



Ocean**Optics**



# OCEAN ST SERIES

**Compact Spectrometers**

Installation and Operation Manual

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Ocean Optics. For more information visit  
[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 [OceanOptics.com](http://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.



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.

# Introduction

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## 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

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## 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.

## Software Installation

Use OceanView version 2.0.10 and above for Ocean ST. 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 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.



## 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

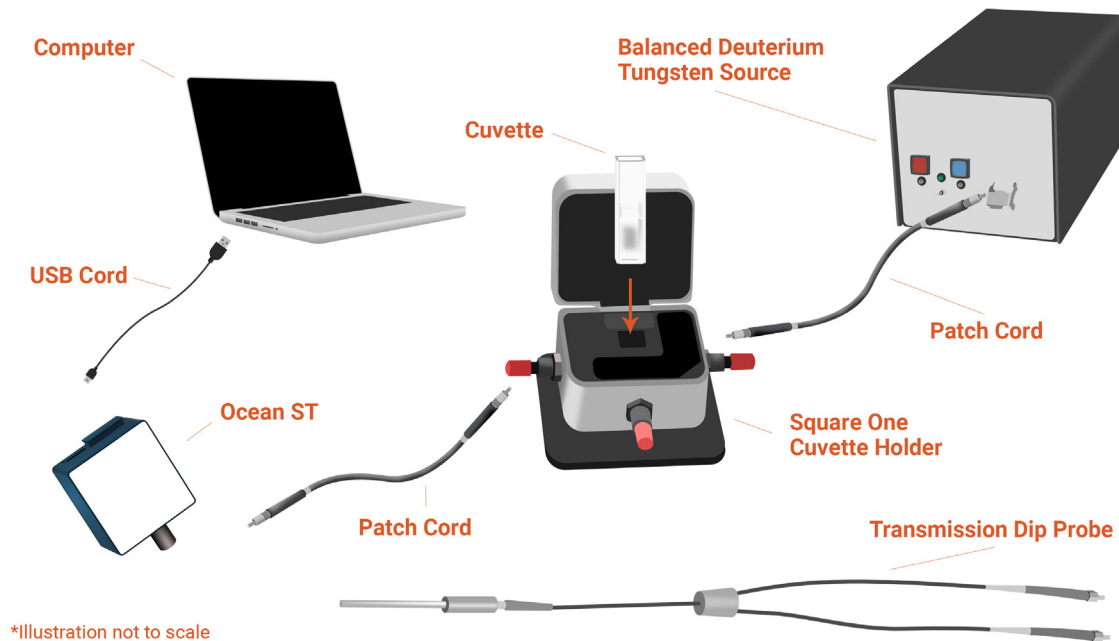
The Ocean ST connects to a computer via the USB port. When connected through a USB 2.0 or 1.1 port, the spectrometer draws power from the host computer, eliminating the need for an external power supply.

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](http://OceanOptics.com).
5. Attach the fiber to the fiber optic connector on the spectrometer.

