OCEAN ST SERIES

Compact Spectrometers

Installation and Operation Manual

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Before You Get Started

Warnings & Cautions

Caution: Read this manual thoroughly before using and operating this equipment.

Caution: Do not let contaminants get into the bench. Keep the protective cap on the slit aperture when not connected to an accessory, probe or fiber.

Caution: Only change the slit aperture in a clean environment where contaminants including dust cannot enter the bench during the procedure.

Caution: Substitution of a component or accessory different from that supplied may result in measurement error, equipment damage, increased radio-frequency emissions or decreased immunity from electrical disturbances.

Caution: Repairs should be undertaken only by personnel trained or authorized by Ocean Optics. The device does not contain any user serviceable parts.

Caution: Do not immerse the device in any fluid, place fluids on top of or attempt to clean with liquid detergents or cleaning agents. This may cause an electrical hazard. Use a clean linen cloth to wipe the equipment. Do not use if accidental wetting occurs.

Caution: Do not remove any covers. Doing so may increase the risk of electrical shock or compromise the integrity of the optical components.

Caution: Do not gas sterilize or autoclave this device.

Caution: Consult local codes and ordinances for proper disposal of equipment and other consumable goods.

Caution: The device and/or accessories may not operate correctly if used or stored outside the relevant temperature and humidity ranges described in the Technical Specifications.

Caution: Do not use if device is dropped and/or damaged. Have an authorized service representative check the device before using again.

Caution: Be sure to install any software BEFORE connecting the spectrometer to your PC or host system. The software installs the drivers required for spectrometer installation. If you do not install the software first, the system may not properly recognize the spectrometer.

Caution: The user of this spectrometer shall have the sole responsibility for any malfunction that results from improper use, faulty maintenance, improper repair, damage or alteration by anyone other than Ocean Optics or their authorized service personnel.

Warranty

For the most current warranty information, please visit OceanOptics.com.

Certifications and Compliance

Warning	This is an FCC 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.

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.

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.

WEEE Compliance	The WEEE symbol on the product indicates that the product must not be disposed of with normal household waste. Instead, such marked waste equipment must be disposed of by arranging to return to a designated collection point for the recycling of waste electrical and electronic equipment. Separating and recycling this waste equipment at the time of disposal will help to conserve natural resources and ensure that the equipment is recycled in a manner that protects human health and the environment.

CE	This device has been tested and complies with the following standards: EN 61326-1:2013 EMC - Directive 2014/30/EU
RoHS Compliant	This device complies with RoHS materials standards.
ISO Certification	Ocean Optics, the applied spectral knowledge company, has been certified for ISO 9001:2015 certification applicable to the design and manufacture of electro-optical equipment.

Ocean ST

Introduction

Product Description

Ocean ST Microspectrometers provide powerful capabilities in a small size. At less than 50 mm square, the Ocean ST delivers optical resolution, sensitivity and stability comparable to much larger, more expensive spectrometers. The small footprint makes it ideal for integration into setups and applications where space is at a premium. Full spectral analysis with low stray light, a high signal-to-noise ratio and excellent optical resolution are all accomplished in this small package.

Features

Ocean ST offers three models: UV (185-650 nm), Visible (350-810 nm) and NIR (645-1085 nm). By selecting the appropriate entrance slit for your Ocean ST microspectrometer, you can optimize the optical resolution of the setup for your application.

- Plug-and-play capability via the USB-C connection
- Ultra-compact and lightweight
- 4 GPIO pins and the ability to provide power to the ST through the Ocean Optics standard 16 pin connector
- Includes OceanDirect Software

Items Included with Shipment

- Ocean ST Microspectrometer
- USB-C Cable
- Wavelength Calibration Data Sheet
- Linearity Calibration Data Sheet (please save Calibration sheets for future reference)

Installation and Setup

<table>
<tr><td>

NOTE

Be sure to install the spectroscopy software BEFORE connecting the spectrometer to your PC. The software installs the drivers required for spectrometer installation. If you do not install the software first, the system will not properly recognize the spectrometer. If you have already installed the Ocean ST to a computer running on a Windows platform prior to installing the operating software, consult the Troubleshooting section for information on correcting a corrupt Ocean ST installation.

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Software Installation

Use OceanView version 2.0.10 and above for Ocean ST. You can use OceanView on the following operating systems:

<table>
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NOTE

Be sure that you download the correct software package for your computer version (32 or 64-bit). See Frequently Asked Questions in Troubleshooting for more information on determining your computer version.

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</table>

Windows			Mac
8	8.1	10	OS X Version 10.5 or later on Intel processor

*Software may run with previous operating systems but Ocean Optics does not actively support these installations.

