



# FLAME

Scientific-Grade Spectrometer

Installation and Operation Manual



For Products: FLAME-S, FLAME-T

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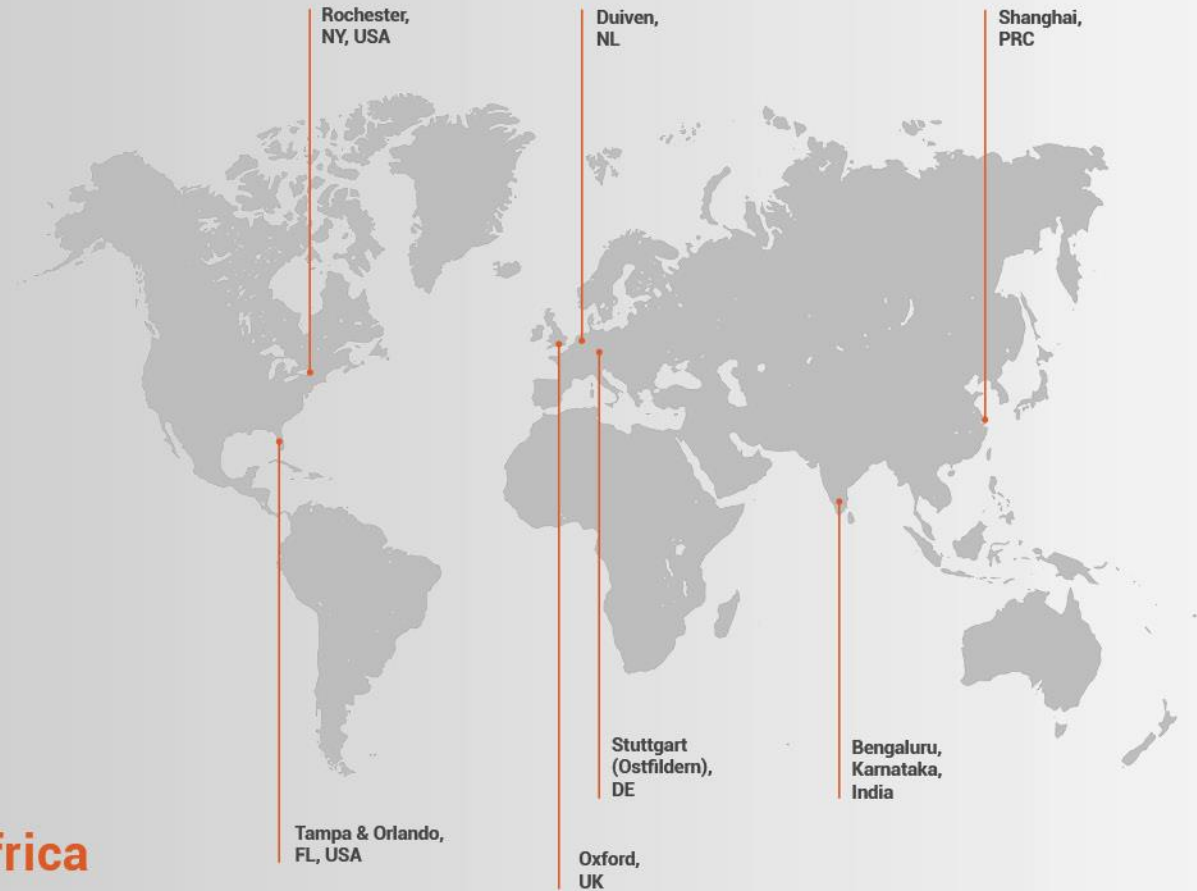
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# About This Manual

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## Warnings & Cautions



This device may cause radio interference or may disrupt the operation of nearby equipment. It may be necessary to take mitigation measures such as re-orienting, relocating or shielding the location.