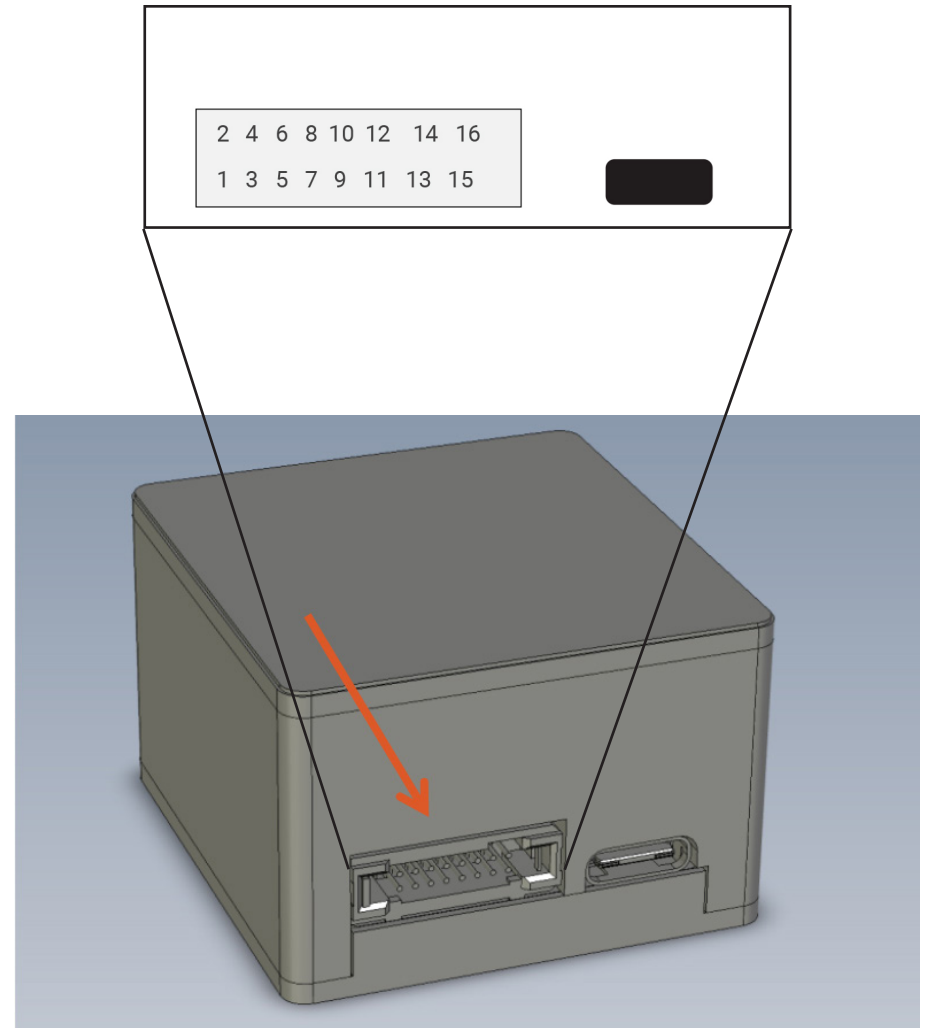
If you installed the spectrometer operating software prior to connecting the Ocean ST, the software automatically installs the correct drivers. If the drivers do not successfully install (or if you connected the Ocean ST to the computer before installing the software), consult Troubleshooting.



# 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
1	RS-232 TX	Spectrometer transmit to host
2	RS-232 RX	Spectrometer receive from host
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

PIN	Function	Description
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

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

### *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

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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.

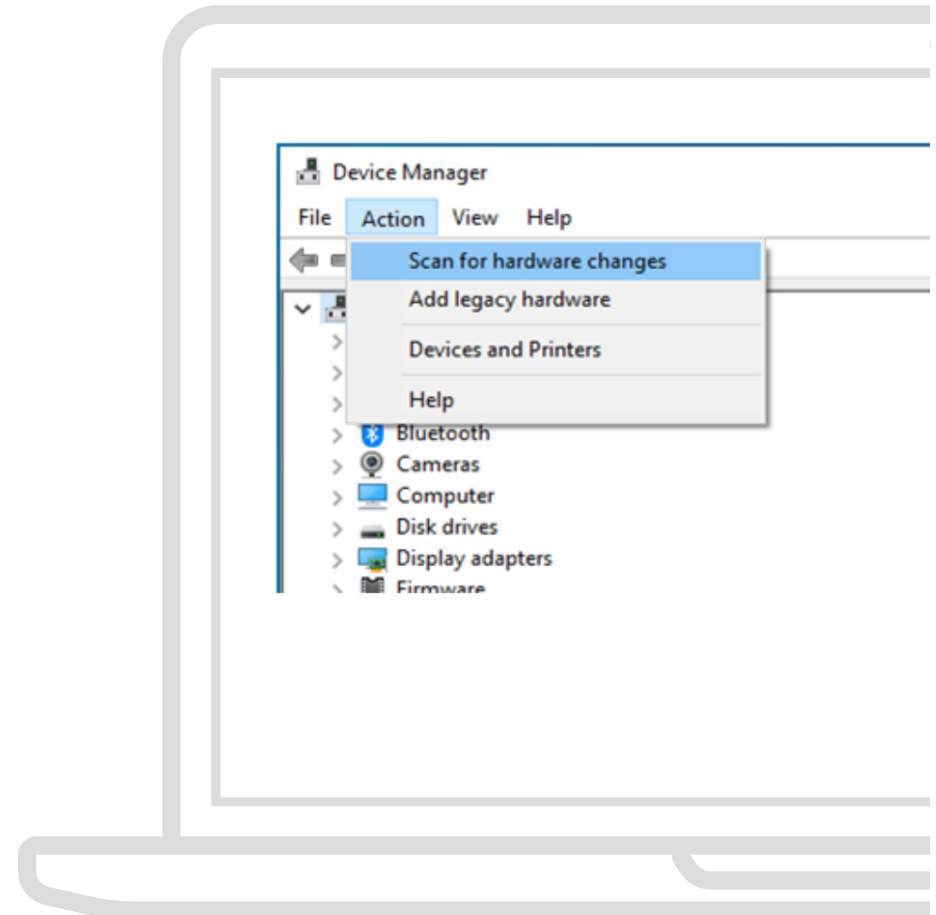
### **I am having trouble installing the drivers, what should I do?**

