

## Transitioning to Flame from the USB Series Spectrometers

Whitepaper by Ocean Optics Staff

### Introduction

The Flame Spectrometer is the latest generation of Ocean Optics' miniature fiber optic spectrometers, improving on our versatile, general-purpose USB2000+ and USB4000 spectrometers. The Flame is 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. Some of the new features include the following:

- Indicator LEDs show the power and data transfer status of the spectrometer at all times.
- User-interchangeable slit allows you to vary the resolution and throughput of the spectrometer on demand. In seconds, go from high resolution to high throughput using the same spectrometer.
- The introduction of new, automated manufacturing methods has dramatically improved optical alignment accuracy resulting in improved unit-to-unit performance and reproducibility, which is particularly significant for OEM use.
- High thermal stability allows for accurate and repeatable measurements in demanding environments.



With these new features come a few differences with how the Flame operates versus its predecessors, the USB2000+ (FLAME-S) and the USB4000 (FLAME-T):

- LEDs monitor the power and data transfer status of the spectrometer and can be controlled via OceanView or the **LED Status** firmware command.
- Interchangeable slits – no recalibration required. You can now perform absorbance and fluorescence measurements with one spectrometer.
- New 40-pin accessory connector. The GPIOs initialize to be inputs rather than outputs.
- An industry-standard micro-USB is used instead of the USB type B.

- Can be used with SpectraSuite spectrometer operating software and versions of OceanView prior to Release 1.5, but appears as either a USB2000+ (FLAME-S) or USB4000 (FLAME-T). Upgrade to the latest OceanView software to take advantage of the Flame’s new features. (Note that the Flame driver will appear as a USB2000+.)

## Purpose

The purpose of this whitepaper is to provide detail on the difference between the hardware and software control and functionality of the Flame compared to the USB2000+ and USB4000. This document is designed to help users transition from the USB Series Spectrometers to the Flame.

Please contact the Ocean Optics product support team or your OEM sales contact for more detailed information and troubleshooting.

## LEDs Provide Immediate and Continuous Feedback

Red and green LEDs on the side of the Flame provide convenient visual feedback of spectrometer operation and status.

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

LEDs can be turned off in OceanView or by using the **LED Status** firmware command.



## Interchangeable Slits Conveniently Match the Flame to Your Application

The Flame allows you to change your spectrometer’s slit to match your application requirements. If your spectrometer has an installed filter, this must also be ordered with the new slit size. There’s no need to calibrate your spectrometer when changing the slit, just install and start measuring. There is one exception to this. You cannot change from a standard slit to a slit with a filter because it changes the optical focus and wavelength calibration of the spectrometer. In this case you would need to send the spectrometer back to Ocean Optics. You can order additional replacement slits either individually or as a kit (in various widths from 5  $\mu\text{m}$  to 200  $\mu\text{m}$ ). Smaller slit sizes achieve the best optical resolution while larger slits have higher light throughput. Slit size is labeled as shown.

Slit	Description	Pixel Resolution
INTSMA-5	5- $\mu\text{m}$ wide x 1-mm high	~3.0 pixels
INTSMA-10	10- $\mu\text{m}$ wide x 1-mm high	~3.2 pixels
INTSMA-25	25- $\mu\text{m}$ wide x 1-mm high	~4.2 pixels
INTSMA-50	50- $\mu\text{m}$ wide x 1-mm high	~6.5 pixels
INTSMA-100	100- $\mu\text{m}$ wide x 1-mm high	~12 pixels
INTSMA-200	200- $\mu\text{m}$ wide x 1-mm high	~24 pixels

Slit	Description	Pixel Resolution
INTSMA-000	Interchangeable bulkhead with no slit	NA
INTSMA-KIT	Interchangeable SMA Kit connectors: 5µm; 10µm; 25µm; 50µm; 100µm 200µm	NA

Ocean Optics also offers a range of FC connector slits in the same wavelengths, with the product code INTFC-XXX. An INTFC-KIT is also available. Note that these items are made to order and have a longer lead time. Contact an Ocean Optics Application Sales Engineer for more details.

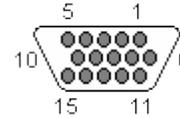
## Greater Thermal Stability

Environmental and portable applications in particular will benefit from the repeatable results delivered in environments with varying temperatures (from 0 to 50° C) and reduced unit-to-unit variation. Thermal stability has been verified at 0.06 pixels/°C, which equates to 0.02 nm/°C for a spectrometer with a 650 nm range.

## DD4 Accessory Connector

Like its USB predecessors, the Flame has an accessory connector located on the front vertical wall of the unit. The Flame includes 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 available, JAE part number DD4BA40WA1.

Unlike the USB series spectrometers, the GPIOs default to be inputs rather than outputs. Triggering is done through Pin #2. The maximum voltage for the GPIOs is 4 volts. The Flame may shut down if you put 5V onto the GPIO pins to protect the circuitry of the device.