Configuring the Ocean ST

The Ocean ST can be used with OceanView software when connected to the USB port. If you have followed the previous steps and started your spectroscopy application, 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.
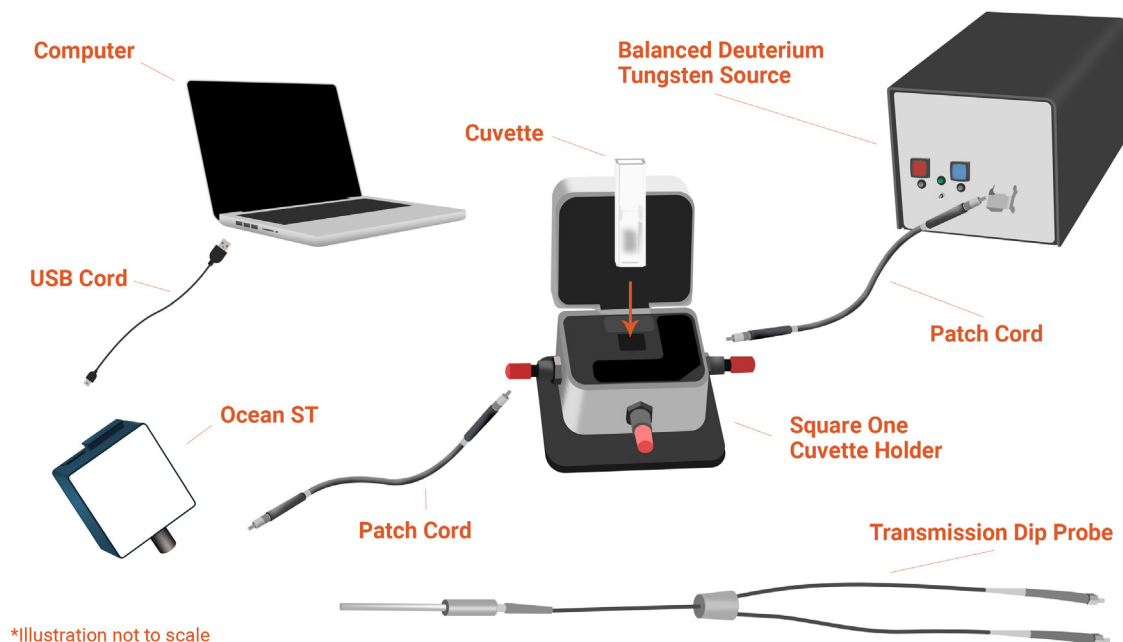
Hardware Setup

The Ocean ST connects to a computer via the USB port. When connected through a USB 2.0 or 1.1 port, the spectrometer draws power from the host computer, eliminating the need for an external power supply

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

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

2. Locate the USB cable (CBL-USB-AMCM) provided with the Ocean ST.

3. Insert the micro connector end of the cable into the side of the Ocean ST and the larger end of the cable into the USB port of the computer.

4. Connect any spectroscopy accessories. To find operating instructions for Ocean ST-compatible products (such as light sources, sampling chambers, and probes), consult the Ocean Optics website at OceanOptics.com.

5. Attach the fiber to the fiber optic connector on the spectrometer.

If you installed the spectrometer operating software prior to connecting the Ocean ST, the software automatically installs the correct drivers. If the drivers do not successfully install (or if you connected the Ocean ST to the computer before installing the software), consult Troubleshooting.