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
<b>Optical and Spectroscopic</b>			
Integration Time	3.8 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 $\mu\text{m}$ slit)	2.2 nm		
Scan Rate	160 Hz		
Thermal Wavelength Drift	0.02 nm/ $^{\circ}\text{C}$		
Triggering	Software, External Rising Edge		
Wavelength Range	185-650 nm	350-810 nm	645-1085 nm
Entrance Slit	25 $\mu\text{m}$ -200 $\mu\text{m}$		



# Technical Specifications

Specification	Ocean ST-UV	Ocean ST-VIS	Ocean ST-NIR
<b>Mechanical</b>			
Input Fiber Connector	SMA 905		
Physical Dimensions:	42.1 mm x 40.3 mm x 26.6 mm		
Weight:	70.4 g		
<b>Environmental</b>			
Temperature: Storage Operation	Storage: -30 °C to 70 °C Operation: 0 °C to 55 °C		
Humidity Tolerance (non-condensing only)	<85%		
Operation	For indoor use		
Operating Altitude (maximum)	2000 m		
Overvoltage Category	1		
Pollution Degree	2		

# Technical Specifications

Model	Wavelength Range	Optical Resolution	Entrance Slit
OCEAN-ST-UV-25	185-650 nm	2.2 nm	25 $\mu\text{m}$
OCEAN-ST-UV-50		3.7 nm	50 $\mu\text{m}$
OCEAN-ST-UV-100		6.3 nm	100 $\mu\text{m}$
OCEAN-ST-UV-200		13.0 nm	200 $\mu\text{m}$
OCEAN-ST-VIS-25	350-810 nm	2.2 nm	25 $\mu\text{m}$
OCEAN-ST-VIS-50		3.7 nm	50 $\mu\text{m}$
OCEAN-ST-VIS-100		6.3 nm	100 $\mu\text{m}$
OCEAN-ST-VIS-200		13.0 nm	200 $\mu\text{m}$
OCEAN-ST-NIR-25	645-1085 nm	2.2 nm	25 $\mu\text{m}$
OCEAN-ST-NIR-50		3.7 nm	50 $\mu\text{m}$
OCEAN-ST-NIR-100		6.3 nm	100 $\mu\text{m}$
OCEAN-ST-NIR-200		13.0 nm	200 $\mu\text{m}$

## Spectrometer Configuration

This section describes the spectrometer's configurable parameters. The spectrometer provides configurable integration time, acquisition modes, trigger modes, delays, and strobe signals. This configurability provides the user with a high level of control over the timing of their integration and the ability to synchronize external devices such as lasers or light sources to the spectrometer.

### Integration Time

The Integration Time defines the length of exposure time for the detector. The user may set the Integration Time through software. A longer Integration Time allows more photons to be collected each acquisition, increasing the signal value. A shorter Integration Time reduces the number of photons collected each acquisition, thereby reducing the signal value. Refer to the Spectrometer Technical Specifications table for the minimum and maximum values supported for Integration Time.

### Trigger Modes

The time when the spectrometer receives a trigger is called a Trigger Event. The Trigger Event is the signal to start an Acquisition Cycle. An Acquisition Cycle consists of a delay, then one or more integrations, followed by a readout of the data to be returned to the host system.

The spectrometer supports different trigger modes, which are set with the Trigger Mode command. The supported trigger modes are briefly described in the following subsections. The combination of the Acquisition Mode and

the Trigger Mode defines the timing for each acquisition. For more details on the timing and behavior of each trigger mode, refer to the Acquisition Mode section.

### *Software Trigger Mode (Trigger Mode 0)*

The Trigger Event is initiated with a command from software running on the host system. The integration time is set by software configuration.

### *External Edge Trigger Mode (Trigger Mode 1)*

The Trigger Event 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 Mode (Trigger Mode 2)*

The Trigger Event 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.

### Acquisition Modes

The spectrometer may support different acquisition modes described in this section. These modes can be selected to perform multiple integrations within a single acquisition. This allows the hardware to perform integrations back-to-back and possibly provide hardware accelerated averaging. The following table summarizes some of the key differences between the acquisition modes and what configurations are supported.

