

# External Triggering Options Instructions

## Overview

Ocean Optics USB2000, USB4000, HR2000, HR2000+, HR4000, QE65000, NIR Series, S2000, and S1024DW Spectrometers provide several methods of acquiring data (see table below). In the Normal mode, the spectrometer is “free running.” That is, the spectrometer is continuously scanning, acquiring, and transferring data to your computer, according to parameters set in the software. In this mode, however, there is no way to synchronize the scanning, acquisition, and transfer of data with an external event. However, trigger pulses for synchronizing an external event with the spectrometer are available.

To synchronize data acquisition with external events, other modes of acquiring data are available. Each mode involves connecting an external triggering device to the spectrometer and then applying an external trigger to the spectrometer before the software receives the data. The length of the integration time and the source for the integration clock depend upon the mode chosen. All other acquisition parameters are set in the software.

Also see the *HR4000 and USB4000 Triggering Modes Engineering Note*

([http://www.oceanoptics.com/technical/engineering/HR4000 and USB4000 Triggering Modes.pdf](http://www.oceanoptics.com/technical/engineering/HR4000%20and%20USB4000%20Triggering%20Modes.pdf)) for more information on external triggering with these spectrometers.

Triggering Mode	Description	Applicable Spectrometer(s)
Normal	Spectrometer acquires spectra continuously.	All
External Software	Integration time is set in the software. Software receives a trigger event and transmits spectra obtained in the data acquisition cycle in which the trigger occurred.	All
External Hardware	Integration time set via chip in spectrometer (USB Series/HR Series/S2000 D Series) or jumpers (S2000 series). Spectrometer waits for a sharp rise in voltage on the trigger input pin, and then acquires spectra until the voltage is removed.	USB2000/USB4000/ HR2000/HR2000+/HR4000/ S2000/S1024DW
External Synchronization	Spectrometer acquires data from an external trigger event (such as a push button) until the next time the trigger is activated, at which time the spectrometer ceases spectral acquisition and begins a new acquisition. Integration time cannot be set, since the trigger can fire at random intervals.	USB2000/USB4000/ HR2000/HR2000+/HR4000/ S2000/S1024DW

Triggering Mode	Description	Applicable Spectrometer(s)
Quasi-Real Time Acquisition Mode	The integration clock is set to 4ms, which is the time required to completely read out all the pixels. When the software (user) requests a spectrum, the integration clock waits for the current period to expire, changes to the desired integration time set via software commands, and then returns to 4ms. With this approach, the start of the integration period will always be within 4ms of the time when the request for a spectrum is issued. No trigger signal is required to operate in this mode.	USB4000

## IMPORTANT: Voltage Regulation

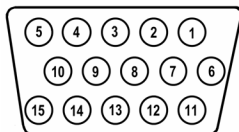
The *maximum* recommended voltage on the Triggering Pin is 5.5 V. If your triggering device exceeds this voltage, you must regulate or condition the signal (via transistor buffering, transformer isolation or opto-isolation, for example) or isolate the signal from the spectrometer.

### Note

To use one of the External Triggering options, you must know the specifications and limitations of the triggering device. The design of the triggering device may prevent you from using one of the external triggering modes as it is described in these pages.

Consult the following images and table for information on which pin to connect to the triggering device when using each triggering mode on the spectrometer.

## Pinout Diagrams for Ocean Optics Spectrometers



J2 (D-SUB-15) Accessory Connector on NIR Series, S2000 and S1024DW Spectrometers

20	18	16	14	12	10	8	6	4	2
19	17	15	13	11	9	7	5	3	1

Pinout Diagram of 20-pin Connector on USB4000 and HR2000 Spectrometers

10	8	6	4	2
9	7	5	3	1

Pinout Diagram of 10-pin Connector on USB2000 Spectrometer

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

Pinout Diagram of 30-pin Connector on HR2000+, HR4000 and QE65000 Spectrometers

## Trigger Input Pin Information for Ocean Optics Spectrometers

Trigger Mode	Trigger Input Pin					Description
	S2000 S1024DW	QE65000	USB2000 USB4000 HR2000	USB4000 HR2000+	NIR512 NIR256	
External Software	8	10	7	10	8	Asynchronous Mode - Integration time specified in software
External Synchronization	5	Not Available	Not Available	Not Available	Not Available	Synchronous Mode - User provides integration clock
External Hardware	4	Not Available	7	10	Not Available	Synchronous Mode - Integration fixed by jumpers