Computer

USB Cord

Ocean ST

Patch Cord

Balanced Deuterium Tungsten Source

Cuvette

Patch Cord

Square One Cuvette Holder

Transmission Dip Probe

*Illustration not to scale

Hardware Features

16 Pin IO Connector

This port allows the Ocean ST to be connected to Ocean Optics light sources and other external equipment.
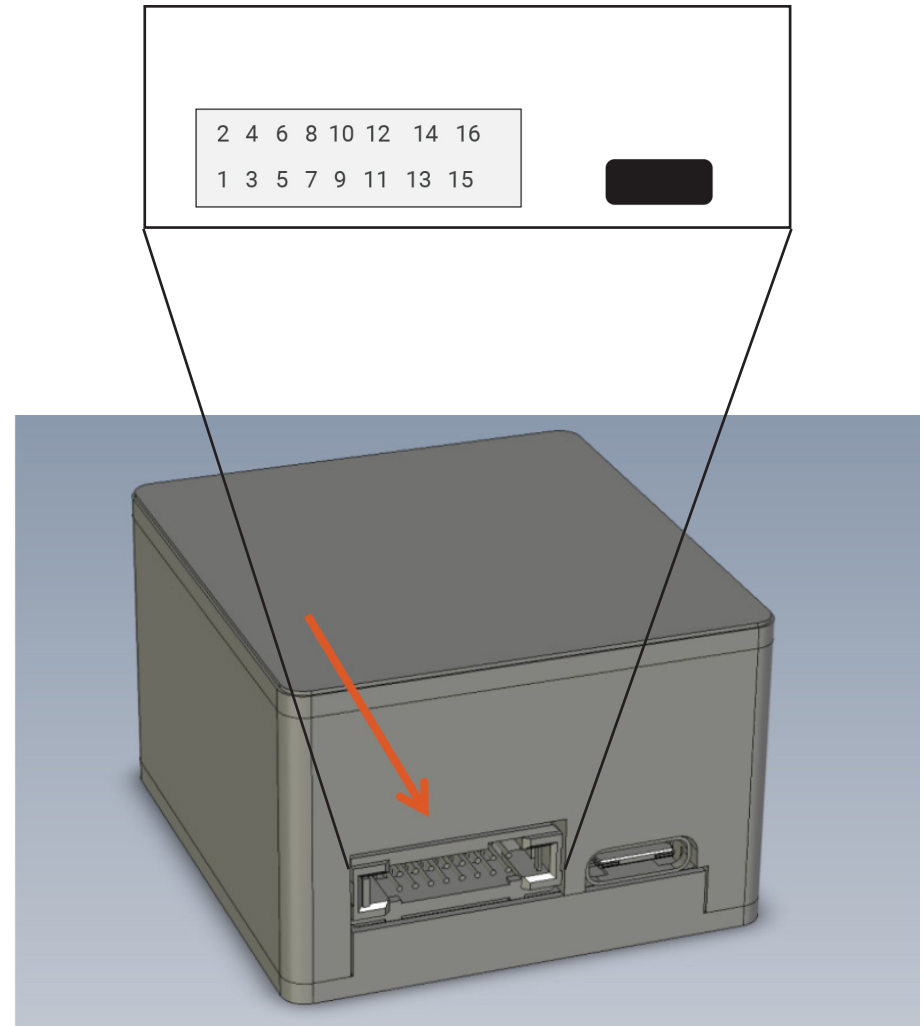
PIN	Function	Description	PIN	Function	Description
1	RS-232 TX	Spectrometer transmit to host	9	GPIO.0	General purpose I/O
2	RS-232 RX	Spectrometer receive from host	10	GPIO.1	General purpose I/O
3	GND	Ground	11	GPIO.2	General purpose I/O
4	RSTn	External reset input	12	GPIO.3	General purpose I/O
5	LampEnable	Output	13	Reserved	
6	ExtTrigIn	External trigger input	14	Reserved	
7	SingleStrobe	Single strobe output	15	+5VDC	External power supply input
8	ContStrobe	Continuous strobe output	16	GND	Ground

Connector pins 4 through 12 are 3.3V CMOS compatible inputs and outputs, with +/- 1mA drive capability.

Ocean ST

External Reset Input Pin

The Ocean ST can reset itself via an external reset pin. Applying a logic low input to the RSTn pin places the ST into a hardware reset condition and will remain in reset until the input is brought high again. Note that this is a full hardware reset. Any operating parameters also are reset to defaults that can be restored by re-initializing via software commands.

16 Pin Connector Cable

This cable connects the Ocean ST to external light sources that utilize a DB15 connector. Use CBL-ISDF-PX-DB15 for the PX-2 pulsed xenon source and CBL-ISDF-DB15 for all other light sources.

RS-232 Interface

The spectrometer supports an optional RS-232 interface for communication as an alternative to USB. Refer to the Serial Communications Protocol Technical Note available on our website for details on how to connect to and use the RS-232 interface.

Troubleshooting

Sometimes things do not go according to plan. When issues arise, do not hesitate to contact us and our Tech Support team will leap into action. Some typical questions are answered here. For more information, consult the FAQs on the Ocean Optics website.

Ocean ST Connected to Computer Prior to Application Installation

Windows Operating Systems

If you connected your Ocean ST device to the computer prior to installing your spectroscopy 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 to remove the incorrectly installed device, device driver, and installation files.

Remove the Unknown Device from Windows Device Manager

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 Ocean ST 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.

Apple Mac OSX Operating Systems

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

Frequently Asked Questions

I connected the USB cable and started OceanView but I don't see my spectrometer attached.

Use the "Action -> Scan for hardware changes" selection in the Device Manager to rescan for attached devices.

I am having trouble installing the drivers, what should I do?

Hardware device driver installation is usually seamless on Microsoft Windows operating systems and should happen in the background when you connect your spectrometer to a computer with the software installed. However, some Windows systems require a bit more care when connecting your spectrometer for the first time.

If your spectrometer is not recognized by OceanView on your computer, you need to manually install the spectrometer drivers. See your OceanView manual for this procedure.

I connected the Ocean ST to the computer before installing my spectroscopy operating software to install the drivers. What do I do now?