Table 1 Acquisition Mode Summary Table

Acquisition Mode	Single Spectrum	High Speed Averaging Mode (HSAM)
Number of Integrations	1	Scans to Average
Number of Spectra returned	1	1
Integrations performed Back-to-Back	No	Yes
Trigger Modes Supported	<ul style="list-style-type: none"> <li>• Software Trigger</li> <li>• External Edge Trigger</li> <li>• External Level Trigger</li> </ul>	<ul style="list-style-type: none"> <li>• Software Trigger</li> <li>• External Edge Trigger</li> </ul>
Description	Performs a single integration and returns a single spectrum.	Performs a number of integrations specified by the Scans to Average configuration. One spectrum containing the average for each pixel is returned.

## Single Spectrum

The Single Spectrum Acquisition Mode performs a single integration per acquisition cycle. The spectrum is returned to the host system before the spectrometer accepts a new trigger. This is the default acquisition mode when powering on your spectrometer.

The Single Spectrum Acquisition Mode supports all Trigger Modes. The subsections below provide detailed timing diagrams and values for each Trigger Mode when operating in Single Spectrum Acquisition Mode.

## Software Trigger Mode

The Software Trigger Mode is the default Trigger Mode on device power-on. In the Software Trigger Mode, the Trigger Event is initiated by a request from software on the host system. Note that there is some latency between the software on the host computer and the Trigger Event; this latency varies between computer systems. The Trigger Event starts an Acquisition Cycle which consists of an initial delay, an integration time, then a final delay before the data is returned to the host system.

The initial delay between the Trigger Event and the start of integration time is the sum of the user defined Acquisition Delay ( $t_{ACQDLY}$ ) and a fixed delay ( $t_{BUSY1}$ ).

The Integration Time ( $t_{INTEG}$ ) is configurable in software by the user. This is the time that the detector is collecting spectra data.

The final delay ( $t_{BUSY2}$ ) occurs 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 low.

