

USB Series Spectrometers Overview

Choosing the Best USB2000+ or USB4000 Option for Your Application

Ocean Optics USB-Series spectrometers are versatile performers for a wide array of applications. Although our flagship USB2000+ and USB4000 spectrometers have comparable electronics and architecture, they do have one very important difference: their linear CCD array detectors. In addition, USB2000+ and USB4000 spectrometers are available in application-ready (preconfigured for specific application types) and build-your-own (user-configured for maximum flexibility) versions.

Comparing the USB2000+ and USB4000 Spectrometers

The USB2000+ has a 2048-element Sony ILX511B detector and the USB4000 has the 3648-element Toshiba TCD1304AP detector. Both are linear silicon CCD arrays with an effective range of 200-1100 nm and are available with the same optical bench accessory options (quartz window for UV performance, order-sorting filters and so on).



Advantages of the USB2000+

- Its Sony ILX511B detector is coated with a phosphor for better response in the UV – making it especially useful for applications below 350 nm.
- It has a faster minimum integration time – 1 ms (compared with 3.8 ms for the USB4000). That's an advantage for applications involving transient events such as measuring a pulsed light source.
- In applications where you have a considerable amount of light, its faster integration time helps you avoid saturating the detector.
- It has better optical resolution performance – an advantage when resolving fine spectral features is necessary.



Advantages of the USB4000

- It has better response at wavelengths beyond 400 nm – making it a good choice for VIS-Shortwave NIR applications.
- Its signal to noise ratio (300:1) is slightly better than that for the USB2000+. This is important in low-light level applications.
- It's slightly less expensive than the USB2000+. Both systems offer great value at a reasonable price.

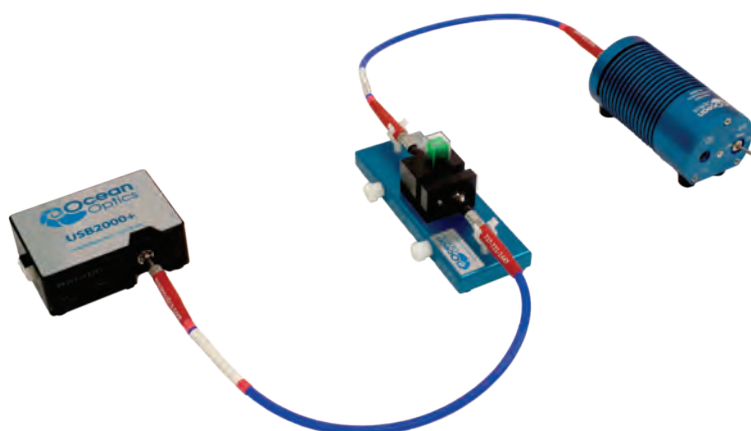
USB Series Spectrometer Models at a Glance

You can configure a USB2000+ or USB4000 with gratings and optical bench accessories for a variety of applications. Or, over the next several pages, investigate one of the many application-ready USB2000+/USB4000 systems described in the table below:

Best for	USB2000+ Series	USB4000 Series
General Use	USB2000+UV-VIS USB2000+VIS-NIR	USB4000-UV-VIS USB4000-VIS-NIR
General Use with Enhanced Sensitivity	USB2000+UV-VIS-ES USB2000+VIS-NIR-ES	USB4000-UV-VIS-ES USB4000-VIS-NIR-ES
Extended Range (200-1025 nm)	USB2000+XR1	USB4000-XR1
Extended Range (200-1025 nm) with Enhanced Sensitivity	USB2000+XR1-ES	USB4000-XR1-ES
Fluorescence	No preconfigured models	USB4000-FL (several excitation wavelength options)
Irradiance	USB2000+RAD	No preconfigured models

USB2000+UV-VIS and USB2000+VIS-NIR

Application-ready Spectrometers for the UV-VIS and VIS-NIR



Solutions absorbance is a common application for a USB2000+-VIS-NIR. A typical setup could include a 1 cm cuvette holder with optical fibers and a visible light source.