As described at the beginning of the Troubleshooting section, the steps to take to resolve this issue differ, depending on your computer's operating system.
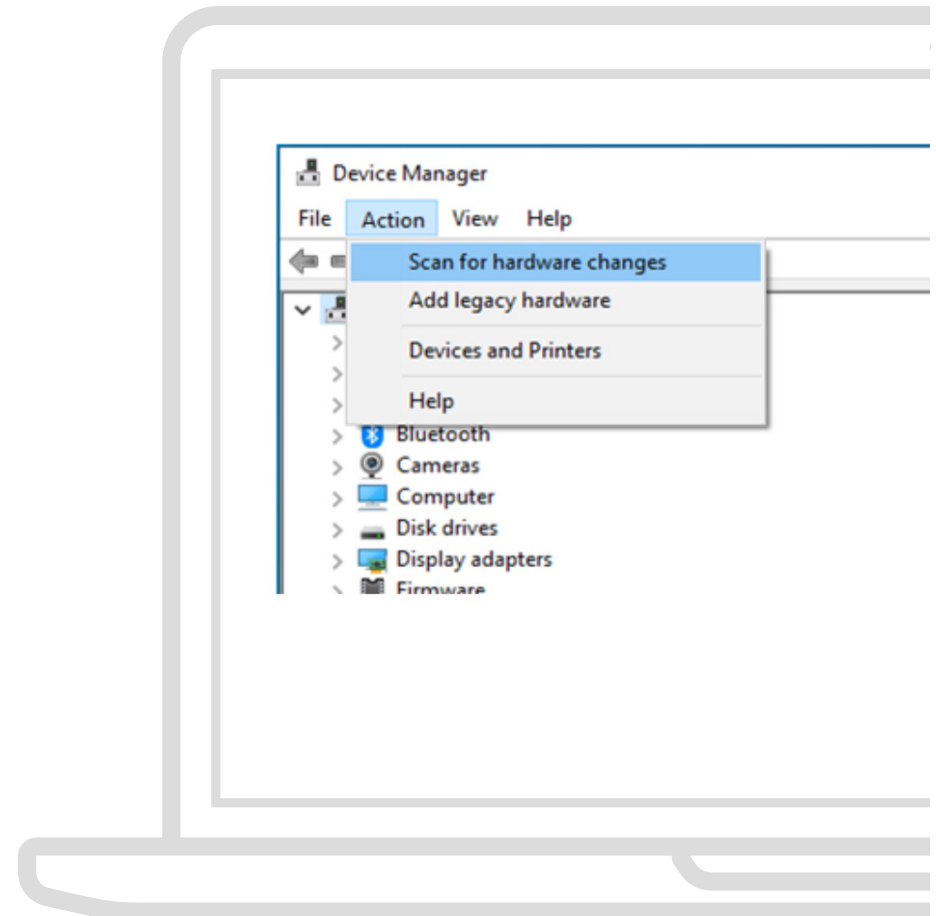
How do I check the configuration of my spectrometer?

Check the label on the bottom of your spectrometer. You can also check your configuration using OceanView by opening the Schematic window and double-clicking the spectrometer icon.

Repairs

Sometimes accidents happen! If you need to return your Ocean Optics Product for repair, here is what to do:

1. Contact us to evaluate and diagnose the problem. If it is determined that the product must be returned, the representative will issue an RMA number.

2. Package your product, ideally in the original packaging, and return it to Ocean Optics, along with the RMA number that you received.

NOTE

For RMA returns under warranty we will organize and pay for shipping both ways. For accidental damage, you pay only to have the product shipped to your closest Ocean Optics location or authorized distributor office.

Upon careful examination, we'll advise you with an estimate. When your product is ready, it will be returned to you.

Servicing

To keep your instrument in tip-top shape we recommend yearly wavelength recalibration. You can do this yourself if you have appropriate tools or we can do this for you. Contact your local representative to find out more about service availability and cost. We offer the following services:

- Wavelength Calibration
- Absolute Irradiance Calibrations

Technical Specifications

Specification	Ocean ST-UV	Ocean ST-VIS	Ocean ST-NIR
Optical and Spectroscopic			
Integration Time	1.56 ms-6 s		
Dynamic range (single acquisition)	1000:1		
Signal to Noise (single scan @ 10 ms)	190:1		
Signal to Noise (1 second average with HSAM)	2250:1		
Optical Resolution (FWHM) (w/25 μm slit)	2.2 nm		
Scan Rate	160 Hz		
Thermal Wavelength Drift	0.02 nm/°C		
Triggering	Software, External Rising Edge		
Wavelength Range	185-650 nm	350-810 nm	645-1085 nm
Entrance Slit	25 μm-200 μm		

Technical Specifications

Specification	Ocean ST-UV	Ocean ST-VIS	Ocean ST-NIR
Mechanical			
Input Fiber Connector	SMA 905		
Physical Dimensions:	42.1 mm x 40.3 mm x 26.6 mm		
Weight:	70.4 g		
Environmental			

Temperature:
    Storage
    Operation
	Storage: -30 °C to 70 °C
	Operation: 0 °C to 55 °C		

Humidity Tolerance (non-condensing only)	<85%		

Technical Specifications

Model	Wavelength Range	Optical Resolution	Entrance Slit
OCEAN-ST-UV-25	185-650 nm	2.2 nm	25 μm
OCEAN-ST-UV-50		3.7 nm	50 μm
OCEAN-ST-UV-100		6.3 nm	100 μm
OCEAN-ST-UV-200		13.0 nm	200 μm
OCEAN-ST-VIS-25	350-810 nm	2.2 nm	25 μm
OCEAN-ST-VIS-50		3.7 nm	50 μm
OCEAN-ST-VIS-100		6.3 nm	100 μm
OCEAN-ST-VIS-200		13.0 nm	200 μm
OCEAN-ST-NIR-25	645-1085 nm	2.2 nm	25 μm
OCEAN-ST-NIR-50		3.7 nm	50 μm
OCEAN-ST-NIR-100		6.3 nm	100 μm
OCEAN-ST-NIR-200		13.0 nm	200 μm