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

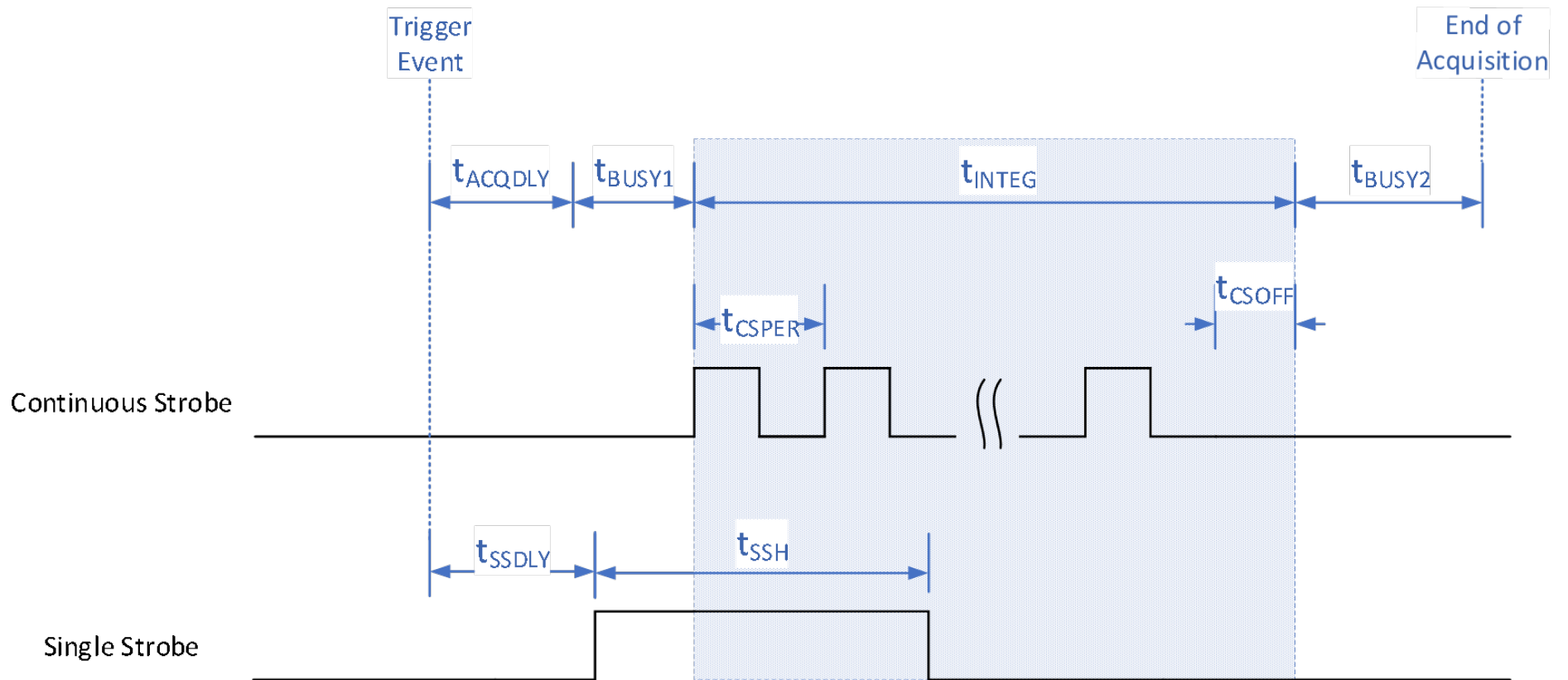


Figure 1 Software Trigger Timing Diagram

Software Trigger timing characteristics are defined in the tables below.

Table 6 ST 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	--	1561 $\mu$ s	--	Constant at 1561 $\mu$ s
$t_{INTEG}$	Integration Time	3800 $\mu$ s	--	6 s	User specified, 10 $\mu$ s resolution
$t_{BUSY2}$	Final Busy	--	1553 $\mu$ s	--	Constant at 1553 $\mu$ 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, 10 $\mu$ s resolution. Should be less than Integration Time to activate.
$t_{CSOFF}$	Continuous Strobe Off Time	0 $\mu$ s	--	$t_{CSPER}$	

## External Edge Trigger Mode

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 to 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.

