

## Ocean HR Series



# OCEAN HR SERIES

## High Resolution Spectrometers

Installation and Operation Manual

# Locations

## Americas

### Manufacturing & Logistics

3500 Quadrangle Blvd., Orlando, FL 32817, USA

**Sales:** info@oceanoptics.com

**Orders:** orders@oceanoptics.com

**Support:** techsupport@oceanoptics.com

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

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

### Ocean Optics Rochester, NY

176 Anderson Ave, Ste. F304, Rochester, NY 14617

### International Light Technologies, Inc.

10 Technology Drive, Peabody, MA 01960

## Europe, Middle East & Africa

### Sales & Support

Geograaf 24, 6921 EW Duiven, The Netherlands

### Logistics

Maybaachstrasse 11, 73760 Ostfildern, Germany

**Email:** info@oceanoptics.eu

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

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

**Germany:** +49 711-341696-0

**UK:** +44 1865-819-922

**France:** +33 442-386-588

## Asia

### Ocean Optics China

666 Gubei Rd., Kirin Tower Suite 601B  
Changning Distric, Shanghai, PRC, 200336

**Email:** asiasales@oceanoptics.com

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

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

**Japan & Korea:** +82 10-8514-3797

### Ocean Optics India

Prestige Shantiniketan, Gate no. 2  
Tower C, 7th Floor  
Whitefield main road, Mahadevpura  
Bengaluru-560048 Karnataka, India

**Phone:** +91 80-67475336

[www.oceanoptics.com](http://www.oceanoptics.com)



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# Before You Get Started

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## 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 [www.oceanoptics.com](http://www.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.



**FCC  
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.



**Warning**

This device has been tested and complies with the following standards:

Electromagnetic Compatibility Directive – 2004/108/EC

EN 61326-1:2013

EN 55011:2009 w/A1:2010

**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.

# Introduction

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## Product Description

Ocean HR series high-resolution spectrometers are compact and robust, with rapid acquisition speed and excellent spectral stability. Ocean HR models cover various wavelength ranges within 190-1100 nm, with a choice of slit sizes to help you manage throughput and optical resolution.

## Features

- Plug-and-play capability via the USB-C connection.
- User-interchangeable slit.
- LEDs show power and data transfer status.
- 4 GPIO pins.
- Includes OceanDirect Software.

## Items Included with Shipment

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

# Installation and Setup

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## NOTE

Be sure to install the spectroscopy application 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 HR spectrometer 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 HR installation.

## Software Installation

Use OceanView version 2.0.13 or above for Ocean HR spectrometers. You can use OceanView on the following operating systems:

## NOTE

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

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.

Consult the OceanView manual for computer hardware requirements.

## Configuring HR Spectrometers

Ocean HR spectrometers 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

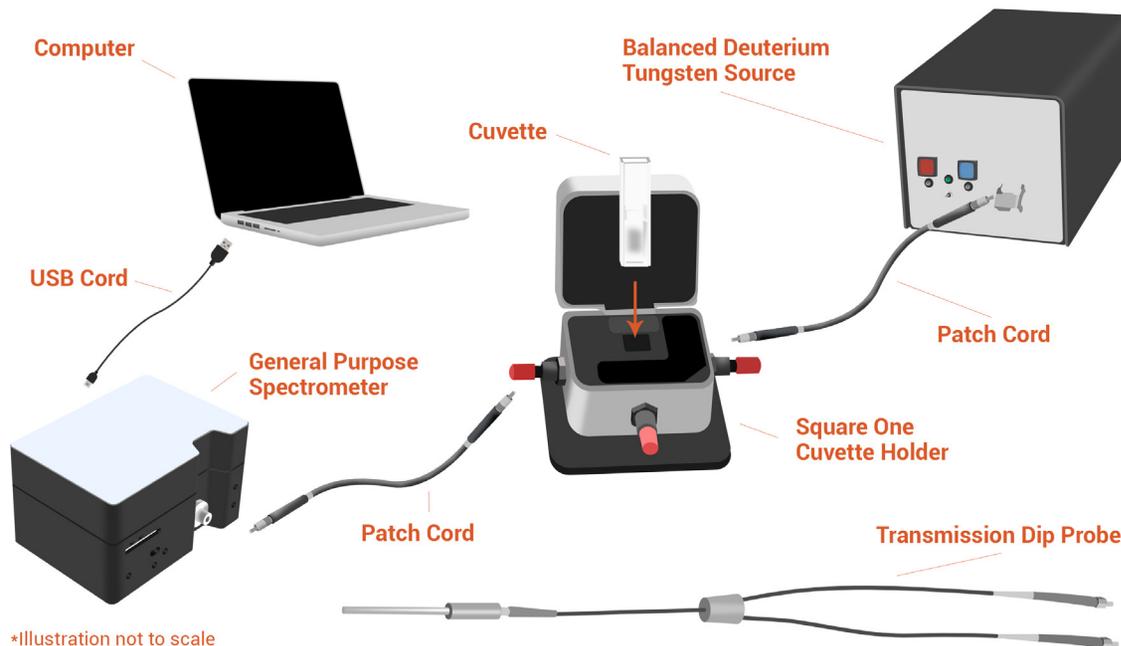
The Ocean HR Spectrometer connects to a computer via the USB port. When connected through a USB 2.0 or 1.1 port, the spectrometer draws power from the host computer, eliminating the need for an external power supply.

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

1. Install the spectrometer operating software on the destination computer.
2. Locate the USB cable (USB-CBL-2.0-6) provided with the spectrometer.

3. Insert the micro connector end of the cable into the side of the spectrometer 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 HR-compatible products (such as light sources, sampling chambers, and probes), consult the Ocean Optics website at [www.oceanoptics.com](http://www.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 HR, the software automatically installs the correct drivers. If the drivers do not successfully install (or if you connected the spectrometer to the computer before installing the software), consult Troubleshooting.



