chip in each Torus contains wavelength calibration coefficients, linearity coefficients, and a serial number unique to each individual spectrometer. The spectrometer operating 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 from the light source 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 your spectroscopy operating software.
7. The software compares the sample to the reference measurement and displays processed spectral information.

Interface Options

The Torus has both USB and serial port connectors (with the use of an adapter), enabling you to connect the spectrometer to a computer via a USB 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.

Shipment Components

The following information and documentation ships with the Torus 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.
- ❑ **USB Cable (USB-CBL-1)**
Use this cable to connect your spectrometer to a computer running on a Windows, Mac or Linux operating system.
- ❑ **Wavelength Calibration Data Sheet**
Each spectrometer is shipped with a Wavelength Calibration Data Sheet that contains information unique to your spectrometer. The 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.

- ❑ **Fibers**
- ❑ **Light Sources**
- ❑ **Integrated Sampling Systems**
- ❑ **Cuvettes**
- ❑ **Filter Holders**

Installing the Torus

Overview

You must install the spectroscopy operating software application prior to connecting the Torus Spectrometer to the computer. This software installs the drivers required for Torus installation. If you do not install the software first, the system will not properly recognize the Torus.

If you have already connected the Torus to a computer running on a Windows platform prior to installing your software, consult *Chapter 3: [Troubleshooting](#)* for information on correcting a corrupt Torus installation.

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

Torus Installation

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

USB Mode

Note

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

► Procedure

Follow the steps below to connect the Torus 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 Torus.
3. Insert the square end of the cable into the side of the Torus.
4. Insert the rectangular end of the cable into the USB port of the computer.

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

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

Serial Port Mode

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

► **Procedure**

Follow the steps below to connect the Torus to the computer via serial port:

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

Connect Spectroscopic Accessories

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

Torus Configuration

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

If you have followed the previous steps and started your 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.

Consult your spectrometer operating software manual for detailed instructions on operating your spectrometer (see [Product-Related Documentation](#)).

Change the Slit

There's no need to calibrate your spectrometer when changing the slit, just install and start measuring. There is one exception to this. You cannot change from a standard slit to a slit with a filter because it changes the optical focus and wavelength calibration of the spectrometer. In this case you would need to send the spectrometer back to Ocean Optics. A filter must be ordered for each slit (if your application requires a filter) and the spectrometer needs to be calibrated and focused with the filter installed. This only applies to filters installed inside the slit assembly.

► Procedure

1. Find the SMA connector. If a fiber is attached, remove it.



2. Use the Allen key to remove the 2 the screws attaching the slit to the spectrometer.
3. Pull the slit out of the spectrometer.
4. Put the new INTSMA slit connector into the spectrometer; with the key of the connector on the left side.



5. Install the 2 screws again. Use the Allen key to tighten the screws carefully (do not over-tighten).
6. If necessary, connect the fiber again.

Troubleshooting

Overview

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

Torus Connected to Computer Prior to Software Installation

Windows Operating Systems

If you connected your Ocean Optics Torus device to the computer prior to installing your Ocean Optics software application 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 Torus from your computer.
6. Replug the spectrometer into your computer.

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

Mac Operating Systems

Since there are no device files for the Torus Spectrometer in a Mac operating system, you should not encounter any problems if you installed the spectrometer before the 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 Torus

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 Torus.

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:

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/pixel²)

C_3 = the third coefficient (nm/pixel³)

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 Torus 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

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 # 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

- 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 Torus onto an EEPROM memory chip in the Torus.

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

► **Procedure**

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

1. Ensure that the Torus is connected to the computer 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 Torus 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 Torus.

External Triggering

Overview

The Torus supports four triggering modes, which are set with the Trigger Mode command. Details of each triggering mode follow.

Normal (Free Running)

In this mode, the Torus uses the user-defined integration clock and continuously scans the CCD array. All of the signals described in the previous section are provided by the spectrometer to the CCD automatically based on the integration time selected in the software by the user.