**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 emissions or decreased immunity.

**Caution:** Repairs should be undertaken only by personnel trained or authorized by Ocean Insight. 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. 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:** To ensure reliable operation, it is recommended that the power supply be attached prior to inserting the USB connector.

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

## Warranty

For the most current warranty information, please visit [OceanInsight.com](http://OceanInsight.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.



### FCC Compliance

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which the user will be required to correct the interference at his own expense.

## Warning



The authority to operate this equipment is conditioned by the requirement that no modifications will be made to the equipment unless the changes or modifications are expressly approved by the manufacturer.

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## 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

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RoHS-Compliant



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

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### ISO Certification

Ocean Insight, 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

Flame spectrometers are built using industry leading manufacturing techniques that help deliver high thermal stability and low unit to unit variation without compromising the flexibility and configurability that are the hallmark of the design. Features such as interchangeable slits, indicator LEDs and simple device connectors deliver more freedom and less frustration.

## Features

- Plug-and-play capability via the micro-USB connection.
- User-interchangeable slit.
- LEDs show power and data transfer status.
- Compact and lightweight.
- Choice of USB or RS-232 serial communications.
- 8 GPIO pins and the ability to provide power to external devices through the 40-pin connector.

## Items Included with Shipment

- Flame Spectrometer
- Micro USB Cable
- Wavelength Calibration Data Sheet (please save the Wavelength Calibration Data Sheet 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 Flame to a computer running on a Windows platform prior to installing the operating software, consult the Troubleshooting section for information on correcting a corrupt Flame installation.

## Software Installation

Use OceanView version 1.5 and above for Flame. 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			Apple	Linux
8	8.1	10	OS X Version 10.5 or later on Intel processor	Any version released for an x86 or amd64 platform since 2010

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

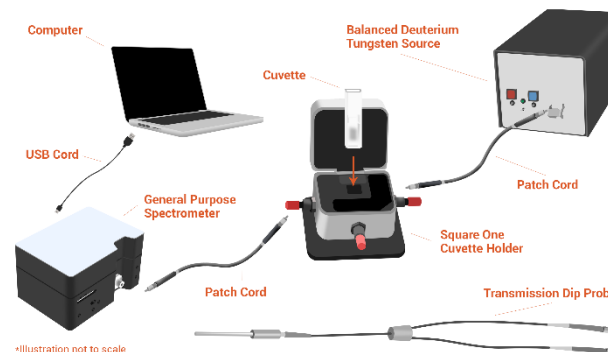
Consult the OceanView manual for hardware requirements when using OceanView.

## Hardware Setup

The Flame Spectrometer connects to a computer via the USB port or serial 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 Flame to a computer via the USB port:

1. Install the spectrometer operating software on the destination computer.
2. Locate the USB cable (CBL-MICROTOA-USB) provided with the Flame.
3. Insert the micro connector end of the cable into the side of the Flame and the larger end of the cable into the USB port of the computer.
4. Connect any spectroscopy accessories. To find operating instructions for Flame-compatible products (such as light sources, sampling chambers, and probes), consult the Ocean Insight website at [OceanInsight.com](http://OceanInsight.com).
5. Attach the fiber to the fiber optic connector on the spectrometer.



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

### NOTE

The Flame driver appears as USB2000+ to your computer since a common driver is used to ensure backwards and forwards compatibility. This does not affect functionality.

## Hardware Features

### Flame LEDs

The Flame features two indicator lights that operate as shown:

LED	Steady	Flashing
red	Unit is on	N/A
green	Unit is ready	Unit is acquiring data

#### NOTE

LEDs can be turned off in OceanView or by using a firmware command.