Timing Signals

Single Strobe Output

Synchronization of external devices to the spectrometer's integration period can be accomplished with the Single Strobe Output. The Single Strobe Output is an active-high programmable pulse that occurs at a user-defined time during each acquisition cycle. This pulse has a user-defined delay (t_{SSDLY}) and a user-defined width (t_{SSH}). Both values are programmable in 1 μs increments for the range of 0 to 65,535 μs.

The timing of the Single Strobe signal output is referenced from a Trigger Event. The Single Strobe Delay defines the time from the Trigger Event until the rising edge of the Single Strobe output. Note that a programmed Acquisition Delay can cause the Single Strobe to pulse before the start of integration. After the Single Strobe Delay has elapsed and the Single Strobe Output has gone high, it will remain active for a duration equal to the Single Strobe Width. The Single Strobe Output will return to a low or inactive state at the end of the Single Strobe Width.

If the Single Strobe Output is programmed for a longer period than the integration time, it will reset to its inactive state at the end of the integration period.

See timing diagrams later in this section for more information of the Single Strobe Timing.

Synchronous Continuous Strobe

The Continuous Strobe output signal is a programmable pulse that occurs at a user-defined time during each acquisition cycle. The Continuous Strobe is a series of pulses defined by a user-defined period with a 50% duty cycle. The Continuous Strobe Period (t_{CSPER}) has a resolution of 10 μs. The polarity is also selectable so that the Continuous Strobe signal period starts with either a 0 or 1.

The Continuous Strobe signal is only valid during the integration period (t_{INTEG}). The Continuous Strobe period has a resolution of 10 μs for a range of 0 to 655,350 μs. However, the Continuous Strobe signal is only exercised if it can complete a full period within the integration period. If there are multiple Continuous Strobe periods within an integration period, only full periods are realized. This means the time between the last Continuous Strobe period and the end of integration time is between 0 and t_{CSPER}.

For the Continuous Strobe signal to be fully realized for at least one period, the integration time must be greater than or equal to the Continuous Strobe Period. See timing diagrams for more information about Continuous Strobe Timing.

Triggering Modes

The Ocean ST supports two triggering modes, which are set with the Trigger Mode command. Detailed information about each triggering mode follows. Also, refer to the External Triggering Options document located on our website at OceanOptics.com.

The two trigger modes are:

Software Triggering: A trigger is initiated internal to the Spectrometer with a command from Ocean Optics approved software. The integration period is set by software configuration.

External Edge Triggering: A trigger is initiated by the rising edge of the external trigger signal on the auxiliary connector. The integration period is set by software configuration.

Software Trigger

The default triggering mode is for a software trigger. A Software Trigger may be initiated by OceanView, OmniDriver, or OceanDirect software. Once a command is sent to the Spectrometer, an internal trigger is generated, which begins an acquisition cycle.

If a start time of T_0 is defined as the moment a software command requests an acquisition, then there is a latency time of t_{PROC}, which is the Software Command Processing time from T_0 to when the integration cycle starts. This latency varies from computer system to computer system.

The integration delay, t_{INTDLY}, starts after t_{PROC} and ends before the start of integration time, t_{INTEG}. The integration delay is the sum of the user defined acquisition delay, t_{ACQDLY} and t_{BUSY1}.

The integration period, t_{INTEG}, is user defined but has a minimum value of 1560 µs.

Following the integration period, the detector is busy to finish the acquisition cycle and that time is t_{BUSY2}. After this time, the detector is ready for another trigger.

The equation for the integration delay can be written as

$$t_{INTDLY} = t_{ACQDLY} + t_{BUSY1}$$

where t_{BUSY1} = 1560 µs

The single strobe is active at the end of t_{PROC} and with the start of the acquisition delay, t_{ACQDLY}. The single strobe itself can have a delay defined as t_{SSDLY}. The single strobe is a single pulse that goes high at the end of t_{SSDLY} and stays high for a time of t_{SSH}. The values for the single strobe delay and pulse high time are set by the user in OceanView or OceanDirect software.

The continuous strobe signal is a series of pulses with a user specified period that starts with the beginning of the integration time, t_{INTEG}. The pulses have a 50% duty cycle and only full periods are exercised during an integration period. If a subsequent continuous strobe period cannot be completed before the end of the integration cycle, the continuous strobe signal is turned off and set to 0.

Software Trigger timing parameters are described below.