## Hardware Features

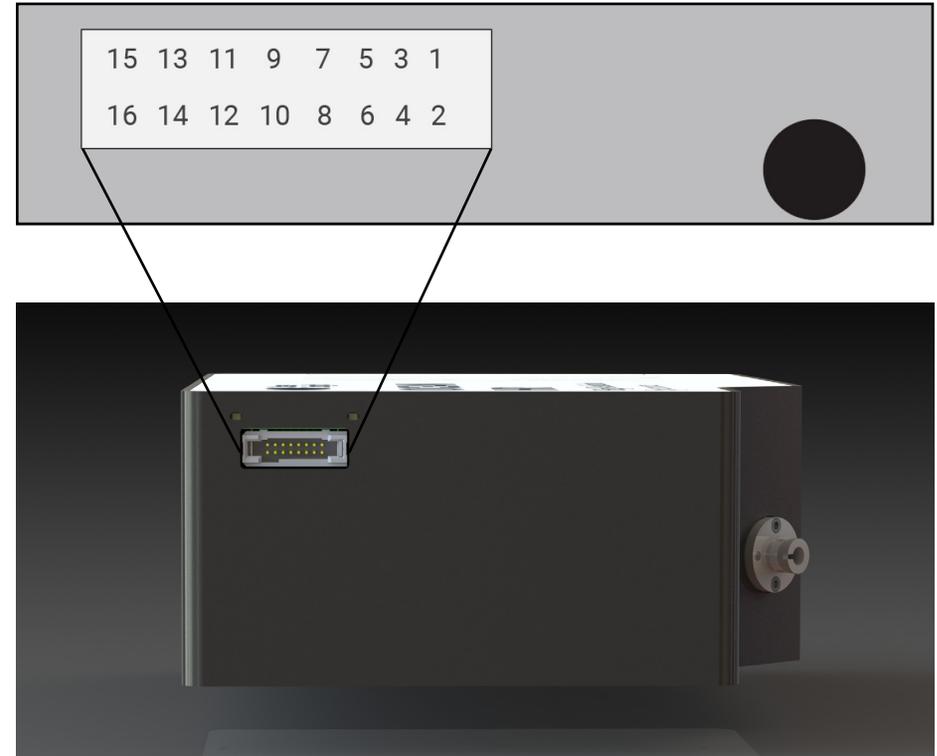
### *Status Indicator LEDs*

Ocean HRs have features two indicator lights that operate as shown:

LED	Steady	Flashing
Red	Unit is on	N/A
Green	N/A	Unit is transmitting data

### NOTE

LEDs can be turned off in OceanView or by using a software API command in OmniDriver or OceanDirect.



### *16 Pin IO Connector*

This port allows the Ocean HRs to be connected to Ocean Optics light sources and other external equipment.

<b>PIN</b>	<b>Function</b>	<b>Description</b>
1	Reserved	Do not connect
2	Reserved	Do not connect
3	GND	Ground
4	RSTn	External reset input
5	LampEnable	Output
6	ExtTrigIn	External trigger input
7	SingleStrobe	Single strobe output
8	ContStrobe	Continuous strobe output

<b>PIN</b>	<b>Function</b>	<b>Description</b>
9	GPIO.0	General purpose I/O
10	GPIO.1	General purpose I/O
11	GPIO.2	General purpose I/O
12	GPIO.3	General purpose I/O
13	Reserved	
14	Reserved	
15	+5VDC	External power supply input
16	GND	Ground

Pins 4-12 on the auxiliary connector are 3.3V CMOS-compatible inputs or outputs, with +/- 1mA drive capability.

### *External Reset Input Pin*

The Ocean HR can reset itself via an external reset pin. Applying a logic low input to the RSTn pin places the HR 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. All operating parameters are also reset to defaults, which can be restored by re-initializing via software commands.

### *16 Pin Connector Cable (CBL-ISDF-DB15)*

This cable connects to the following external light sources:

DH - 3PLUS
DH - 2000 (US)
HPX - (US)
HL - 2000 - FSHA
HL - 3P

### *16 Pin Connector Cable (CBL-ISDF-PX-DB15)*

PX - 2
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# Troubleshooting

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Sometimes things do not go according to plan. If problems 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 HRs Connected to Computer Prior to Application Installation

### Windows Operating Systems

If you connected your Ocean HR 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 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: [www.oceanoptics.com](http://www.oceanoptics.com).

### *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.
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 HR 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.

#### 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.

## Apple Mac OSX Operating Systems

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

## Frequently Asked Questions

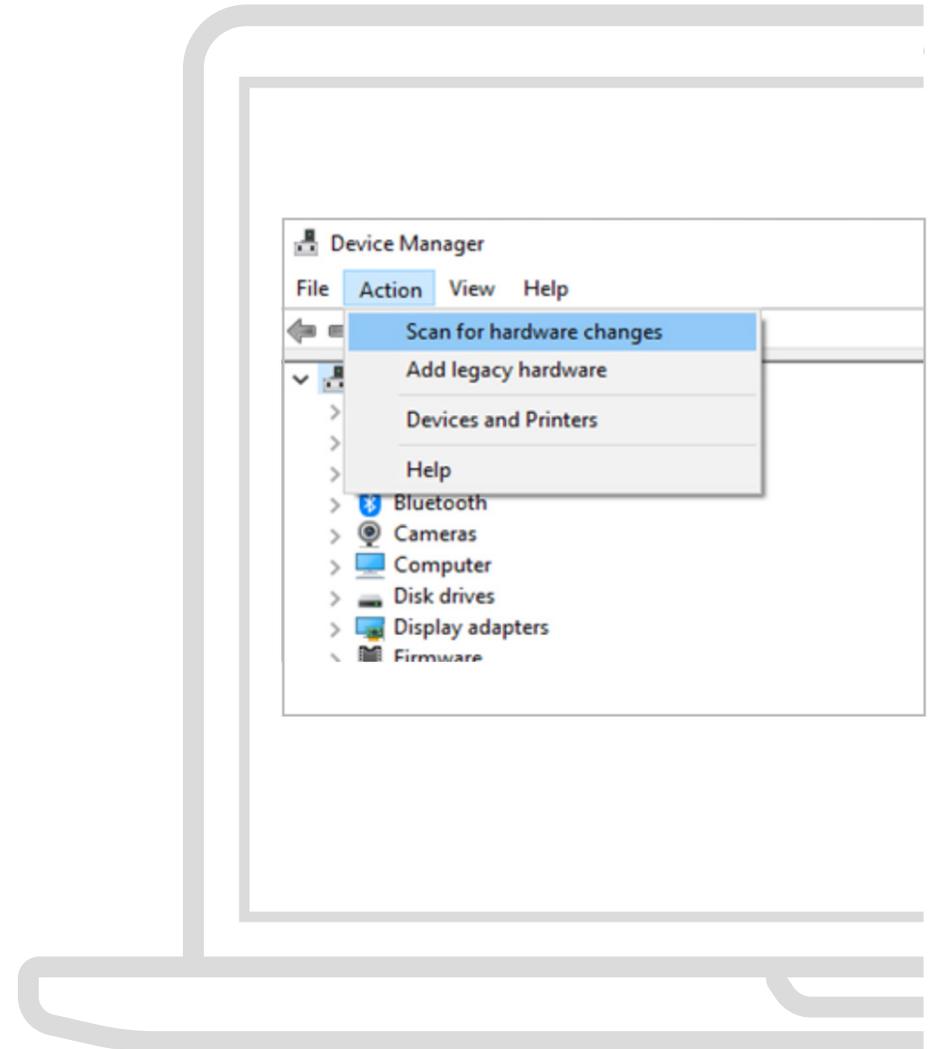
### I connected the USB cable and started OceanView but I don't see my spectrometer attached.