We offer general-purpose UV-VIS and VIS-NIR spectrometers – where all of the optical bench accessories are already selected – for basic spectroscopy applications such as measuring absorbance in solutions and reflectance of solids. Here are some key features:

- Each of the four models has an order-sorting filter and 25 μm slit for optical resolution of ~ 1.5 nm (FWHM)
- The USB2000+UV-VIS covers the 200-850 nm range and the USB2000+VIS-NIR covers 350-1000 nm
- Enhanced sensitivity models (ES) have an installed detector collection lens for increased light collection efficiency
- Software is priced separately and operates on Windows, OS X and Linux operating systems

Specifications	USB2000+UV-VIS	USB2000+VIS-NIR	USB2000+UV-VIS-ES	USB2000+VIS-NIR-ES
Dimensions:	89.1 mm x 63.3 mm x 34.4 mm	89.1 mm x 63.3 mm x 34.4 mm	89.1 mm x 63.3 mm x 34.4 mm	89.1 mm x 63.3 mm x 34.4 mm
Weight:	190 g	190 g	190 g	190 g
Detector:	2048-element linear silicon CCD array	2048-element linear silicon CCD array	2048-element linear silicon CCD array	2048-element linear silicon CCD array
Integration time:	1 ms - 65 seconds	1 ms - 65 seconds	1 ms - 65 seconds	1 ms - 65 seconds
Dynamic range:	8.5×10^7 (system), 1300:1 (single acquisition)	8.5×10^7 (system), 1300:1 (single acquisition)	8.5×10^7 (system), 1300:1 (single acquisition)	8.5×10^7 (system), 1300:1 (single acquisition)
Sensitivity:	75 photons/count; also, 2.9×10^{-17} joule/count 2.9×10^{-17} watts/count (for 1-second integration)	75 photons/count; also, 2.9×10^{-17} joule/count 2.9×10^{-17} watts/count (for 1-second integration)	75 photons/count; also, 2.9×10^{-17} joule/count 2.9×10^{-17} watts/count (for 1-second integration)	75 photons/count; also, 2.9×10^{-17} joule/count 2.9×10^{-17} watts/count (for 1-second integration)
Signal-to-noise ratio:	250:1 (at full signal)	250:1 (at full signal)	250:1 (at full signal)	250:1 (at full signal)
Dark noise:	50 (RMS)	50 (RMS)	50 (RMS)	50 (RMS)
Grating:	600 lines/mm, set to 200-850 nm (blazed at 300 nm)	600 lines/mm, set to 350-1000 nm (blazed at 500 nm)	600 lines/mm, set to 200-850 nm (blazed at 300 nm)	600 lines/mm, set to 350-1000 nm (blazed at 500 nm)
Slit:	25 μm width (height is 1000 μm)	25 μm width (height is 1000 μm)	25 μm width (height is 1000 μm)	25 μm width (height is 1000 μm)
Detector collection lens:	No	No	Yes	Yes
Focal length:	42 mm (input); 68 mm (output)	42 mm (input); 68 mm (output)	42 mm (input); 68 mm (output)	42 mm (input); 68 mm (output)
Order-sorting:	Single-piece, multi-bandpass detector coating to eliminate second-order effects from 200-850 nm	Single-piece, multi-bandpass detector coating to eliminate second-order effects from 350-1000 nm	Single-piece, multi-bandpass detector coating to eliminate second-order effects from 200-850 nm	Single-piece, multi-bandpass detector coating to eliminate second-order effects from 350-1000 nm
Resolution:	1.5 nm (FWHM)	1.5 nm (FWHM)	1.5 nm (FWHM)	1.5 nm (FWHM)
Stray light:	< 0.05% at 600 nm < 0.10% at 435 nm < 0.10% at 250 nm	< 0.05% at 600 nm < 0.10% at 435 nm	< 0.05% at 600 nm < 0.10% at 435 nm < 0.10% at 250 nm	< 0.05% at 600 nm < 0.10% at 435 nm
Fiber optic connector:	SMA 905 to single-strand optical fiber (0.22 NA)	SMA 905 to single-strand optical fiber (0.22 NA)	SMA 905 to single-strand optical fiber (0.22 NA)	SMA 905 to single-strand optical fiber (0.22 NA)