Symbol	Description	Time			Notes
		min	typ	max	
t_{PROC}	Trigger Command Processing				System dependent (e.g., computer hardware, software, driver)
t_{ACQDLY}	Acquisition Delay	0 μs	--	1.19 hours	User specified, 1 μs resolution
t_{BUSY1}	Busy	--	1560 μs	--	Constant at 1560 μs
t_{INTEG}	Integration Period	1560 μs	--	11.9 hours	User specified, 10 μs resolution
t_{BUSY2}	Busy	--	1560 μs	--	Constant at 1560 μs
t_{SSDLY}	Single Strobe Delay	0 μs	--	1.19 hours	User specified, 1 μs resolution
t_{SSH}	Single Strobe High Time	0 μs	--	1.19 hours	User specified, 1 μs resolution
t_{CSPER}	Continuous Strobe Period	0 μs	--	11.9 hours	User specified, 10 μs resolution
t_{CSOFF}	Continuous Strobe Off Time	0 μs	--	t_{CSPER}	

The following timing diagram represents the acquisition process
for a Software Trigger event.
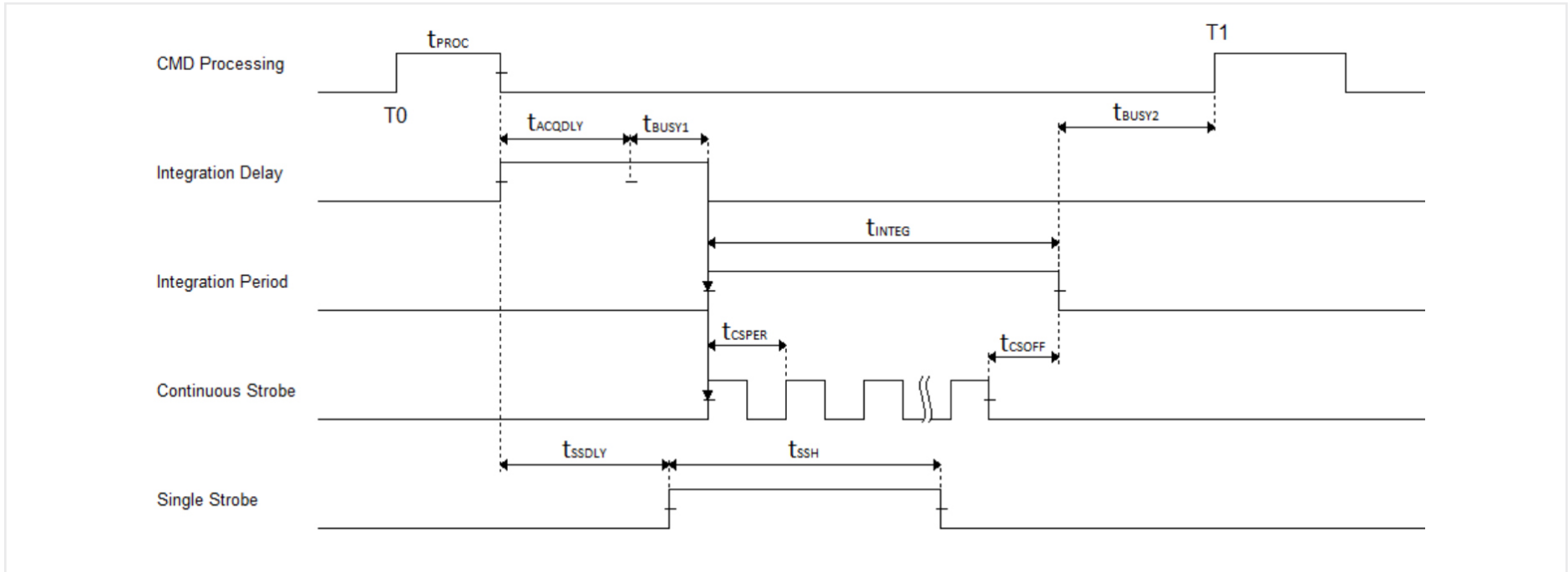
External Edge Trigger