Listed below is the pin description for the Flame DD4 Accessory Connector:

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*

Pin #	Function	Voltage Level	Description
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*
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
17	SPI Master MOSI	3.3 V	The SPI Master Out Slave In (MOSI) signal for communications to other SPI peripherals.
18	SPI Master CS	3.3 V	TTL output signal used to pulse a strobe that is divided down from the Master Clock signal.
19	SPI Master MISO	3.3 V	The SPI Master In Slave Out (MISO) signal for communications to other SPI peripherals.
20	Ground	N/A	Ground
21	I <sup>2</sup> C Master Clock	3.3 V	I <sup>2</sup> C Master Clock
22	I <sup>2</sup> C Master Data	3.3 V	I <sup>2</sup> C Master Data
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
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

Pin #	Function	Voltage Level	Description
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	Reserved	N/A	Do not connect
39	Ground	N/A	Ground
40	Auxiliary Power In/Out	N/A	<p>Used either to draw power from (output) or supply power to (input) the Flame. Internally, the pin is connected to the output of a load switch driven by the 5V USB power supply.</p> <p><b>Output:</b> The load switch soft-starts the auxiliary power supply and prevents the spectrometer + auxiliary power from drawing excessive current from the USB power supply. Devices drawing power from this pin must comply with USB specifications (especially that the total power draw of the spectrometer and the user's device must not exceed 500mA). Therefore, it is recommended that devices draw less than 100mA from this pin as future Flame spectrometer variants may internally require up to 400mA.</p> <p><b>Input:</b> This pin can also be used to supply power to the Flame when 5V USB is not present. In this case, because the pin is connected downstream of the load switch, the soft start and overcurrent protection have been bypassed. For future compatibility, it is recommended that any peripherals supplying current into this pin must be able to supply at least 500mA.</p> <p><b>Note:</b> Do not supply both USB input power and auxiliary input power concurrently. If both supplies are connected, the result will be a load share. Although the load switch should protect the two supplies from contention if they are connected, the performance of the spectrometer may be affected.</p>
<p><b>* 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. The GPIOs are 3.3V tolerant.</b></p>			

### Cables and Connectors Available

Cables are available to connect your Flame Spectrometer to accessories:

- DB15 accessory cable for light sources and other accessories (FLAME-CBL-DD4P-DD15P). This includes Ocean Optics accessories such as the PX-2 and DH-mini light sources. The DB15 connector is a 15-pin VGA-type connector.

- PAK50 accessory cable (FLAME-CBL-DD4P-PAK50P) for HR-type 30-pin connector for the HR4-BREAKOUT Breakout Box (HR4-BREAKOUT-BOX). The breakout box accessory provides a series of standard interfaces as well as a breadboard for rapid prototyping.
- Breakout board (FLAME-DD4 -BREAKOUT-BOARD ). This breaks out the 40-pin DD4 connector to a set of wiring points that can be used to connect each pin, as desired. It's a small printed circuit board that clips into the side of the device. A set of header pins is provided with the board and can be fitted by the user.
- Custom cables for unique applications.

## Important Notes for Our OEM Customers Regarding Flame Firmware and Software

The FLAME-S and FLAME-T use the same FX2 processor as the existing USB2000+ and USB4000. In fact, the code that is in the Flame processor is almost the same, except for a few details. In addition to the Flame firmware being able to control the LEDs and the GPIO pins defaulting to inputs rather than outputs, you'll find differences in the Flame's firmware.

To start, the firmware version number now takes the form "FLAME-S 1.23.4" rather than "USB2000+ 1.23.4. " This version number is how the Ocean Optics software distinguishes between Flame and USB devices.

The firmware also uses a new process to update the FPGA via USB Programmer. Therefore, the Flame cannot use FPGA versions that were built for the old FPGA. Only FPGA versions later than 4000 will work since new Flame FPGAs are programmed via "mcs" files instead of "xsvf" files. You need to have the latest USB Programmer version to reprogram a Flame and the latest Flame FX2 code to reprogram the FPGA. So, for instance, if you have FX2 code that does not support FPGA downloads, then you must first update the FX2, then update the FPGA, and finally update the FX2 back to the original custom code.

The following have NOT changed between the USB series and the Flame series:

- PID and VID are the same as the USB2000+ (for FLAME-S) and USB4000 (for FLAME-T).
- The USB command set and RS232 command set are identical to the USB2000+ (for FLAME-S) and USB4000 (for FLAME-T) command set.
- Triggering modes, timing, and strobes are identical.
- If you are a USB2000+ or USB4000 customer with an existing software program that uses OmniDriver, RS232, or communicates directly to the device via USB, it still works with the FLAME-S or FLAME-T, respectively, with no modifications, unless it has a dependency on firmware version number format.
- You do not need to install any new drivers onto a computer that already has drivers installed for a USB2000+ or USB4000 spectrometer. The Flame devices use the same drivers as the USB devices, and in fact will show up as USB2000+ (for FLAME-S) or USB4000 (for FLAME-T) in the Device Manager.
- If you are a USB2000+ or USB4000 customer with existing custom firmware for the FX2, your firmware will still work on the FLAME-S or FLAME-T, respectively. LEDs should be off by default with old firmware, but be sure to double check this.
- The DD4 connector provides 40 pins, including 8 programmable GPIOs, for more flexibility and allows for direct attachment of cables without the need of Samtec adapters; however, it is a fine-pitch part. For this reason, various other adapters and cables are available from Ocean Optics that make interfacing to this connector much simpler. See Cables and Connectors Available (above) for more details.