## External Triggering vs. Triggering an External Event

There could be some confusion between the concepts of External Triggering and triggering an external event. The following sections explain each of these concepts.

### External Triggering

In External Triggering, an event outside the sampling system (such as a push button, lever activation, or laser pulse) triggers the voltage level on the spectrometer's trigger pin and instructs the spectrometer to begin spectra acquisition.

### Triggering an External Event

When triggering an external event, the spectrometer instructs an external device (typically a lamp such as the PX-2 or the LS-450) to illuminate immediately prior to spectral acquisition.

# Level Triggering and Edge Triggering

In External Triggering, there are two modes of triggering available. The trigger mode in use determines the kind of triggering that the system will use.

## Level Triggering

Level triggering mode is only available when using External Software Triggering mode. In this mode, the software monitors the A/D converter for an increase in the voltage level applied to the trigger pin. When the appropriate increase in voltage is received (5 volts), the software instructs the spectrometer to acquire spectra.

In this mode, the A/D converter will acquire data in intervals based on the integration time set in the software. Thus, if a trigger occurs in the middle of an integration period, the software will retrieve the spectra obtained for that entire integration period (before AND after the trigger event). Similarly, if a trigger occurs immediately prior to the end of an integration period, the software will still retrieve the spectra obtained during that integration period.

For example, if the integration time is 50 ms and the trigger event occurs 48 ms into the integration cycle, the 2 ms following the trigger will be acquired, and the 48 ms prior to and including the trigger will be acquired.

## Edge Triggering

Edge triggering mode is available when using External Hardware and External Synchronization Triggering modes. In both of these modes, the spectrometer monitors the trigger input pin for **rapid rise in the voltage** (which may or may not reach the 5 volt plateau) applied to the trigger pin. When this voltage rise is received and the spectrometer “sees” the voltage peak caused by the increase, the spectrometer acquires spectra and transmits the spectra to the software.

In External Hardware Triggering mode, the spectrometer ceases data acquisition once the voltage rise drops. In External Synchronization Triggering mode, however, data acquisition continues until the next rise in voltage is “seen” by the spectrometer.

# Integration Times Available with External Triggering

The following table illustrates the integration times available with External Triggering modes:

Spectrometer	External Software	External Hardware	External Synchronization
USB2000/HR2000	Set in Software	50 msec	Cannot Manually Set
USB4000/HR2000+/HR4000	Set in Software	Set in Software	Input by software
NIR Series	Set in Software	Not Available	Not Available
S2000/S1024DW	Set in Software	Set on Jumpers	Cannot Manually Set
S2000 D-Series	Set in Software	55 msec	Cannot Manually Set
QE65000	Set in Software	Not Available	Not Available

## Software Support

The following table details External Triggering support capacity in all Ocean Optics software products:

Product	Supported	Not Supported
SpectraSuite	All Modes	--
OOIBase	All Modes	--
OOIBase32	All Modes	--
OOIBase32 Platinum	All Modes	--
OOIColor	External Software and External Hardware	External Synchronization
OOI Driver Products	All Modes	--
OOISensors	External Software	External Synchronization and External Hardware
OOIrrad	External Software and External Hardware	External Synchronization
Palm Spec	External Software	External Sync and External Hardware

# Configuring External Triggering

## External Software Trigger Mode

In this level-triggered mode, the spectrometer is “free running,” just as it is in the Normal mode. The spectrometer is continually scanning and collecting data. With each trigger, the data collected up to the trigger event is transferred to the software. If you continuously apply triggers (for example, by holding down the button on via an external switch), this mode is equivalent to operating in the Normal mode.