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. Also consult the *Correcting Device Driver Issues* document on [www.oceanoptics.com](http://www.oceanoptics.com)



## How do I know my spectrometer has power?

The red LED on the spectrometer should be constantly on if the unit is receiving power.

## How do I know my spectrometer is transmitting data?

The green LED on the spectrometer flashes when transmitting data.

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

As detailed below, 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.

### 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 or distributor office.

## 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.

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

Test conditions for the following data: 25° C

Specification	HR2	HR4	HR6
<b>Optical and Spectroscopic</b>			
Integration Time	1 $\mu$ s-6 s	3.8 ms-10 s	7.2 ms-5 s
Dynamic Range <sup>1</sup>	3000:1 (single scan)	1400:1 (single scan)	15000:1 (single scan)
Signal to Noise Ratio	25800:1 (per second with High Speed Averaging Mode)	3000:1 (per second, w/High Speed Averaging Mode)	3500:1 (per second, w/High Speed Averaging Mode)
Optical Resolution (FWHM)	<1.0 nm w/25 $\mu$ m slit (configuration-dependent)		
Scan Rate <sup>2</sup>	>400 scans/second	73.7 scans/second (w/o High Speed Averaging Mode)	73 scans/second (w/o High Speed Averaging Mode)
Thermal Stability	<0.06 pixels/° C	<0.08 pixels/° C	0.05 pixels/° C <sup>3</sup>
Triggering	Software, External rising edge, External level		
Wavelength Range (beginning/ending wavelengths may vary marginally)	190-880 nm (UV-Vis); 340-1025 nm (Vis-NIR); 190-1100 nm (extended range)		180-850 nm (UV-Vis)
Entrance Slit	5, 10, 25, 50, 100, 200 $\mu$ m		
<b>Detector</b>			
Active Pixels	2048	3648	2048

# Technical Specifications

Specification	HR2	HR4	HR6
Corrected Linearity	99.8%		99.7%
<b>Electrical</b>			
Power-up Time	3 s	NA	NA
Connectors	USB Type-C, SMA, TFM-108-02-L-DH		
USB Type-C Ratings: VCC	Minimum 4.40V, Nominal 5V, Maximum 5.25V		
IO Standard	3.3V CMOS		
Absolute Maximum Ratings: Voltage on any pin (other than input power)	5V		
Interface	USB 2.0 High Speed		
External Triggering Jitter	21 ns		
<b>Mechanical</b>			
Input Fiber Connector	SMA 905		
Physical Dimensions (LWH)	148.8 x 106.4 x 48.2 mm		

# Technical Specifications

Specification	HR2	HR4	HR6
Weight		930.6 g	
<b>Environmental</b>			
Temperature (storage)		-30 °C - 70 °C	
Temperature (operation)		0 °C - 55 °C	
Humidity		<85%	
Operation		For indoor use	
Operating Altitude (maximum)		2000 m	
Overvoltage Category		I	
Pollution Degree		2	
<sup>1</sup> Dynamic range of the system is the range of the detectable light level and can be thought of as the maximum detectable light level at the minimum integration time divided by the minimum detectable light level at the maximum integration time.			
<sup>2</sup> Scan rate is dependent on factors external to the spectrometer.			
<sup>3</sup> Tested with the UV-visible spectrometer model.			

## Timing Signals

The spectrometer supplies two strobe output signals to allow the user to synchronize external devices to trigger events and integration time. Each strobe signal can be independently enabled or disabled. The following subsections define the Single Strobe and Continuous Strobe Output signals. The Single and Continuous Strobe signals are accessible on the 16 Pin IO Connector. Refer to the timing diagrams later in this section for more information on the Acquisition Delay timing.

### *Single Strobe Output*

Synchronization of external devices to the spectrometer's Trigger Event 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. The Single Strobe output has two user configurable settings, Single Strobe Delay and Single Strobe Width.

The timing of the Single Strobe output signal is referenced from the Trigger Event. The Single Strobe Delay ( $t_{SSDLY}$ ) defines the time from the Trigger Event until the rising edge of the Single Strobe output. 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 ( $t_{SSH}$ ). The Single Strobe output will return to a low or inactive state at the end of the Single Strobe Width.

Note that there is a delay from the Trigger Event until the start of integration. So, if the Single Strobe Delay is less than the Integration Delay, then the Single Strobe will assert before the start of integration. Also note that if the Single Strobe output is configured for a longer period than the integration time, it will reset to its inactive state at the end of the integration time. Refer to the timing diagrams later in this section for more information on the Single Strobe Timing.