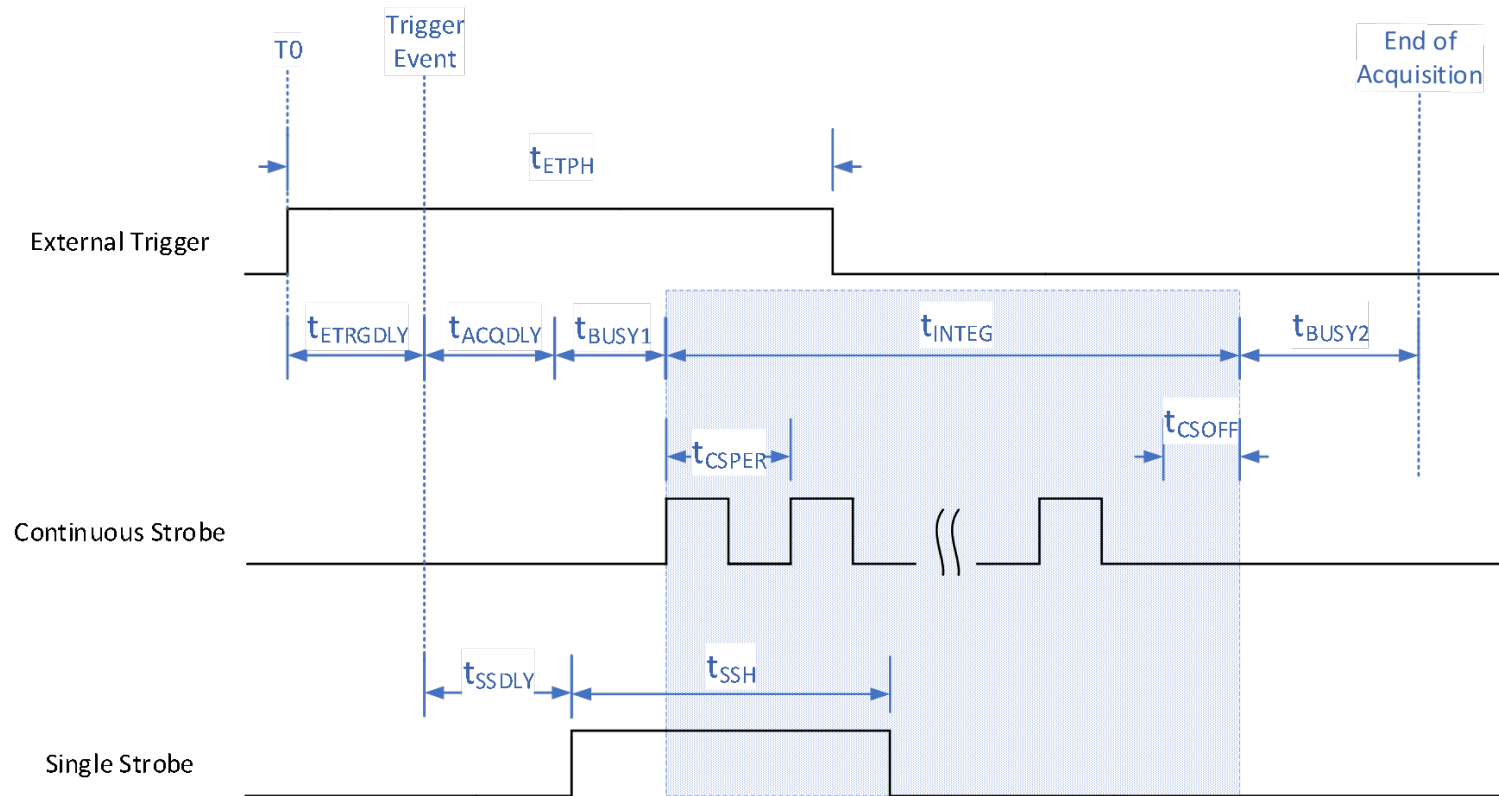


Figure 2 External Edge Trigger Timing Diagram



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

Table 13 ST 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	--	1561 $\mu$ s	--	Constant at 1561 $\mu$ s
$t_{INTEG}$	Integration Time	3800 $\mu$ s	--	6 s	User specified, 10 $\mu$ s resolution
$t_{BUSY2}$	Final Busy	--	1553 $\mu$ s	--	Constant at 1553 $\mu$ 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, 10 $\mu$ s resolution. Should be less than Integration Time to activate.
$t_{CSOFF}$	Continuous Strobe Off Time	0 $\mu$ s	--	$t_{CSPER}$	

## External Level Trigger Mode

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 ( $t_{ETRGDLY}$ ). There is a constant delay from the Trigger Event to the start of integration ( $t_{BUSY1}$ ). The start of Integration Time can be further delayed by configuring the Acquisition Delay ( $t_{ACQDLY}$ ).

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.