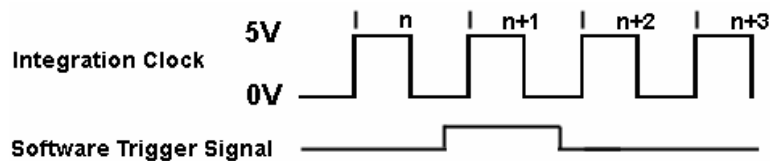
In the External Software Trigger mode, you set the integration time (as well as all other acquisition parameters) in the software. The source for the integration clock comes from the A/D converter.

---

### Note

This is the only external triggering mode where the integration time is set in the software.

---



*If the software trigger is asserted during integration cycle n, the photons from this integration period will be read out and digitized at the start of integration cycle n+1*

### External Software Triggering – Trigger Timing

#### When to Use the External Software Trigger Mode

Use the External Software Trigger mode if you:

- Are using a continuous illumination source, and the light intensity is constant before, during, and after the trigger.
- Need to set the integration time in the software.

#### Using the External Software Trigger Mode

##### ► Procedure

1. Connect the line to the appropriate pin on the spectrometer:

### **USB2000, USB4000 and HR2000 Spectrometers**

Supply a line from Pin 7 of the Multi-pin Connector on the spectrometer to your triggering device.

### **HR2000+, HR4000 and QE65000 Spectrometers**

Supply a line from Pin 10 of the Multi-pin Connector on the spectrometer to your triggering device.

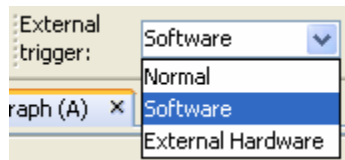
### **NIR Series, S2000, and S1024DW Spectrometers**

Supply a line from Pin 8 of the J2 Accessory Connector to the triggering device, and then connect Pin 10 of the J2 Accessory Connector (ground) to the ground of the triggering device.

2. Set triggering in the software:

#### **SpectraSuite**

Use the External Trigger selection box on the Trigger toolbar to set the trigger mode of the spectrometer to **Software**.



#### **OOIBase32**

- a. Click the Data Acquisition icon or select **Spectrum | Configure Data Acquisition** from the OOIBase32 menu bar and set the acquisition parameters in the software
- b. Select the **External Trigger** page on the Configure Data Acquisition screen and select **Software Trigger**.
- c. Enable the **Automatically save file on trigger** box if you wish to save the data to a file after each trigger.

If you enable this function, OOIBase32 displays a file save dialog box after each trigger. To avoid manually naming a file for each trigger, you can enable the Autoincrement Filenames function from the **File | Autoincrement Filenames | Enabled** option in the menu bar.

---

#### **Note**

Once you select an external trigger mode, your computer will appear unresponsive. This is normal, as the computer is waiting for a trigger. You must apply one more trigger to the spectrometer after selecting a new trigger mode.

---

## External Triggering Options Instructions

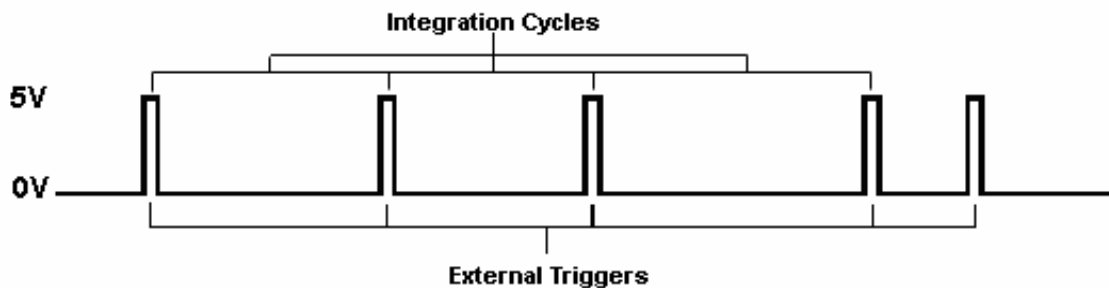
Since this is a level-triggered mode, the delay between the trigger pulse and spectrum acquisition varies, depending on the speed at which the software polls the line and recognizes it is HIGH, as well as the amount of time until the start of the next integration period.