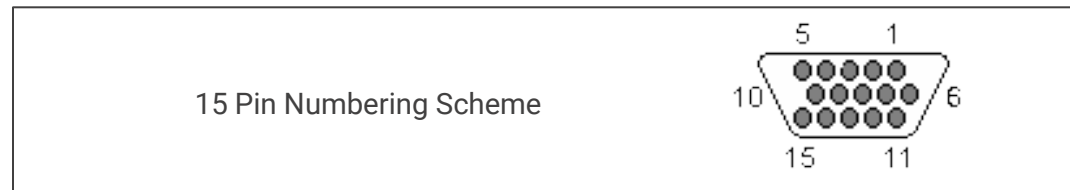
## Cables and Connectors

Cables are available to connect your Flame Spectrometer to accessories:

- Accessory cable for light sources and other accessories (DB15 Connector Cable)
- Accessory cable for HR-type connector (PAK50 Connector Cable)
- Breakout board (DD4 -BREAKOUT-BOARD ) This breaks out the 40 pin DD4 connector to a set of header pins that can be used to wire each pin, as required.

### DB15 Connector Cable (FLAME-CBL-DD4P-DB15P)

This cable connects the Flame to existing Ocean Insight accessories that use a DB-15HD connector. These include the PX-2, LLS and HL-2000-FHSA light sources.



15 PIN	DD4	Name	15 PIN	DD4	Name	15 PIN	DD4	Name
1	4	Single Strobe	6	7	GPIO 1	11	22	I2C SDA
2	3	Continuous Strobe	7	NC	Reserved (NC)	12	21	I2C SCL
3	40	Vusb	8	2	External Trigger In	13	5	Lamp Enable
4	2	External Trigger In	9	8	GPIO 2	14	NC	Reserved (NC)
5	2	External Trigger In	10	1	Ground	15	11	GPIO 4

***PAK50 Connector Cable (FLAME-CBL-DD4P-PAK50P)***

This cable connects the Flame to the optional [Breakout Box](#).

PAK50P	DD4	Name	PAK50P	DD4	Name
1	25	RS232 Rx	16	11	GPIO 4
2	24	RS232 Tx	17	4	Single Strobe
3	8	GPIO 2	18	12	GPIO 5
4	40	VUSB	19	16	SPI CLK
5	1	GND	20	3	Continuous Strobe
6	21	I2C SCL	21	18	SPI CS
7	6	GPIO 0	22	13	GPIO 6
8	22	I2C SDA	23	28	Reserved (do not connect)
9	7	GPIO 1	24	NC	Reserved (NC)

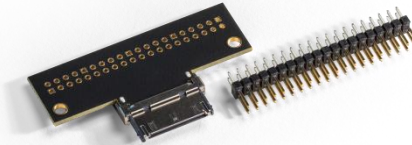


PAK50P	DD4	Name	PAK50P	DD4	Name
10	2	External Trigger In	25	5	Lamp Enable
11	9	GPIO 3	26	14	GPIO 7
12	40	VUSB	27	10	GND
13	17	SPI MOSI	28	NC	Reserved (NC)
14	40	VUSB	29	15	GND
15	19	SPI MISO	30	NC	Reserved (NC)

For the DD4, connect shield to connector case, if shield is included.

## Breakout Box (HR4-BREAKOUT)

The Breakout Box is a passive module that separates the signals from the Flame's DD4 40-pin connector to an array of standard connectors and headers, enabling functionality with a wide range of accessories. In addition to the accessory connector, the breakout box features a circuit board based on a neutral breadboard pattern that allows custom circuitry to be prototyped on the board itself. See [OceanInsight.com](http://OceanInsight.com) to access the manual for the Breakout Box.



# Troubleshooting

Sometimes things do not go according to plan. If not, 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 Insight website.