### *Continuous Strobe Output*

The Continuous Strobe output signal is a periodic signal with a 50% duty cycle that occurs during the integration time each acquisition cycle. The Continuous Strobe output has a user configurable Continuous Strobe Period ( $t_{CSPER}$ ). The Continuous Strobe signal is only valid during the integration time ( $t_{INTEG}$ ).

When operating in Software Trigger or External Edge Trigger modes, the Continuous Strobe signal is only exercised if it can complete a full period within the integration period. For the continuous Strobe signal to be fully realized for at least one period, the integration time must be greater than the Continuous Strobe Period. If there are multiple Continuous Strobe periods within an integration period, only full periods are generated. This means the time between the last Continuous Strobe period and the end of integration time ( $t_{CSOFF}$ ) is between 0 and  $t_{CSPER}$ .

When operating in External Level Trigger mode, the Continuous Strobe output will return to a low logic level at the end of the integration time. This may truncate any Continuous Strobe period in progress, resulting in a partial period.

Refer to the timing diagrams later in this section for more information on the Continuous Strobe timing.

## Trigger Timing

A Trigger Event is an action that causes the spectrometer to start an acquisition cycle. An acquisition cycle can be broken up into 3 sections. The first section is a delay, the second is the integration time, and then lastly a busy time. A Trigger Event can be driven by a command from software or the External Trigger input signal located on the 16 Pin IO Connector.

There are several triggering modes for the spectrometer, and they have specific timing requirements. In addition, the Single Strobe and Continuous

Strobe output behavior are directly related to the trigger modes. This section will define and describe the overall function of the trigger modes and strobe signals.

### *Acquisition Delay*

The Acquisition Delay is a user programmable time that delays the start of integration from the Trigger Event. Note that the start of the Continuous Strobe output signal is tied to the beginning of integration, so the Acquisition Delay will also delay the start of the Continuous Strobe output. The Single Strobe is relative to the Trigger Event, so it is not affected by the Acquisition Delay. The Acquisition Delay does not affect the length of integration, it only delays the start of integration relative to the Trigger Event.

Refer to the timing diagrams later in this section for more information on the Acquisition Delay timing.

### *Trigger Modes*

The spectrometer supports three trigger modes, which are set with the Trigger Mode command. Detailed information of each trigger mode follows.

The 3 trigger modes are:

**Software Trigger:** A trigger is initiated internal to the spectrometer with a command from software. The integration time is set by software configuration.

**External Edge Trigger:** A trigger is initiated by the rising edge of the External Trigger input signal on the 16 Pin IO Connector . The integration time is set by software configuration.

**External Level Trigger:** A trigger is initiated by the rising edge of the External Trigger input signal on the 16 Pin IO Connector . The integration time is determined by the pulse width of the External Trigger input.

### *Software Trigger*

The default triggering mode is for a software trigger. A software trigger may be initiated by either OceanView, Omnidriver, or OceanDirect software. Once a command is sent to the spectrometer, an internal trigger is generated which begins an acquisition cycle. The moment that the spectrometer recognizes a software trigger is called a Trigger Event. Note that there is some latency between the software on the host computer and the Trigger Event; this latency varies between computer systems.

There is a delay between the Trigger Event and the start of integration time. This delay is the sum of the user defined acquisition delay ( $t_{ACQDLY}$ ) and a fixed delay ( $t_{BUSY1}$ ).

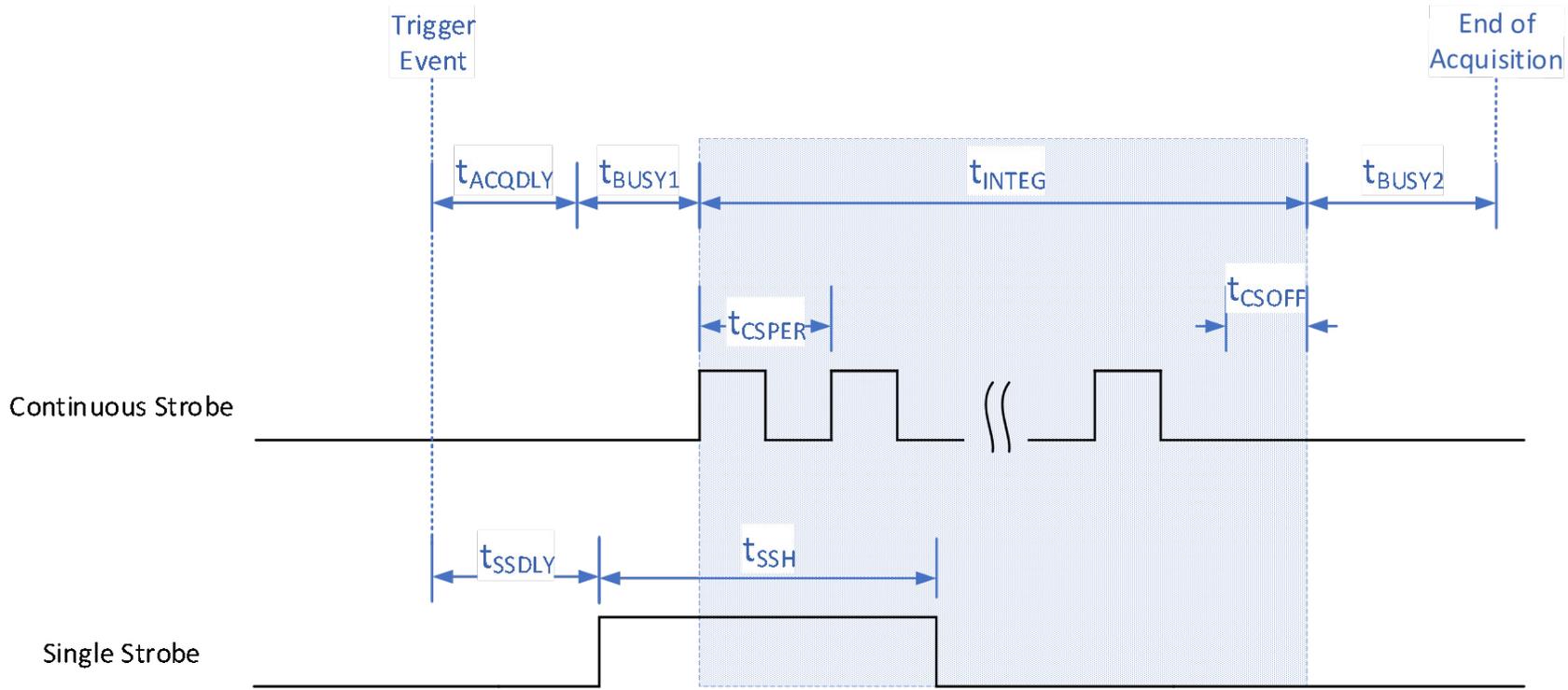
The integration time ( $t_{INTEG}$ ) is user defined in software. This is the time that the detector is collecting spectra data.