## External Synchronization Trigger Mode – S2000 and S1024DW Spectrometers Only

In this edge-triggered mode, the spectrometer is idle until you apply the initial trigger to the spectrometer. With each trigger, the spectrometer:

1. Stops taking its current scan (if applicable)
2. Transfers data to the software
3. Begins a new scan
4. Integrates until another trigger is applied

In the External Synchronization Trigger mode, the frequency of triggers to the spectrometer determines the effective integration time. The effective integration time is the time between rising edges of signals applied to Pin 5 of the J2 Accessory Connector. All other acquisition parameters are set in the software. The source for the integration clock is the external triggering device itself, such as a periodic TTL signal.



### External Synchronization Triggering – Trigger Timing

## When to Use External Synchronization Trigger Mode

Use the External Synchronization Trigger mode if you:

- Must synchronize your scans to an external clock source
- Are using a lock-in amplifier
- Are using a chopper



## Using the External Synchronization Trigger Mode

### ► Procedure

1. Supply a line from Pin 5 of the J2 Accessory Connector to the triggering device. (See figure in [Pinout Diagrams for Ocean Optics Spectrometers](#) on page 2 for pin location.)
2. Connect Pin 10 of the J2 Accessory Connector (ground) to the ground of the triggering device.
3. Click the Data Acquisition icon or select **Spectrum | Configure Data Acquisition** from the OOIBase32 menu bar and set the other acquisition parameters.
4. Select the External Trigger page on the Configure Data Acquisition screen and select Synchronization.
5. Enable the **Automatically save file on trigger** box if you wish to save the data to a file after each trigger.

If you enable this function, OOIBase32 displays a file save dialog box after each trigger. To avoid manually naming a file for each trigger, you can enable the Autoincrement Filenames function from the **File | Autoincrement Filenames | Enabled** option in the menu bar.

---

### Note

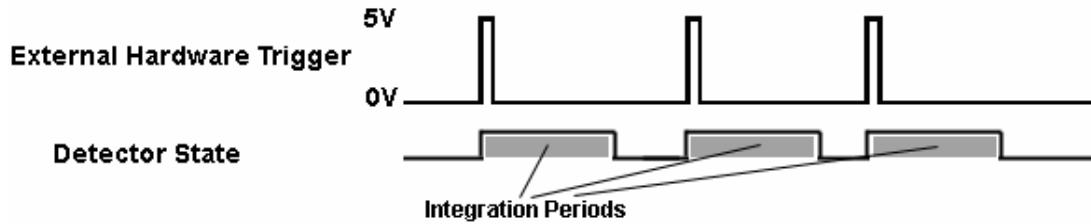
Once you select an external trigger mode, your computer will appear unresponsive. This is normal, as the computer is waiting for a trigger.