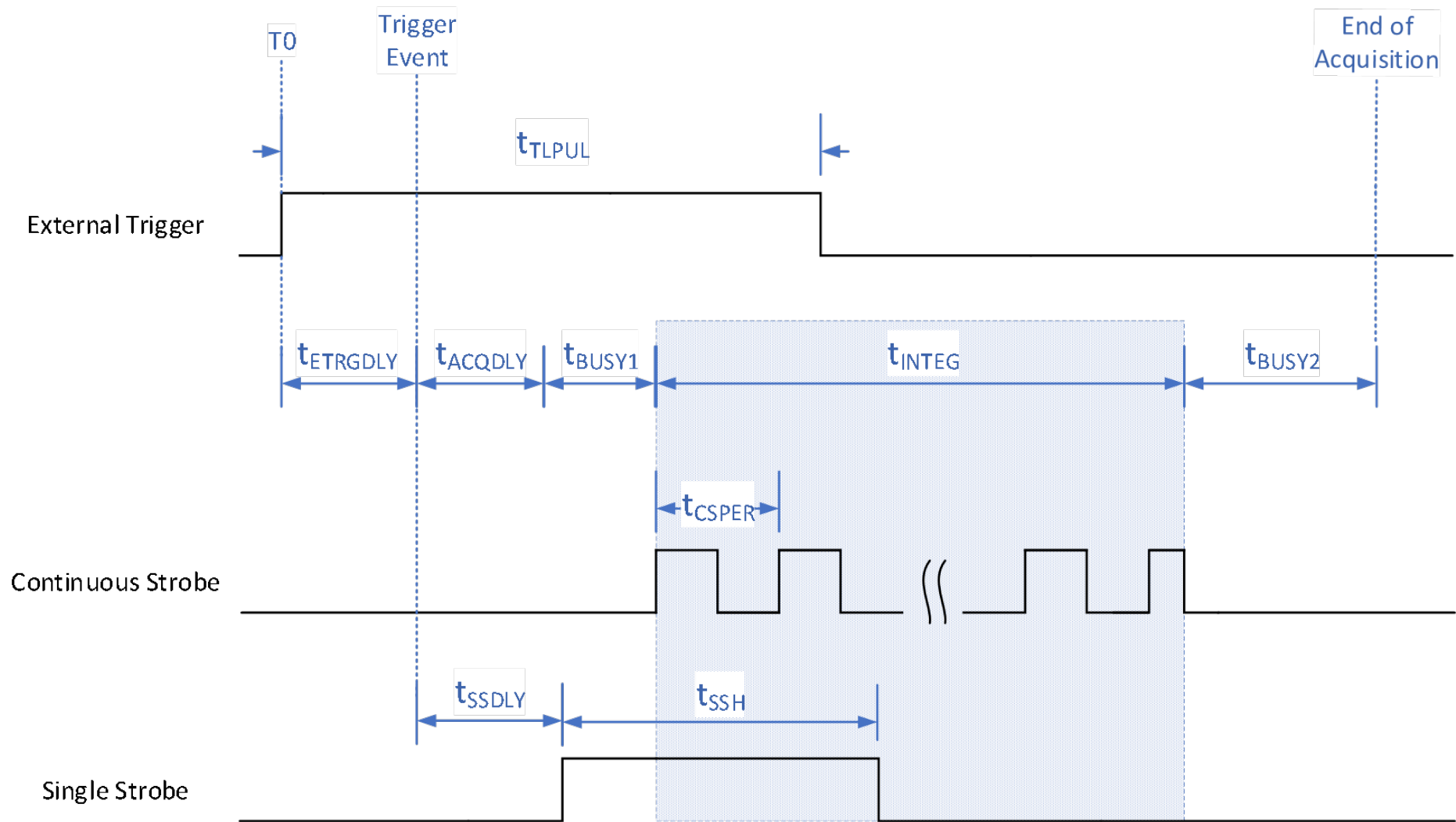


Figure 3 External Level Trigger Timing Diagram

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

Table 20 ST External Level Trigger Timing Characteristics

Symbol	Description	Time			Notes
		min	typ	max	
$t_{\text{TL PUL}}$	External Level Trigger Pulse Width	3800 $\mu\text{s}$	--	6 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	--	1561 $\mu\text{s}$	--	Constant at 1561 $\mu\text{s}$
$t_{\text{INTEG}}$	Integration Time	3800 $\mu\text{s}$	--	6 s	Integration time is equal to $t_{\text{TL PUL}}$ .
$t_{\text{BUSY2}}$	Final Busy	--	1553 $\mu\text{s}$	--	Constant at 1553 $\mu\text{s}$
$t_{\text{SSDLY}}$	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, 10 $\mu\text{s}$ resolution. Continuous Strobe negates at end of integration time.

## High Speed Averaging Mode (HSAM)

High Speed Averaging Mode enables the spectrometer to perform multiple integrations within one acquisition cycle. The spectrometer performs averaging of the integrations on the hardware. The result is that each pixel of the spectrum returned to the host computer represents the average of that pixel value over the specified number of integrations.

HSAM only supports Software and External Edge Trigger modes. External Level Trigger is not supported with HSAM. If configured for Software Trigger, the Trigger Event occurs when the spectrometer recognizes the request for spectra capture. If configured for External Edge Trigger mode, then the Trigger Event occurs a short delay ( $t_{ETRGDLY}$ ) after the rising edge of the External Trigger input signal.

The following timing diagram shows an acquisition cycle when configured with HSAM over N number of integrations.