There is another delay ( $t_{BUSY2}$ ) after the integration time completes until the end of the acquisition cycle. After the acquisition cycle completes, the spectrometer transfers data to the host computer and is then ready for another trigger.

The Single Strobe timing is relative to the Trigger Event. The Single Strobe has a configurable 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 specified time of  $t_{SSH}$ . The values for the Single Strobe delay and pulse width are set by the user in 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 the integration time. If a subsequent Continuous Strobe period cannot be completed before the end of the integration time, the continuous strobe signal is turned off and set to 0.

The following timing diagram shows an acquisition cycle for a Software Trigger event.



Software Trigger timing characteristics are defined in the tables below.

Table 1 HR2 Software Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{ACQDLY}$	Acquisition Delay	0 $\mu$ s	--	335,500 $\mu$ s	User specified, 1 $\mu$ s resolution
$t_{BUSY1}$	Initial Busy	1 $\mu$ s	--	218 $\mu$ s	1 $\mu$ s when $t_{INTEG} \geq 218 \mu$ s (219 $\mu$ s - $t_{INTEG}$ ) when $t_{INTEG} < 218 \mu$ s
$t_{INTEG}$	Integration Time	1 $\mu$ s	--	6 s	User specified, 1 $\mu$ s resolution
$t_{BUSY2}$	Final Busy	--	218 $\mu$ s	--	Constant at 218 $\mu$ s
$t_{SSDLY}$	Single Strobe Delay	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{SSH}$	Single Strobe Width	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{CSPER}$	Continuous Strobe Period	0 $\mu$ s	--	$t_{INTEG}$	User specified, 1 $\mu$ s resolution. Should be less than Integration Time to activate.
$t_{CSOFF}$	Continuous Strobe Off Time	0 $\mu$ s	--	$t_{CSPER}$	

Table 2 HR4 Software Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{ACQDLY}$	Acquisition Delay	0 $\mu$ s	--	335,500 $\mu$ s	User specified, 1 $\mu$ s resolution
$t_{BUSY1}$	Initial Busy	--	3706 $\mu$ s	--	Constant at 3706 $\mu$ s
$t_{INTEG}$	Integration Time	3800 $\mu$ s	--	10 s	User specified, 1 $\mu$ s resolution
$t_{BUSY2}$	Final Busy	--	3706 $\mu$ s	--	Constant at 3706 $\mu$ s
$t_{SSDLY}$	Single Strobe Delay	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{SSH}$	Single Strobe Width	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{CSPER}$	Continuous Strobe Period	0 $\mu$ s	--	$t_{INTEG}$	User specified, 1 $\mu$ s resolution. Should be less than Integration Time to activate.
$t_{CSOFF}$	Continuous Strobe Off Time	0 $\mu$ s	--	$t_{CSPER}$	

Table 3 HR6 Software Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{ACQDLY}$	Acquisition Delay	0 $\mu$ s	--	335,500 $\mu$ s	User specified, 1 $\mu$ s resolution
$t_{BUSY1}$	Initial Busy	--	15 ns	--	Constant at 15 ns
$t_{INTEG}$	Integration Time	7200 $\mu$ s	--	5 s	User specified, 1 $\mu$ s resolution
$t_{BUSY2}$	Final Busy	--	4977 $\mu$ s	--	Constant at 4977 $\mu$ s
$t_{SSDLY}$	Single Strobe Delay	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{SSH}$	Single Strobe Width	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{CSPER}$	Continuous Strobe Period	0 $\mu$ s	--	$t_{INTEG}$	User specified, 1 $\mu$ s resolution. Should be less than Integration Time to activate.
$t_{CSOFF}$	Continuous Strobe Off Time	0 $\mu$ s	--	$t_{CSPER}$	

### External Edge Trigger

The External Edge Trigger mode for the spectrometer uses a rising edge on the External Trigger input signal from the 16 pin IO connector as the source for a Trigger Event. The External Trigger signal must have a minimum high time of at least 10 ns. There is a short delay ( $t_{ETRGDLY}$ ) between the external signal rising edge and Trigger Event where the acquisition cycle begins.

For the case of an External Edge Trigger,  $T_0$  is 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 ( $t_{BUSY1} + t_{ACQDLY}$ ), followed by the integration time ( $t_{INTEG}$ ), then finally the last busy time ( $t_{BUSY2}$ ).

The Single Strobe signal for the case of an edge trigger event is similar that of a software trigger. The single strobe delay is relative to the Trigger Event. The Single Strobe Width defines the pulse width of the Single Strobe output signal.

Also, the Continuous Strobe signal function while in External Edge Trigger mode is the same as that of the software trigger. The Continuous Strobe output signal starts with the start of the integration time. Only full periods of the Continuous Strobe are exercised during integration time.

The following timing diagram shows an acquisition cycle for an External Edge Trigger event.