## Frequently Asked Questions

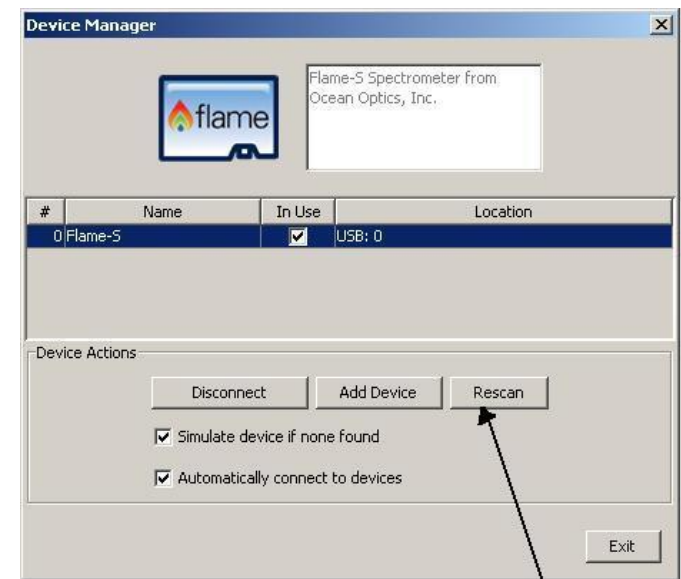
### I connected the USB cable and started OceanView but I don't see my spectrometer attached.

Use the Rescan button 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.OceanInsight.com](http://www.OceanInsight.com)



Rescan Button

### 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'm installing OceanView but I need a product key; where can I find this?

The product key was sent to the contact e-mail on the sales order when you purchased your OceanView license. Contact [info@OceanInsight.com](mailto:info@OceanInsight.com) for more information. You'll need your sales order number, quotation number, the serial number of the spectrometer that was purchased with the software, and, if known, the e-mail address under which your product key was created to recover your key.

## I connected the Flame 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.

### *Microsoft Windows Operating Systems*

#### NOTE

If these procedures do not correct your device driver problem, you must obtain the *Correcting Device Driver Issues* document from the Ocean Insight website.

1. Open Windows Device Manager. Consult the Windows operating instructions for your computer for directions, if needed.
2. Locate the **Universal Serial Bus Devices** option and expand the **Universal Serial Bus 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 Flame from your computer.
6. Replug the spectrometer into your computer.

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

### *Apple Mac OSX Operating Systems*

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

### *Linux Operating Systems*

For Linux operating systems, all you need to do is install the spectrometer operating software, then unplug and replug in the spectrometer. Technically, the driver files for Linux simply give nonprivileged users permission to use newly connected hardware. There isn't any long-term harm to plugging in the device before installing the software.

## How do I determine whether my Windows computer is 32-bit or 64-bit?

Errors can occur if you download the wrong version of software (for 32-bit or 64-bit computers). To verify your computer version for most Windows computers, go to the Properties window (under Computer or My Computer). If no version is listed, then your system is a 32-bit. For more information see the Microsoft Frequently Asked Questions at <http://windows.microsoft.com/en-us/windows/32-bit-and-64-bit-windows#1TC=windows-7>

## 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 Insight 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 Insight, 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 Insight or 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	FLAME-S	FLAME-T
<b>Optical and Spectroscopic</b>		
Integration Time	1 ms – 65 seconds	3.8 ms to 10 seconds
Dynamic Range for single acquisition <sup>1</sup>	1300:1	
Dynamic Range of system <sup>2</sup>	2 x 10 <sup>8</sup>	3.4 x 10 <sup>6</sup>
Signal-to-Noise (single acquisition)	250:1	300:1
Resolution (FWHM)	0.1 – 10.0 nm (configuration dependent)	
Scan rate (max) <sup>3</sup>	400 Hz	260 Hz
Spectrometer Channels	One	
Thermal Stability	0.02 nm/°C for 650 nm range, 0.06 pixels/°C	
Triggering	4 modes	
Triggering Jitter	21 nanoseconds	
<b>Detector</b>		
Detector range	190–1100 nm	
Pixels	2048 pixels	3648 pixels
Pixel size	14 μm x 200 μm	8 μm x 200 μm
Electronic shutter	No	Yes
Pixel well depth	~62,500 electrons	~100,000 electrons
Readout noise (single dark spectrum)	50 counts RMS, 300 counts peak-to-peak	