USB4000-UV-VIS and USB4000-VIS-NIR

Application-ready Spectrometers for the UV-VIS and VIS-NIR



The USB4000-UV-VIS and USB4000-VIS-NIR are reliable, robust spectrometers that have a 3648-element linear CCD array detector for good signal-to-noise performance as well as enhanced electronics for controlling the spectrometer and accessories.

Each spectrometer has a 3648-element Toshiba TCD1304AP detector with a multibandpass order-sorting filter and 25 μm slit for optical resolution to ~ 1.5 nm (FWHM). We also offer enhanced-sensitivity (ES) models – distinguished by more efficient light collection optics. The USB4000-UV-VIS covers the 200-850 nm wavelength range and the USB4000-VIS-NIR covers 350-1000 nm. Software is priced separately and operates on Windows, OS X and Linux.

Although the USB4000-UV-VIS and USB4000-VIS-NIR have a preconfigured optical bench, there's still flexibility built in. That's because these spectrometers are compatible with our entire range of SMA 905-terminated fiber optic accessories. USB4000-UV-VIS and USB4000-VIS-NIR spectrometers make great choices for a variety of basic absorbance, reflectance and emission applications.

Specifications	USB4000-UV-VIS	USB4000-VIS-NIR	USB4000-UV-VIS-ES	USB4000-VIS-NIR-ES
Dimensions:	89.1 mm x 63.3 mm x 34.4 mm	89.1 mm x 63.3 mm x 34.4 mm	89.1 mm x 63.3 mm x 34.4 mm	89.1 mm x 63.3 mm x 34.4 mm
Weight:	190 g	190 g	190 g	190 g
Detector:	Toshiba TCD1304AP Linear CCD array	Toshiba TCD1304AP Linear CCD array	Toshiba TCD1304AP Linear CCD array	Toshiba TCD1304AP Linear CCD array
Integration time:	3.8 ms-10 seconds	3.8 ms-10 seconds	3.8 ms-10 seconds	3.8 ms-10 seconds
Dynamic range:	3.4×10^6 (system), 1300:1 for a single acquisition	3.4×10^6 (system), 1300:1 for a single acquisition	3.4×10^6 (system), 1300:1 for a single acquisition	3.4×10^6 (system), 1300:1 for a single acquisition
Sensitivity:	130 photons/count at 400 nm; 60 photons/count at 600 nm	130 photons/count at 400 nm; 60 photons/count at 600 nm	130 photons/count at 400 nm; 60 photons/count at 600 nm	130 photons/count at 400 nm; 60 photons/count at 600 nm
Signal-to-noise ratio:	300:1 (at full signal)	300:1 (at full signal)	300:1 (at full signal)	300:1 (at full signal)
Dark noise:	50 (RMS)	50 (RMS)	50 (RMS)	50 (RMS)
Grating:	600 l/mm, set to 200-850 nm (blazed at 300 nm)	600 l/mm, set to 350-1000 nm (blazed at 500 nm)	600 l/mm, set to 200-850 nm (blazed at 300 nm)	600 l/mm, set to 350-1000 nm (blazed at 500 nm)
Slit:	1000 μm x 25 μm	1000 μm x 25 μm	1000 μm x 25 μm	1000 μm x 25 μm
Detector collection lens:	No	No	Yes	Yes
Focal length:	42 mm (input); 68 mm (output)	42 mm (input); 68 mm (output)	42 mm (input); 68 mm (output)	42 mm (input); 68 mm (output)
Order-sorting:	Single-piece, multi-bandpass detector coating to eliminate second-order effects from 200-850 nm	Single-piece, multi-bandpass detector coating to eliminate second-order effects from 350-1000 nm	Single-piece, multi-bandpass detector coating to eliminate second-order effects from 200-850 nm	Single-piece, multi-bandpass detector coating to eliminate second-order effects from 350-1000 nm
Optical resolution:	1.5-2.3 nm (FWHM)	1.5-2.3 nm (FWHM)	1.5-2.3 nm (FWHM)	1.5-2.3 nm (FWHM)
Stray light:	<0.05% at 600 nm; 0.10% at 435 nm	<0.05% at 600 nm; 0.10% at 435 nm	<0.05% at 600 nm; 0.10% at 435 nm	<0.05% at 600 nm; 0.10% at 435 nm
Fiber optic connector:	SMA 905 to single-strand optical fiber (0.22 NA)	SMA 905 to single-strand optical fiber (0.22 NA)	SMA 905 to single-strand optical fiber (0.22 NA)	SMA 905 to single-strand optical fiber (0.22 NA)