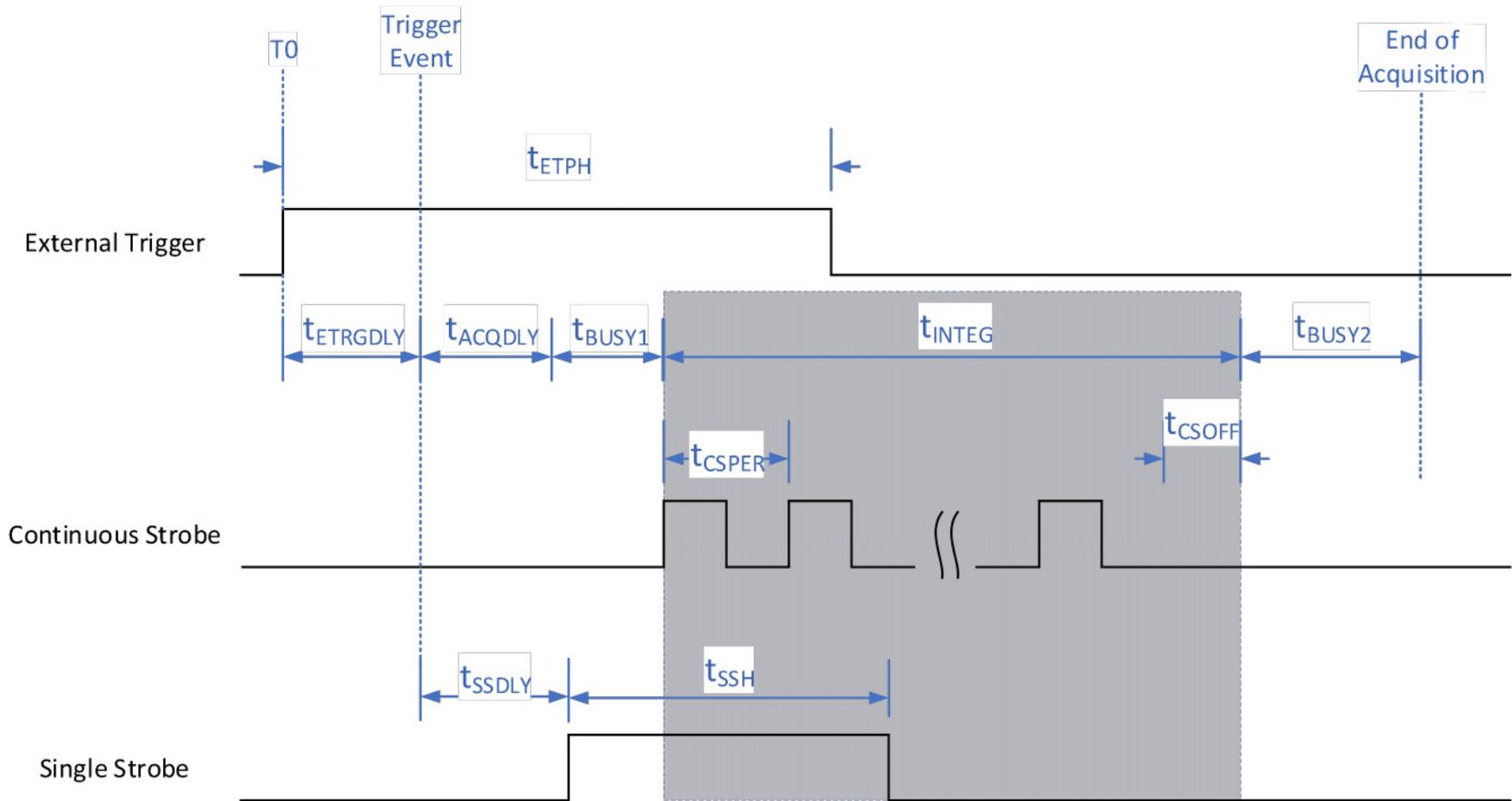


Figure 2 External Edge Trigger Timing Diagram

External Edge Trigger timing characteristics are defined in the tables on the next page.

Table 4 HR2 External Edge Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{ETPH}$	External Edge Trigger Pulse Width	10 ns	--	--	
$t_{ETRGDLY}$	External Edge Trigger Delay	20 ns	--	30 ns	Time from External Trigger rising edge to Trigger Event
$t_{ACQDLY}$	Acquisition Delay	0 $\mu$ s	--	335,500 $\mu$ s	User specified, 1 $\mu$ s resolution
$t_{BUSY1}$	Initial Busy	1 $\mu$ s	--	218 $\mu$ s	1 $\mu$ s when $t_{INTEG} \geq 218 \mu$ s (219 $\mu$ s - $t_{INTEG}$ ) when $t_{INTEG} < 218 \mu$ s
$t_{INTEG}$	Integration Time	1 $\mu$ s	--	6 s	User specified, 1 $\mu$ s resolution
$t_{BUSY2}$	Final Busy	--	218 $\mu$ s	--	Constant at 218 $\mu$ s
$t_{SSDLY}$	Single Strobe Delay	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{SSH}$	Single Strobe Width	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{CSPER}$	Continuous Strobe Period	0 $\mu$ s	--	$t_{INTEG}$	User specified, 1 $\mu$ s resolution. Continuous Strobe negates at end of integration time.
$t_{CSOFF}$	Continuous Strobe Off Time	0 $\mu$ s	--	$t_{CSPER}$	

Table 5 HR4 External Edge Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{\text{TL PUL}}$	External Edge Trigger Delay	20 ns	--	30 ns	Time from External Trigger rising edge to Trigger Event
$t_{\text{ETRGDLY}}$	Acquisition Delay	0 $\mu\text{s}$	--	335,500 $\mu\text{s}$	User specified, 1 $\mu\text{s}$ resolution
$t_{\text{ACQDLY}}$	Initial Busy	--	3706 $\mu\text{s}$	--	Constant at 3706 $\mu\text{s}$
$t_{\text{BUSY1}}$	Integration Time	3800 $\mu\text{s}$	--	10 s	Integration time is equal to $t_{\text{LPUL}}$ .
$t_{\text{INTEG}}$	Final Busy	--	3706 $\mu\text{s}$	--	Constant at 3706 $\mu\text{s}$
$t_{\text{BUSY2}}$	Single Strobe Delay	0 $\mu\text{s}$	--	--	User specified, 1 $\mu\text{s}$ resolution. Single Strobe returns low at the end of integration time.
$t_{\text{SSDLY}}$	Single Strobe Width	0 $\mu\text{s}$	--	--	User specified, 1 $\mu\text{s}$ resolution. Single Strobe returns low at the end of integration time.
$t_{\text{SSH}}$	Continuous Strobe Period	0 $\mu\text{s}$	--	--	User specified, 1 $\mu\text{s}$ resolution. Continuous Strobe negates at end of integration time.
$t_{\text{CSPER}}$	Continuous Strobe Period	0 $\mu\text{s}$	--	$t_{\text{INTEG}}$	User specified, 1 $\mu\text{s}$ resolution. Continuous Strobe negates at end of integration time.