External Software Trigger

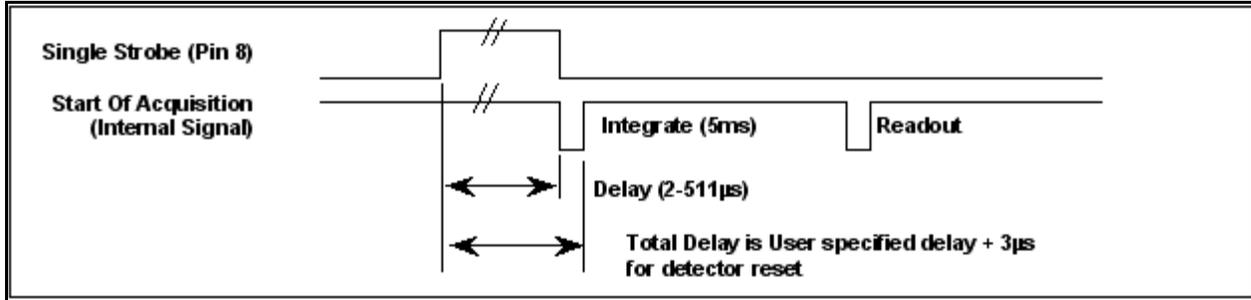
In this mode, the ExtTrigIn signal acts as an enable switch. If ExtTrigIn is kept HIGH, the Torus will acquire spectra as if it was in the normal free running mode. If ExtTrigIn is kept LOW, the Torus will not acquire spectra.

External Hardware Trigger

On the Torus, Ocean Optics has altered the functionality of the External Hardware Trigger function and reprogrammed the Single Strobe signal function. These alterations of the USB2000 enable you to operate in the Variable Delay Mode without the presence of an external trigger signal. The Torus will simulate the signal to trigger the appropriate circuitry in the spectrometer.

The table below summarizes the capacity of the Torus in Variable Delay Mode:

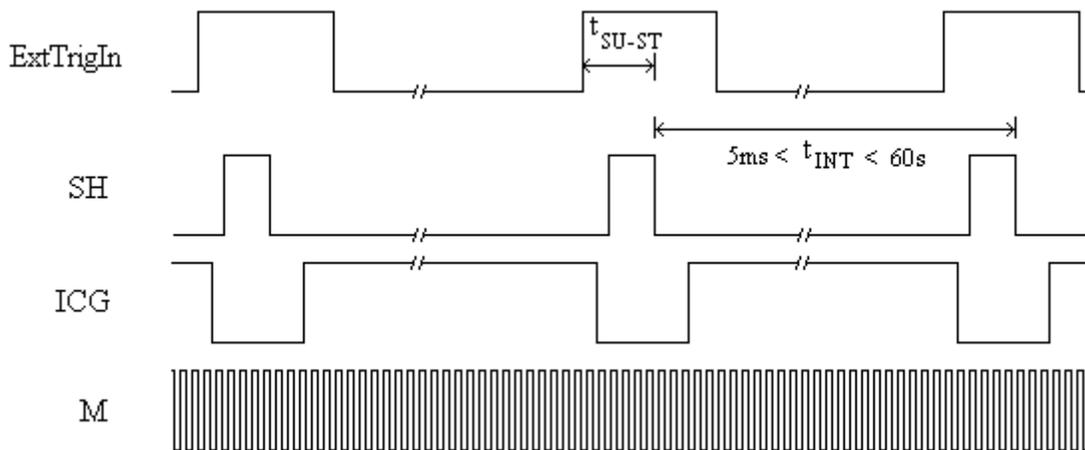
Parameter	Value in Normal Acquisition Mode	Value in Variable Delay Mode
Integration time	User controlled	5 ms fixed
Strobe delay	0 μ s	2 – 511 μ s + 3 μ s
Jitter	< 25 ns	< 25 ns



Timing Diagram for Variable Delay Mode

External Synchronization Trigger

In this mode of the Torus, the integration clock is essentially input into the spectrometer. The synchronized trigger must have a frequency range of 5ms to 60s (shutter mode cannot be used in External Synchronization Trigger mode). If no External Trigger Input Signal is applied, the spectrometer will not take any spectra, and the software will appear “frozen” until an External Trigger Input Signal is detected. With a continuous ExtTrigIn, the spectrometer will provide the required signals to the CCD as shown below:



External Synchronization Trigger

The time between when ExtTrigIn goes HIGH and the beginning of the integration period is specified to be between $8\mu\text{s} < t_{\text{SU_ST}} < 10\mu\text{s}$. The ExtTrigIn signal does not need to have an even duty cycle, but the time between rising edges should remain constant for a given integration time.