USB Series Spectrometers

Extended Range XR Spectrometers



Our XR-Series USB Spectrometers are responsive across a wide spectral range and provide you optical resolution of ~ 2.0 nm (FWHM) with the convenience of a single, monolithic unit that covers wavelengths from ~ 200 -1025 nm.

The XR option is now available for our USB2000+ (USB2000+XR1) and USB4000 (USB4000-XR1) Spectrometers and can be configured into custom systems (specify GRATING_#XR1). The extended-range grating is also available in a portable Jaz Spectrometer configuration (see JAZ-EL200-XR1 in the Jaz section). And for enhanced sensitivity, select the USB2000+XR1-ES or USB4000-XR1-ES.

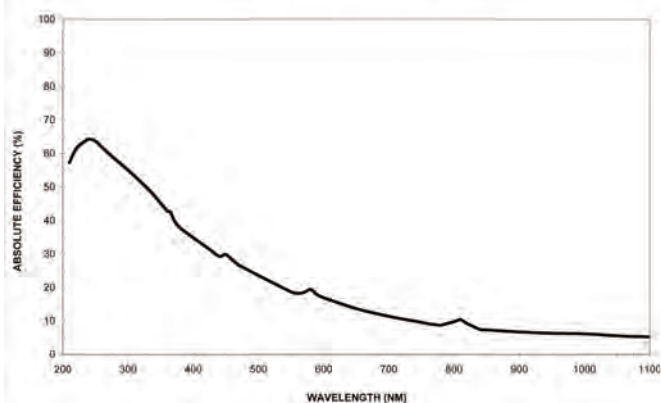
With the XR Series, there's no need to daisy-chain multiple spectrometers to enable UV-NIR coverage. Thanks to the XR's 500 lines/mm groove density grating, you have the advantages of broader spectral coverage as well as good optical resolution.

This grating delivers 825 nm of spectral range and is blazed at 250 nm. And, because their optical bench designs are not affected, the USB2000+ and USB4000 experience no trade-off in performance with the new grating.

Specifications	USB2000+XR1	USB4000-XR1	USB2000+XR1-ES	USB4000-XR1-ES
Spectrometer type:	USB2000+ advanced electronics spectrometer	USB4000 general-purpose spectrometer	USB2000+ enhanced-sensitivity spectrometer	USB4000 enhanced-sensitivity spectrometer
Grating:	Grating #31, 500 l/mm, blazed at 250 nm	Grating #31, 500 l/mm, blazed at 250 nm	Grating #31, 500 l/mm, blazed at 250 nm	Grating #31, 500 l/mm, blazed at 250 nm
Spectral range:	200-1025 nm	200-1025 nm	200-1025 nm	200-1025 nm
Entrance slit:	25 μ m	25 μ m	25 μ m	25 μ m
Detector collection lens:	No	No	Yes	Yes
Optical resolution (FWHM):	~ 1.7 -2.1 nm	~ 1.7 -2.0 nm	~ 1.7 -2.1 nm	~ 1.7 -2.0 nm
Order-sorting filter:	Yes	Yes	Yes	Yes

Note: Dimensions, detector and electronics specifications are comparable to the specifications for the USB2000+ and USB4000 Spectrometers and their application-ready versions.