Table 6 HR6 External Edge Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{\text{TL PUL}}$	External Level Trigger Pulse Width	7200 $\mu\text{s}$	--	5 s	Integration time is equal to $t_{\text{TL PUL}}$
$t_{\text{ETR GDLY}}$	External Edge Trigger Delay	20 ns	--	30 ns	Time from External Trigger rising edge to Trigger Event
$t_{\text{ACQ DLY}}$	Acquisition Delay	0 $\mu\text{s}$	--	335,500 $\mu\text{s}$	User specified, 1 $\mu\text{s}$ resolution
$t_{\text{BUSY1}}$	Initial Busy	--	6 $\mu\text{s}$	--	Constant at 6 $\mu\text{s}$
$t_{\text{INTEG}}$	Integration Time	7200 $\mu\text{s}$	--	5 s	Integration time is equal to $t_{\text{LPUL}}$ .
$t_{\text{BUSY2}}$	Final Busy	--	4977 $\mu\text{s}$	--	Constant at 4977 $\mu\text{s}$
$t_{\text{SSDLY}}$	Single Strobe Delay	0 $\mu\text{s}$	--	-	User specified, 1 $\mu\text{s}$ resolution. Single Strobe returns low at the end of integration time.
$t_{\text{SSH}}$	Single Strobe Width	0 $\mu\text{s}$	--	-	User specified, 1 $\mu\text{s}$ resolution. Single Strobe returns low at the end of integration time.
$t_{\text{CSPER}}$	Continuous Strobe Period	0 $\mu\text{s}$	--	$t_{\text{INTEG}}$	User specified, 1 $\mu\text{s}$ resolution. Continuous Strobe negates at end of integration time.

### External Level Trigger

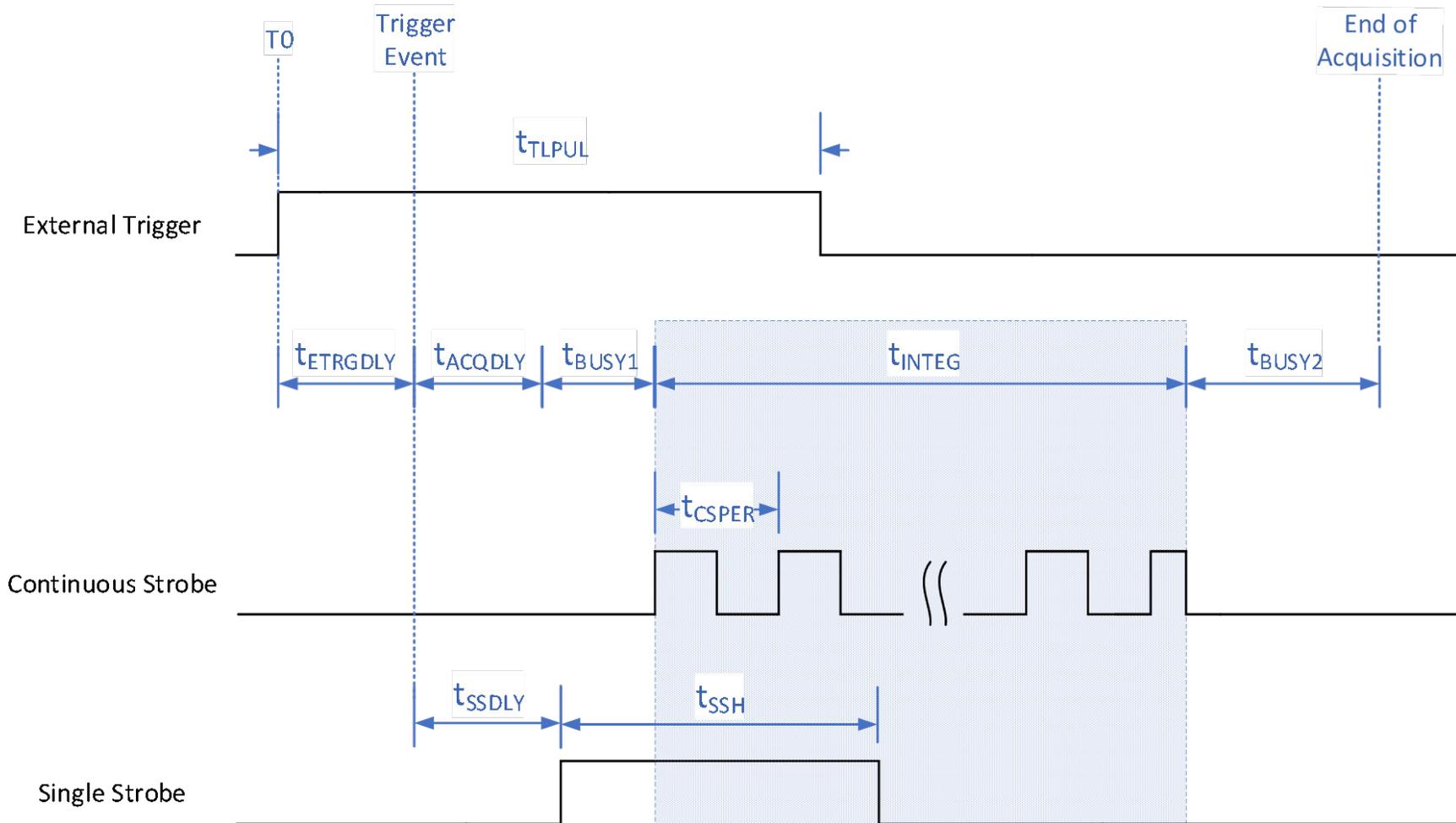
The External Level Trigger mode for the spectrometer waits for a trigger signal in the 16 Pin IO Connector on the External Trigger Input pin. In External Level Trigger mode, rather than using the software configured integration time, the integration time is directly related to the pulse width of the trigger pulse. The rising edge of the External Trigger signal causes a Trigger Event after a short constant time ( $t_{\text{ETR GDLY}}$ ). There is a constant delay from the Trigger Event to the start of integration ( $t_{\text{BUSY1}}$ ). The start of Integration Time can be further delayed by configuring the Acquisition Delay ( $t_{\text{ACQ DLY}}$ ).