The External Edge Trigger mode for the spectrometer looks for a trigger signal on the 16-pin connector. The trigger signal must have a minimum high time of 10 ns. Once the external pulse rising edge is detected, there is a short delay, $t_{ETRGDLY}$, before the acquisition cycle begins.
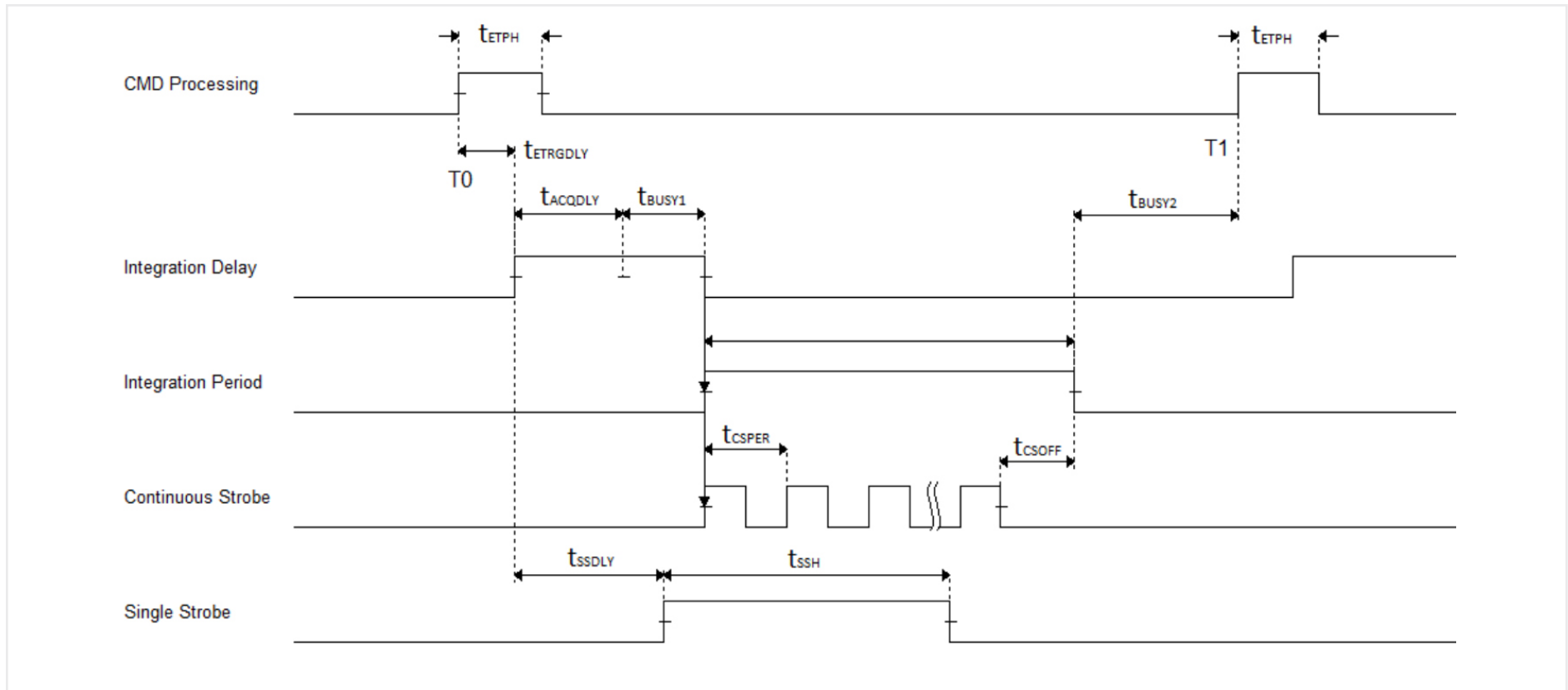
For the case of an External Edge Trigger, T_0 can be defined as the moment the external trigger signal goes from low to high. After the External Edge Trigger Delay, $t_{ETRGDLY}$, there is the integration delay, followed by the integration period, and finally the busy period, t_{BUSY2}, during which time another trigger cannot be accepted.

The equations for the integration delay are the same as those for Software Triggering Mode.

External Edge Trigger timing parameters are described below.

Symbol	Description	Time			Notes
		min	typ	max	
t_{ETPH}	External Edge Trigger Pulse Width	10 ns	--	--	
$t_{ETRGDLY}$	External Edge Trigger Delay	--	30 ns	--	
t_{ACQDLY}	Acquisition Delay	0 μs	--	1.19 hours	User specified, 1 μs resolution
t_{BUSY1}	Busy	--	1560 μs	--	Constant at 1560 μs
t_{INTEG}	Integration Period	1560 μs	--	11.9 hours	User specified, 10 μs resolution
t_{BUSY2}	Busy	--	1560 μs	--	Constant at 1560 μs
t_{SSDLY}	Single Strobe Delay	0 μs	--	1.19 hours	User specified, 1 μs resolution
t_{SSH}	Single Strobe High Time	0 μs	--	1.19 hours	User specified, 1 μs resolution
t_{CSPER}	Continuous Strobe Period	0 μs	--	11.9 hours	User specified, 10 μs resolution
t_{CSOFF}	Continuous Strobe Off Time	0 μs	--	t_{CSPER}	

The following timing diagram represents the acquisition process for an External Edge Trigger event.

The single strobe function for the case of an edge trigger event is similar to that of a software trigger. The single strobe delay is relative to the end of the External Edge Trigger Delay.