Specification	FLAME-S	FLAME-T
Corrected linearity	>99.8%	
Filters (optional)	2 <sup>nd</sup> and 3 <sup>rd</sup> order rejection, long pass	
<b>Electrical</b>		
Power requirement (spectrometer functions)	250 mA at +5 VDC	
Supply voltage	4.75 – 5.25 V	
Power-up time	~2s	
Connectors	Micro-USB and JAE DD4 (DD4RA40JA1) 40-pin connector	
Micro-USB Absolute Maximum Ratings: V <sub>CC</sub>	+ 5.5 VDC	
DD4 Absolute Maximum Ratings: V <sub>CC</sub> (Pin 40) Voltage on any pin (other than input power)	+ 5.5 VDC +4VDC	
Interface: USB RS-232	USB 2.0, 480 Mbps 2-wire RS-232	
<b>Mechanical</b>		
Spectrometer Design	Asymmetric crossed Czerny-Turner	
Input Fiber Connector	SMA 905 or FC	
Gratings	15 different gratings.	
Entrance Slit	5, 10, 25, 50, 100, or 200 μm slits. (Slits are optional. In the absence of a slit, the fiber acts as the entrance slit.)	

Specification	FLAME-S	FLAME-T
Physical Dimensions	88.9 mm x 63.5 mm x 31.9 mm	
Weight	265 g	
<b>Environmental</b>		
Temperature:		
Storage	-30° to +70° C	
Operation	0 to 50° C	
Humidity	0% - 90% noncondensing	
<sup>1</sup> Dynamic range for a single acquisition is a measure of the ratio of full signal to noise.		
<sup>2</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>3</sup> Scan rate is dependent on the operating computer and not the spectrometer. These figures assume a non real-time operating system.		

## Electrical Pinout

The Flame features a 40-pin Accessory Connector, located on the front of the unit.

### DD4 Accessory Connector Pinout Description

When facing the 40-pin Accessory Connector on the front of the vertical wall of the Flame, pin number 1 is on the right.

Listed below is the pin description for the Flame Accessory Connector. The Flame will include a JAE DD4 receptacle, part number DD4RA40JA1. Most accessories that plug into the Flame will include a JAE DD4 plug, part number DD4PA40MA1. There is also a vertical connector, JAE part number DD4BA40WA1.

Pin #	Function	Voltage Level	Description
1	Ground	N/A	Ground
2	Trigger	5 or 3.3 V	The TTL trigger signal.
3	Continuous Strobe	5 V	TTL output signal used to pulse a strobe that is divided down from the Master Clock signal.
4	Single Strobe	5 V	TTL output pulse used as a strobe signal, which has a programmable delay relative to the beginning of the spectrometer integration period.
5	Lamp Enable	5 V	A TTL signal that is driven Active HIGH when the Lamp Enable command is sent to the Flame.
6	GPIO 0	2.5 V	General Purpose Software Programmable Digital Inputs/Output*
7	GPIO 1	2.5 V	General Purpose Software Programmable Digital Inputs/Output*
8	GPIO 2	2.5 V	General Purpose Software Programmable Digital Inputs/Output*
9	GPIO 3	2.5 V	General Purpose Software Programmable Digital Inputs/Output*
10	Ground	2.5 V	General Purpose Software Programmable Digital Inputs/Output*
11	GPIO 4	2.5 V	General Purpose Software Programmable Digital Inputs/Output*