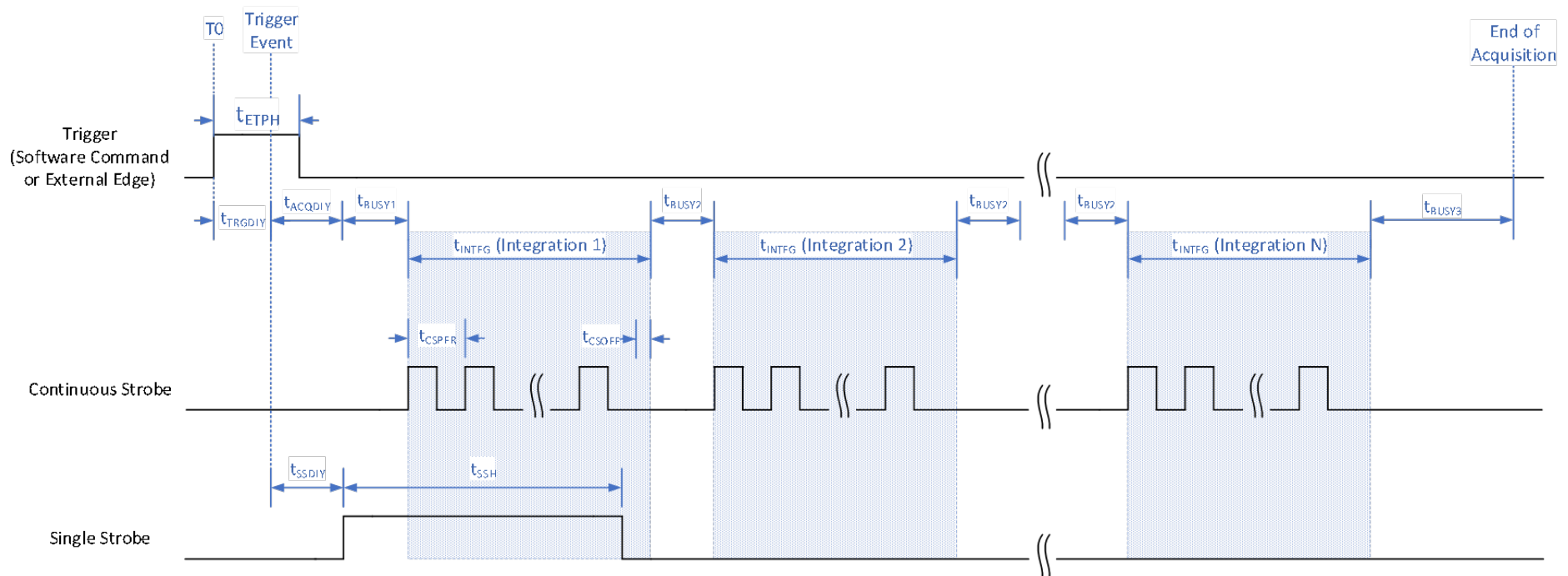


Figure 4 HSAM Timing Diagram

HSAM timing characteristics are defined in the tables below.

Table 27 ST HSAM 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	
$t_{ACQDLY}$	Acquisition Delay	0 $\mu$ s	--	335,500 $\mu$ s	User specified, 1 $\mu$ s resolution
$t_{BUSY1}$	Initial busy time	--	1561 $\mu$ s	--	Constant at 1561 $\mu$ s
$t_{INTEG}$	Integration Time	3800 $\mu$ s	--	6 s	User specified, 10 $\mu$ s resolution
$t_{BUSY2}$	Busy time between integrations	--	0 $\mu$ s	--	Constant at 0 $\mu$ s. Integrations are back-to-back in High Speed Averaging Mode
$t_{BUSY3}$	Final busy time	--	1553 $\mu$ s	--	Constant at 1553 $\mu$ s
$t_{SSDLY}$	Single Strobe Delay	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of the first integration time.
$t_{SSH}$	Single Strobe Width	0 $\mu$ s	--	--	User specified, 1 $\mu$ s resolution. Single Strobe returns low at the end of the first integration time.
$t_{CSPER}$	Continuous Strobe Period	0 $\mu$ s	--	$t_{INTEG}$	User specified, 10 $\mu$ s resolution. Should be less than Integration Time to activate.
$t_{CSOFF}$	Continuous Strobe Off Time	0 $\mu$ s	--	$t_{CSPER}$	
N	Number of Integrations	2	--	65,535	User specified.

## Strobe 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 and their configurable parameters. The Single and Continuous Strobe signals are accessible on the 16 Pin IO Connector.

### *Single Strobe*

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.

### Single Strobe Enable

The Single Strobe Enable option is used to enable or disable the Single Strobe output. If disabled, the Single Strobe output will be constantly driven low. If enabled, the Single Strobe output will be driven active-high based on the Single Strobe Delay and Single Strobe Width configurations.

### Single Strobe Delay

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.

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.

### Single Strobe Width

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 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 in the Acquisition Modes section for more detailed information on the timing of the Single Strobe output.

### *Continuous Strobe*

The Continuous Strobe output signal is a periodic signal with a 50% duty cycle that occurs during the Integration Time of each acquisition cycle. The Continuous Strobe output has a user configurable Continuous Strobe Period ( $t_{CSPER}$ ). The Continuous Strobe signal is only active during the integration time ( $t_{INTEG}$ ). It is driven low at all other times.

### Continuous Strobe Enable

The Continuous Strobe Enable option is used to enable or disable the Continuous Strobe output. If disabled, the Continuous Strobe output will be constantly driven low. If enabled, the Continuous Strobe output will be driven active-high based on the Continuous Strobe Period configuration.

## Continuous Strobe Period

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 time. 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 the integration time, only full periods are generated. This means the time between the last Continuous Strobe period and the end of integration time ( $t_{\text{CSOFF}}$ ) is between 0 and  $t_{\text{CSPER}}$ .

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 in the Acquisition Modes section for more information on the Continuous Strobe timing.

## Acquisition Delay

The Acquisition Delay is a user programmable time that delays the start of integration from the Trigger Event. The Acquisition Delay does not affect the length of integration, it only delays the start of integration relative to the Trigger Event.

Note that the start of the Continuous Strobe output signal is only active during 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.

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



## Questions?

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