XR Extended Range Grating Efficiency



Technical Tip: XR-Series Applications

XR-series spectrometers are especially useful for solar irradiance measurements, atomic emission line analysis, plasma monitoring, process applications and more.

Those applications benefit from the XR's unique optical characteristics. The diffraction grating provides coverage from 200-1025 nm, but that's only part of the story. The broad range doesn't do you much good if you are unable to manage higher-order spectral sorting. So we developed a proprietary order-sorting filter that is applied directly to the detector to eliminate second- and third-order effects.

USB4000-FL Fluorescence Spectrometers

Preconfigured Spectrometers for Fluorescence



The USB4000-FL, USB4000-FL-450 and USB4000-FL-395 Spectrometers are preconfigured for fluorescence measurements from 360-1100 nm. Each spectrometer comes with a 200 μ m slit and detector collection lens for increased light throughput and features plug-and-play operation, a high-performance 3648-element CCD-array detector and fast USB 2.0 connectivity.

There are three USB4000-FL options:

- USB4000-FL

Our basic fluorescence spectrometer can be combined with various excitation sources and accessories for probe- and cuvette-based setups. We offer an extensive range of separate LEDs for excitation.

- USB4000-FL-450 and USB4000-FL-395

These models offer all the advantages of our USB4000-FL, but with a direct-attach 470 nm LED (pictured) or 395 nm LED for excitation. The LED connects to the spectrometer via a 10-pin connector. The spectrometer powers and controls (through software) the LED. The direct-attach LED option provides you with a convenient, small-footprint package for your single-wavelength excitation needs.

Filtering Options

USB4000-FLs can be used with our LVF-series Linear Variable Filters for simple yet effective separation of excitation and fluorescence energy. Use our LVF-L Linear Variable Low-pass Filter to fine-tune your excitation source for maximum signal with minimum overlap. Our LVF-H Linear Variable High-pass Filter can be effective on the detection side. Additional blocking filter options are also available.

Physical	
Dimensions:	89.1 mm x 63.3 mm x 34.4 mm (spectrometer only); 89.1 mm x 120.3 mm x 34.4 mm (spectrometer w/LED)
Weight:	190 g (spectrometer only); 310 g (spectrometer w/LED)
Detector Specifications	
Detector:	Toshiba TCD1304AP Linear CCD array
Detector range:	200-1100 nm
Pixels:	3648 pixels
Pixel size:	8 μ m x 200 μ m
Pixel well depth:	100,000 electrons
Sensitivity:	130 photons/count at 400 nm; 60 photons/count at 600 nm
Optical Bench	
Design:	f/4, Asymmetrical crossed Czerny-Turner
Focal length:	42 mm (input); 68 mm (output)
Entrance aperture:	200 μ m wide slit
Grating:	Grating #3 -- groove density 600 l/mm, set to 360-1000 nm, 500 nm blaze
Detector collection lens:	Yes, L4
Fiber optic connector:	SMA 905 to 0.22 numerical aperture single-strand optical fiber
Spectroscopic	
Wavelength range:	360-1000 nm
Optical resolution:	~10.0 nm FWHM
Signal-to-noise ratio:	300:1 (at full signal)
A/D resolution:	16 bit
Dark noise:	50 RMS counts
Dynamic range:	3.4 x 10 ⁶ (system), 1300:1 for a single acquisition
Integration time:	3.8 ms-10 seconds
Stray light:	<0.05% at 600 nm; 0.10% at 435 nm
Corrected linearity:	>99%
LED Specifications for USB4000-FL-450 and USB4000-FL-395	
Wavelength:	460-490 nm (USB4000-FL-450) and 380-410 nm (USB4000-FL-395)
Power consumption:	60 mA @ 5 VDC
Power output:	60 μ W (minimum) into a 600 μ m fiber
Stability:	+/-1.0% drift after 2-minute warm-up period
Electronics	
Power consumption:	250 mA @ 5 VDC
Data transfer speed:	Full scans to memory every 5 ms with USB 2.0 port
Inputs/Outputs:	Yes, 8 onboard digital user-programmable GPIOs
Analog channels:	No
Auto nulling:	Yes
Trigger modes:	4 modes
Strobe functions:	Yes
Connector:	22-pin connector