Pin #	Function	Voltage Level	Description
12	GPIO 5	2.5 V	General Purpose Software Programmable Digital Inputs/Output*
13	GPIO 6	2.5 V	General Purpose Software Programmable Digital Inputs/Output*
14	GPIO 7	2.5 V	General Purpose Software Programmable Digital Inputs/Output*
15	Ground	N/A	Ground
16	SPI Master Clock	3.3 V	Master clock. See <a href="#">SPI</a> below.
17	SPI Master MOSI	3.3 V	The SPI Master Out Slave In (MOSI) signal for communications to other SPI peripherals. See <a href="#">SPI</a> below.
18	SPI Master CS	3.3 V	TTL output signal used to pulse a strobe that is divided down from the Master Clock signal. See <a href="#">SPI</a> below.
19	SPI Master MISO	3.3 V	The SPI Master In Slave Out (MISO) signal for communications to other SPI peripherals. See <a href="#">SPI</a> below.
20	Ground	N/A	Ground
21	I <sup>2</sup> C Master Clock	3.3 V	I <sup>2</sup> C Master Clock. See <a href="#">I2C</a> below.
22	I <sup>2</sup> C Master Data	3.3 V	I <sup>2</sup> C Master Data. See <a href="#">I2C</a> below.
23	Ground	N/A	Ground
24	RS232 TX	-6 to +6 V	RS232 Transmit signal – for communication with PC connect
25	RS232 RX	N/A	RS232 Receive signal – for communication with PC connect
26	Reserved	N/A	Reserved
27	Reserved	N/A	Reserved

Pin #	Function	Voltage Level	Description
28	Reserved	N/A	Do not connect
29	Reserved	N/A	Reserved
30	Reserved	N/A	Reserved
31	Reserved	N/A	Reserved
32	Reserved	N/A	Reserved
33	Reserved	N/A	Reserved
34	Reserved	N/A	Reserved
35	Reserved	N/A	Reserved
36	Reserved	N/A	Reserved
37	Reserved	N/A	Reserved
38	5V Out	5 V	The input power pin from the Flame.
39	Ground	N/A	Ground
40	5V In	N/A	<p>The input power pin to the Flame. Additionally when operating via a Universal Serial Bus (USB) this is the USB power connection (+5V) which can be used to power other peripherals (Care must be taken to insure that the peripheral complies with USB Specifications). The entire assembly should not draw more than 500 mA.</p> <p>NOTE: Do <u>not</u> connect both USB power and Auxiliary power (as an input) at the same time.</p>
<p>* Do <u>not</u> connect the GPIO pins to 5V. The GPIOs are not 5V tolerant and will be damaged if connected to 5V. The maximum voltage is 4V for the 3.3V logic pins and 3V for the 2.5V logic pins.</p>			



## *SPI*

The Flame has the ability to function as a SPI master through the SPI port, which comprises the SPI Master Clock, SPI Master MOSI, SPI Master CS, and SPI Master MISO pins. To send messages over the SPI port, use the *General SPI Input/Output* message. The Flame does not send or receive any SPI data without direction from its host PC.

- Because SPI is a full-duplex transaction, the *General SPI Input/Output* message both reads and writes at the same time. For instance, a four byte write will return four bytes of dummy read data, and a four byte read requires four bytes of dummy write data:
  - MOSI data is established just prior to the rising edge of the SPI clock
  - MISO data is sampled just after a falling edge of the SPI clock.

## *I2C*

The Flame has the ability to function as an I2C master through the I2C port, which comprises the I2C-SDA, and I2C-SCL pins. To send messages over the I2C port, use the General I2C Write and General I2C Read messages. Note that the Flame does not send or receive any I2C data without direction from its host PC. The I2C lines are pulled up internally to 3.3V by 2K resistors.

## Timing Signals

### Strobe Signals

#### *Single Strobe*

The Single Strobe signal is a programmable TTL pulse that occurs at a user-determined time during each integration period. This pulse has a user-defined High Transition Delay and Low Transition Delay. The pulse width of the Single Strobe is the difference between these delays. It is only active if the Lamp Enable command is active.

Synchronization of external devices to the spectrometer's integration period is accomplished with this pulse. The Strobe Delay is specified by the Single Strobe High Transition Delay (SSHTD) and the Pulse Width is specified by the Single Strobe Low Transition Delay (SSLTD) minus the Single Strobe High Transition Delay ( $PW = SSLTD - SSHTD$ ). Both values are programmable in 500ns increments for the range of 0 to 65,535 (32.7675ms).