---

## External Hardware Trigger Mode – USB2000, USB4000, HR2000, HR2000+ and HR4000 Spectrometers

In this edge-triggered mode, the spectrometer is idle until you apply a trigger to the spectrometer. With each trigger, the following events occur:

1. The spectrometer is cleared and then begins integrating
2. For USB2000 and HR2000: The spectrometer integrates for 50 milliseconds (you can contact Ocean Optics if you require a different integration time)  
For USB4000, HR2000+ and HR4000: The integration time is selectable in software
3. The data is transferred to the software; the spectrometer then sits idle waiting for the next trigger



External Hardware Triggering – Trigger Timing

## When to Use External Hardware Triggering Mode

Use the External Hardware Triggering mode if you:

- Are using a pulsed excitation source or light source in your experiment (such as a laser or flash lamp)
- Are doing LIF (fluorescence with pulsed excitation) or phosphorescence experiments
- Need to synchronize an acquisition with an external event

## Using External Hardware Triggering Mode

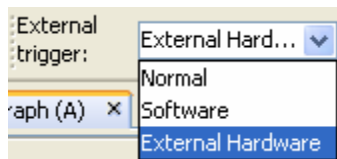
Follow the steps below to enable External Hardware Triggering mode.

### ► Procedure

1. Supply a line from Pin 7 on the USB2000/HR2000 or Pin 10 on the USB4000/HR2000+/HR4000 of the Multi-pin Connector to your triggering device.
2. Set your acquisition parameters, such as integration time, in the software.

### SpectraSuite

Use the External Trigger selection box on the Trigger toolbar to set the trigger mode of the spectrometer to **External Hardware**.



### OOIBase32

- a. Select **Spectrum | Configure Data Acquisition** from the menu. Choose the External Trigger tab and select Hardware Trigger.
- b. Enable the **Automatically save file on trigger** box to save processed data with each external trigger.

If you enable this function, you will be presented with a file save dialog box with each trigger.

To avoid manually naming a file for each trigger, you can enable the **Autoincrement Filenames** function by selecting **File | Autoincrement Filenames | Enabled** from the menu. Choose a base name and starting index for the autoincremented files.

---

### Note

Once you select the External Hardware Trigger mode, your system may appear unresponsive. However, the system is actually waiting for the trigger.

---

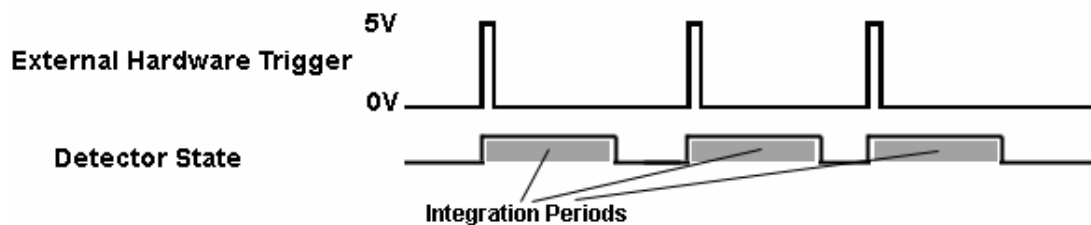
- c. Activate your triggering device. The acquisition parameters, name of the window acquiring data and trigger mode are displayed in the main status bar.

## External Hardware Trigger Mode – S2000 and S1024DW Spectrometers

In this edge-triggered mode, the spectrometer is idle until you apply a trigger to the spectrometer. With each trigger, the spectrometer:

1. Clears its memory and then begins integrating
2. Integrates for a fixed period of time, determined by the jumpered pins on the spectrometer's circuit board
3. Transfers the data to the software
4. Waits for the next trigger

In the External Hardware Trigger mode, you set the integration time by positioning jumpers over pins on the spectrometer's circuit board. All other acquisition parameters are set in the software. The source for the integration clock is the external triggering device itself. This mode is ideal for use with laser and other short-pulse events.



### External Hardware Triggering – Trigger Timing

## When to Use External Hardware Trigger Mode

Use the External Hardware Trigger mode if you:

- Are using a pulsed excitation or light source in your experiment
- Are doing LIF (fluorescence with pulsed excitation) or phosphorescence experiments
- Are able to jumper the pins on Jumper Block 4 of the spectrometer’s electronic board
- Need to synchronize an acquisition with an external event

## Using the External Hardware Triggering Mode

### ► Procedure

Supply a line from Pin 4 of the J2 Accessory Connector to the triggering device. (See figure in [Pinout Diagrams for Ocean Optics Spectrometers](#) on page 2 for pin location.)