Appendix C

Specifications

Overview

This appendix contains information on specifications.

Torus Specifications

The following table provides specification information for the Torus.

Specification	Value
Spectrometer	Torus
Dimensions	149.9 mm x 119.4 mm x 63.5 mm
Weight	954 g
Grating	Toroidal concave holographic (blazed at 400 nm)
Detector	2048-element linear silicon CCD array; Sony ILX511B
Wavelength range	360-825 nm
Entrance aperture	5, 10, 25, 50, or 100 μm wide slits or fiber with user-selectable aperture (tested at F3 and F4)
Integration time	1 ms to 65 seconds
Data transfer rate	Full spectrum every 1 ms with USB 2.0 port, 15 ms with USB 1.1 port, 200 ms with serial port
Optical resolution	≤ 1.6 nm FWHM over the spectral range
Power consumption	250 mA @ 5 VDC
Computer interface	Universal Serial Bus (RS-232 available on side connector)

C: Specifications

Specification	Value
Computer requirements*	IBM-compatible PC with Pentium or better microprocessor 32 MB RAM (16 MB) Windows 2000/XP/7 (32 and 64-bit) and Windows Vista (32-bit only), Mac OS X and Linux when using the USB interface on desktop or notebook PCs. Any 32-bit Windows operating system when using the serial port on desktop or notebook PCs. CE 2.11 and above when using the serial port on handheld PCs.
Operating software	OceanView (for an additional cost)
Fiber optic connector	SMA 905 to single-strand optical fiber

* Download [free software](#) to analyze your computer's USB readiness by clicking here. Windows 2000/XP/7; 32-bit and 64-bit and Windows Vista (32-bit only)

Accessory Connector Pinout

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



Location of Torus Accessory Connector

Accessory Connector Pinout Diagram

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

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

Accessory Connector – Pin Definitions and Descriptions

The following table contains information regarding the function of each pin in the Torus’s 30-Pin Accessory Connector:

Pin #	Function	Input/Output	Description
1	RS232 Rx	Input	RS232 receive signal – Communicates with a computer over DB9 Pin 1
2	RS232 Tx	Output	RS232 transmit signal – Communicates with a computer over DB9 Pin 2
3	GPIO (2)	Input/Output	Reserved
4	V5-SW	N/A	
5	Ground	Input/Output	Ground
6	I2C SL	Input/Output	I2C clock signal for communication to other I2C peripherals
7	GPIO (0)	Input/Output	Base clock
8	I2C SDA	Input/Output	
9	GPIO (1)	Input/Output	Master clock
10	Ext. Trigger In	Input	TTL input trigger signal
11	GPIO (3)	Input/Output	Integration clock
12	VCC, VUSB or 5Vin	Input or Output	Input power pin for Torus – When operating via USB, this pin can power other peripherals – Ensure that peripherals comply with USB specifications
13	MOSI	Output	The SPI Master Out Slave In (MOSI) signal for communications to other SPI peripherals
14	VCC, VUSB or 5Vin	Input or Output	Input power pin for Torus – When operating via USB, this pin can power other peripherals – Ensure that peripherals comply with USB specifications

C: Specifications

Pin #	Function	Input/Output	Description
15	MISO	Input	The SPI Master In Slave Out (MISO) signal for communications to other SPI peripherals
16	GPIO (4)	Input/Output	Reserved
17	Single Strobe	Output	TTL output pulse used as a strobe signal – Has a programmable delay relative to the beginning of the spectrometer integration period
18	GPIO (5)	Input/Output	Acquire spectra (read enable)
19	SPI Clock	Output	The SPI Clock signal for communications to other SPI peripherals
20	Continuous Strobe	Input/Output	TTL output pulse used as a strobe signal – Has a programmable delay relative to the beginning of the spectrometer integration period
21	SPI Chip Select	Output	The SPI Chip/Device Select signal for communications to other SPI peripherals
22	GPIO (6)	Input/Output	Reserved
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	Reserved
27	Ground	Input/Output	Ground
28	N/A	N/A	
29	Ground	Input/Output	Ground
30	N/A	N/A	

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