The timing of the Single Strobe is based on the Start of Integration (SOI). SOI occurs on the rising edge of  $\phi_{ROG}$  which is used to reset the Sony ILX511 detector. In all trigger modes using an External Trigger, there is a fixed relationship between the trigger and the

SOI. In the Normal mode and Software Trigger mode, the SOI still marks the beginning of the Single Strobe, but due to the nondeterministic timing of the software and computer operating system, this timing will change over time and is not periodic. That is, at a constant integration time, the Single Strobe will not be periodic, but it will indicate the start of the integration.

The Trigger Delay (TD) is another user programmable delay that specifies the time in 500 ns increments that the SOI will be delayed beyond the normal Start of Integration Delay (SOID).

An example calculation of the Single Strobe timing follows:

If the TD = 1 ms, SSHTD = 50 ms, and SSLTD = 70 ms then, the rising edge of the Single Strobe will occur approximately 51.82 ms (1 ms + 50 ms + 8.2 us) after the External Trigger Input goes high and the Pulse Width will be 20 ms (70 ms – 50 ms).

### *Continuous Strobe*

The Continuous Strobe signal is a programmable frequency pulse-train with a 50% duty cycle. It is programmed by specifying the desired period whose range is 2 us to 60 s. This signal is continuous once enabled, but is not synchronized to the Start of Integration or External Trigger Input. The Continuous Strobe is only active if the Lamp Enable command is active.

### *Synchronous Continuous Strobe*

In Synchronous mode, the strobe will always be the same integer number of pulses per integration period, and deterministic from the start of integration. Setting the strobe period to greater than the ((integration time/2)-strobe offset) will result in nonguaranteed behavior (there is no time to do a single pulse).

If the application requires more than one pulse per integration period, ensure the continuous strobe and integration period are synchronized. The integration time must be set so that an equal number of strobe events occurs during any given integration period.

## External Triggering

The Flame Spectrometer has several ways of acquiring data. In the Normal/Free-Run 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, 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.

Each trigger 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.

You can trigger the Flame using a variety of External Triggering options through the 40-pin Accessory Connector on the spectrometer. See the External Triggering Options document located at [www.OceanInsight.com](http://www.OceanInsight.com). The triggering document contains further instructions for configuring External Triggering options for the Flame.

## Triggering Modes

The Flame supports three triggering modes, (plus Normal mode), which are set with the Trigger Mode command. Detailed information of each triggering mode follows. Also, refer to the External Triggering Options document located on our website at [OceanInsight.com](http://OceanInsight.com). The following paragraphs describe these modes.

### *Normal*

In the Normal (Free-run) mode, the spectrometer will acquire back-to-back spectra based on the integration period specified. After the Integration Cycle completes, the data is read out of the detector and written into an internal FIFO where it is available for reading. In parallel to this read/write operation, another integration is occurring. If the data from the FIFO is completely read before the parallel integration completes, a back-to-back operation will occur. If the data is not read (FIFO Empty) in this time period, the FPGA will generate an Idle Cycle that is equivalent to one integration period and the data from the detector is discarded. After the Idle Cycle has completed, the FIFO Empty status is checked. If the FIFO is empty and a new spectrum is requested by the software, a new acquisition will begin. If either condition is false, additional Idle Cycles will be generated until both conditions are true.

For the Flame-S and Flame-T, this is also referred to as the nonbuffering mode because only one spectrum is stored within the FPGA and not multiple spectra. In this scenario, ReadEnable is generated by the software/firmware to initiate each new acquisition. Since only one spectrum is stored at a time in the FPGA, a new integration cannot be started until the FIFO data has been fully retrieved by the software.