Also, the continuous strobe signal function is the same as that of the software trigger and starts with the start of the integration cycle. Again, only full periods are exercised during integration time.
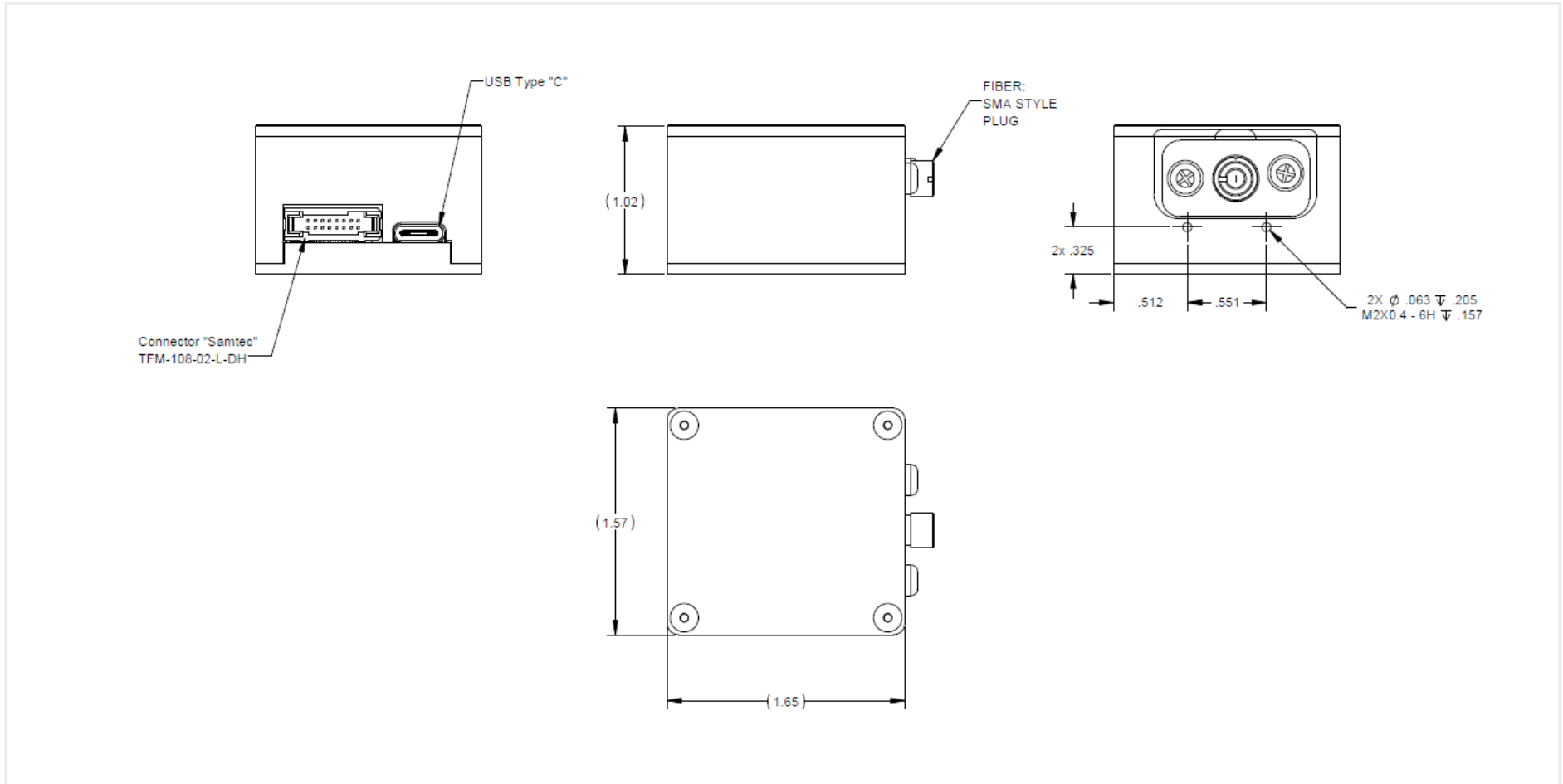
Mechanical Dimensions

Physical Dimensions

42.1 mm (width) x 40.3 mm (depth) x 26.6 mm (height)

Mounting

The Ocean ST spectrometer has the ability to be mounted via 2 attachment points located on the face of the device. Two screws, size M2x0.4 (not supplied), are required. The instrument must be supported when mounted.

Calibration

Each Ocean ST contains wavelength calibration coefficients, linearity coefficients, and a serial number unique to each spectrometer. The spectroscopy 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.

Wavelength Calibration

Each spectrometer is calibrated before it leaves Ocean Optics, however the wavelength for all spectrometers will drift slightly as a function of time and environmental conditions.

For instructions on how to calibrate the OCEAN ST, visit OceanOptics.com.

Irradiance Calibrations

Irradiance calibrations and relative irradiance calibrations are about quantifying the spectra, by translating the signal (incident number of photons) to a calibration. This can be either absolute (an atomic emission light source of known output power) or relative (corrected for instrument response function but not absolute units). It can be considered a measurement technique and is used widely in remote sensing, light metrology and anywhere where you wish to characterize the incident light source. Irradiance calibrations are not required for many techniques because these measure the relative signal changes with respect to the sample and not the light source.

You can find out more about irradiance calibration techniques at OceanOptics.com.

OceanView has wizards that will step you through absolute irradiance and relative calibrations and more information on these is located in the OceanView.

Questions?

Chat with us at **www.oceanoptics.com**.

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Unlock the Unknown

Ocean Optics exists to end guessing. We equip humanity with technology and data to make precisely informed decisions providing transformational clarity for human advancement in health, safety, and the environment.