Since the trigger pulse width determines the integration time, the trigger signal must remain high for a minimum time. If the External Level Trigger pulse does not meet the minimum pulse width, an error will occur and the received spectral values will be all 0's.

The Single Strobe signal functions the same as the other trigger modes.

However, the Continuous Strobe signal is slightly different. The Continuous Strobe is active during the integration time, but the Continuous Strobe signal will be forced low at the end of the integration time. This means the final period of the Continuous Strobe signal is not guaranteed to be a full period.

The following timing diagram shows an acquisition cycle for an External Level trigger event.



External Level Trigger timing characteristics are defined in the tables below.

Table 7 HR2 External Level Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{TLPUL}$	External Level Trigger Pulse Width	220 $\mu$ s	--	6 s	Integration time is equal to $t_{TLPUL}$
$t_{ETRGDLY}$	External Edge Trigger Delay	20 ns	--	30 ns	Time from External Trigger rising edge to Trigger Event
$t_{ACQDLY}$	Acquisition Delay	0 $\mu$ s	--	335,500 $\mu$ s	User specified, 1 $\mu$ s resolution
$t_{BUSY1}$	Initial Busy	--	1 $\mu$ s	--	Constant at 1 $\mu$ s
$t_{INTEG}$	Integration Time	220 $\mu$ s	--	6 s	Integration time is equal to $t_{TLPUL}$ .
$t_{BUSY2}$	Final Busy	--	218 $\mu$ s	--	Constant at 218 $\mu$ s
$t_{SSDLY}$	Single Strobe Delay	0 $\mu$ s	--	-	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{SSH}$	Single Strobe Width	0 $\mu$ s	--	-	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of integration time.
$t_{CSPER}$	Continuous Strobe Period	0 $\mu$ s	--	$t_{INTEG}$	User specified, 1 $\mu$ s resolution. Continuous Strobe negates at end of integration time.

Table 8 HR4 External Level Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{\text{TL PUL}}$	External Level Trigger Pulse Width	3800 $\mu\text{s}$	--	10 s	Integration time is equal to $t_{\text{TL PUL}}$
$t_{\text{ETR GDLY}}$	External Edge Trigger Delay	20 ns	--	30 ns	Time from External Trigger rising edge to Trigger Event
$t_{\text{ACQ DLY}}$	Acquisition Delay	0 $\mu\text{s}$	--	335,500 $\mu\text{s}$	User specified, 1 $\mu\text{s}$ resolution
$t_{\text{BUSY1}}$	Initial Busy	--	3706 $\mu\text{s}$	--	Constant at 3706 $\mu\text{s}$
$t_{\text{INTEG}}$	Integration Time	3800 $\mu\text{s}$	--	10 s	Integration time is equal to $t_{\text{LPUL}}$ .
$t_{\text{BUSY2}}$	Final Busy	--	3706 $\mu\text{s}$	--	Constant at 3706 $\mu\text{s}$
$t_{\text{SSDLY}}$	Single Strobe Delay	0 $\mu\text{s}$	--	--	User specified, 1 $\mu\text{s}$ resolution. Single Strobe returns low at the end of integration time.
$t_{\text{SSH}}$	Single Strobe Width	0 $\mu\text{s}$	--	--	User specified, 1 $\mu\text{s}$ resolution. Single Strobe returns low at the end of integration time.
$t_{\text{CSPER}}$	Continuous Strobe Period	0 $\mu\text{s}$	--	$t_{\text{INTEG}}$	User specified, 1 $\mu\text{s}$ resolution. Continuous Strobe negates at end of integration time.

Table 9 HR6 External Level Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{\text{TLPUL}}$	External Level Trigger Pulse Width	7200 $\mu\text{s}$	--	5 s	Integration time is equal to $t_{\text{TLPUL}}$
$t_{\text{ETRGDLY}}$	External Edge Trigger Delay	20 ns	--	30 ns	Time from External Trigger rising edge to Trigger Event
$t_{\text{ACQDLY}}$	Acquisition Delay	0 $\mu\text{s}$	--	335,500 $\mu\text{s}$	User specified, 1 $\mu\text{s}$ resolution
$t_{\text{BUSY1}}$	Initial Busy	--	6 $\mu\text{s}$	--	Constant at 6 $\mu\text{s}$
$t_{\text{INTEG}}$	Integration Time	7200 $\mu\text{s}$	--	5 s	Integration time is equal to $t_{\text{LPUL}}$ .
$t_{\text{BUSY2}}$	Final Busy	--	4977 $\mu\text{s}$	--	Constant at 4977 $\mu\text{s}$
$t_{\text{SSDLY}}$	Single Strobe Delay	0 $\mu\text{s}$	--	--	User specified, 1 $\mu\text{s}$ resolution. Single Strobe returns low at the end of integration time.
$t_{\text{SSH}}$	Single Strobe Width	0 $\mu\text{s}$	--	--	User specified, 1 $\mu\text{s}$ resolution. Single Strobe returns low at the end of integration time.
$t_{\text{CSPER}}$	Continuous Strobe Period	0 $\mu\text{s}$	--	$t_{\text{INTEG}}$	User specified, 1 $\mu\text{s}$ resolution. Continuous Strobe negates at end of integration time.

# Calibration

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Each Ocean HR 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 your Ocean HR spectrometer, visit [www.oceanoptics.com](http://www.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 [www.oceanoptics.com](http://www.oceanoptics.com).

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

## Questions?

Chat with us at [www.oceanoptics.com](http://www.oceanoptics.com).  
info@www.oceanoptics.com

**US** +1 727-733-2447

**EUROPE** +31 26-3190500

**ASIA** +86 21-6295-6600

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