1. Connect Pin 10 of the J2 Accessory Connector (ground) to the ground of the triggering device.
2. Consult the charts below to determine the integration time. Identify the Spectrometer and A/D converter you are using, and then choose the integration time.

## S2000 Miniature Fiber Optic Spectrometer

Integration Time			Integration Time Equation	Jumper Block 4 (JP4)	
ADC500, SAD500 (500 kHz Master Clock Freq)	ADC1000 (1 MHz Master Clock Freq)	ADC2000 (2 MHz Master Clock Freq)		Pins 1-2	Pins 3-4
8.8 ms	4.4 ms	2.2 ms	$8.8/F_m$	open	open
27.5 ms	13.3 ms	6.7 ms	$27.5/F_m$	open	shorted
55 ms	27.5 ms	13.8 ms	$55/F_m$	shorted	open
137.5 ms	68.8 ms	34.4 ms	$137.5/F_m$	shorted	shorted

$F_m$  = the master clock frequency in MHz; shorted = connected; open = disconnected

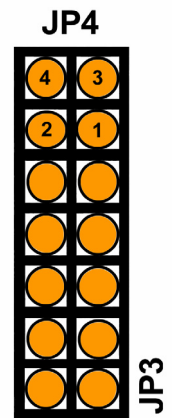
## S1024DW Miniature Fiber Optic Spectrometer

Integration Time SAD500  (500 kHz Master Clock Freq)	Integration Time Equation	Jumper Block 4 (JP4)	
		Pins 1-2	Pins 3-4
5 ms	$1000/F_m$	open	open
60 ms	$12000/F_m$	open	shorted
300 ms	$60000/F_m$	shorted	open
655 ms	$131070/F_m$	shorted	shorted

$F_m$  = the master clock frequency in Hz (i.e., 200 kHz for the SAD500); shorted = connected; open = disconnected

### ► Procedure

- Note the configuration of the pins in the Jumper Block 4 column of the chart.
- Remove the spectrometer from its housing. Do not tamper with the optical bench. (If you have more than one channel in your system, you may have to disconnect the channels from one another. The master spectrometer is always on the bottom of a multiple channel system.)
- Locate Jumper Block 4 (JP4) in the center of the green circuit board, near the optical bench. (See the figure to the right.) Jumper Block 4 consists of the first four pins, which are numbered 1, 2, 3, and 4.
- Using jumpers, configure the pins to match the integration time you selected.



For example, if you have an S2000 and an ADC1000 A/D Converter, you select 13.3 milliseconds as the integration time. To enable this, place a jumper over pins 3 and 4 to short the pins, and leave pins 1 and 2 open.

- Click on the Data Acquisition icon or select **Spectrum | Configure Data Acquisition** from the OOIBase32 menu bar, then set other acquisition parameters (averaging, boxcar smoothing, etc.) in the software.
- Select the **External Trigger** page from the Configure Data Acquisition screen, and then select **Hardware Trigger**.
- Enable the **Automatically save file on trigger** box if you wish to save the data to a file after each trigger.

If you enable this function, OOIBase32 displays a file save dialog box after each trigger. To avoid manually naming a file for each trigger, you can enable the Autoincrement Filenames function from the **File | Autoincrement Filenames | Enabled** option in the menu bar.

---

### Note

Once you select an external trigger mode, your computer will appear unresponsive. This is normal, as the computer is waiting for a trigger.

---

It is important to note that if you apply triggers faster than the fixed integration time, you will miss acquisitions.

## Cables

To configure external triggering functions with an Ocean Optics spectrometer, you may need one of the following cables. To order any of these cables, contact an Ocean Optics Applications Sales Engineer.