### *External Synchronous Trigger Mode*

In the External Synchronous Trigger mode, two external triggers are required to complete a data acquisition. The first rising edge starts the integration period and the second rising edge stops the integration and starts the next. Thus, the integration time is the period between the two external trigger pulses. After the integration period, the spectrum is retrieved and available to the user. As in normal mode, no further spectra are acquired until the original spectrum is read by the user.

### *External Hardware Level Trigger Mode*

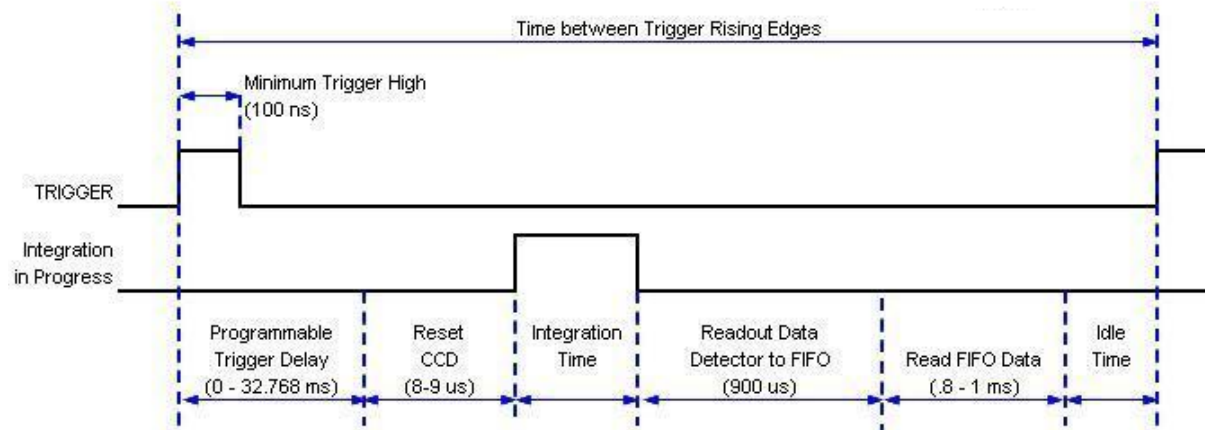
In the External Hardware Level Trigger mode, a rising edge detected by the spectrometer from the External Trigger input starts the integration period specified through the software interface. After the integration period, the spectrum is retrieved and is ready to be

read by the user. As long as the trigger level remains active in a logic one state, back-to-back acquisitions can occur, as in the Normal mode, until the trigger transitions to an inactive level. As in normal mode, no further spectra are acquired until the original spectrum is read by the user.

### External Hardware Edge Trigger Mode

In the External Hardware Edge Trigger mode, a rising edge detected by the spectrometer from the External Trigger input starts the integration period specified through the software interface. After the integration period, the spectrum is retrieved and is ready to be read by the user. If another trigger is sent a new integration cycle will begin. If a spectrum request is not received before the integration cycle has ended then that data will be deleted and a new trigger and spectrum request is required. Only one acquisition will be performed for each External Trigger pulse, no matter what the pulse's duration is. No further spectra are acquired until the original spectrum is read by the user.

HR2000+, USB2000+ and Flame-S -- Timetable for Hardware Edge Trigger Mode



Additional Delay	0 us
Initialize CCD Binning	9 us
Integration time	1,000 us
Read Detector	900 us
Minimum Idle States	1,000 us
Min Trigger Cycle	2,909 us
Min Trigger Cycle	2,909 us
Max Trigger Rate	344 Hz

# Calibration

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An EEPROM flash memory chip in each Flame 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 Insight, however the wavelength for all spectrometers will drift slightly as a function of time and environmental conditions.

For instructions on how to calibrate the Flame, visit [OceanInsight.com](https://www.oceaninsight.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 [OceanInsight.com](https://www.oceaninsight.com).

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

# Unlock the Unknown

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

## Questions?

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