USB2000+RAD Spectrometer

Preconfigured for Irradiance Measurements



The USB2000+RAD Spectroradiometer is a preconfigured combination of a powerful 2-MHz analog-to-digital (A/D) converter, programmable electronics, a 2048-element CCD-array detector, a high-speed USB 2.0 port and cosine corrector. This innovative combination produces our fastest spectrometer yet and provides resolution to 0.35 nm (FWHM). The USB2000+RAD allows you to capture and store a full spectrum into memory up to once per millisecond when the spectrometer is interfaced to a computer via a USB 2.0 port.

This spectroradiometer system features a USB2000+ Spectrometer and attached CC-3-DA cosine corrector. It does not require in-field NIST-traceable UV-VIS calibration as it is precalibrated by Ocean Optics with our SPEC-CAL-UV radiometric calibration service for UV spectrometers. The USB2000+RAD is preconfigured and ready for measurement "out of the box" so that installation and measurement is fast, accurate and convenient.

Features

- Programmable microcontroller
- Up to 1,000 full spectra per second
- Modular design
- Automatically reads wavelength calibration coefficients of the spectrometer and configures operating software
- RoHS and CE compliant

Physical	
Dimensions:	89.1 mm x 63.3 mm x 34.4 mm
Weight:	190 g
Detector	
Detector:	Sony ILX511B linear silicon CCD array
Detector range:	200-1100 nm
Pixels:	2048 pixels
Pixel size:	14 μm x 200 μm
Pixel well depth:	~62,500 electrons
Sensitivity:	75 photons/count at 400 nm; 41 photons/count at 600 nm
Optical Bench	
Design:	f/4, Symmetrical crossed Czerny-Turner
Focal length:	42 mm input; 68 mm output
Entrance aperture:	50 μm wide slit
Grating:	Grating # 2 groove density 600 l/mm, set to 250-800 nm (400 nm blaze)
Detector collection lens:	Yes, L2
Collimating and focusing mirror:	Standard
UV enhanced window:	UV2 quartz window
Fiber optic connector:	SMA 905 to 0.22 numerical aperture single-strand optical fiber
Spectroscopic	
Wavelength range:	200-850 nm
Optical resolution:	~2.0 FWHM
Signal-to-noise ratio:	250:1 (at full signal)
A/D resolution:	16 bit
Dark noise:	50 RMS counts
Dynamic range:	8.5 x 10 ⁷ (system); 1300:1 for a single acquisition
Integration time:	1 ms to 65 seconds (20 s typical)
Stray light:	<0.05% at 600 nm; <0.10% at 435 nm
Corrected linearity:	>99%
Electronics	
Power consumption:	250 mA @ 5 VDC
Data transfer speed:	Full scans to memory every 1 ms with USB 2.0 or 1.1 port, 300 ms with serial port
Trigger modes:	4 modes
Strobe functions:	Yes
Gated delay feature:	Yes
Connector:	22-pin connector



Turn your USB2000+RAD into a spectroradiometric system for calculating Photosynthetically Active Radiation (PAR). SpectraSuite-PAR is a plug-in for our SpectraSuite spectroscopy software that uses absolute irradiance of the light incident on plants and other samples and converts the irradiance values from $\mu\text{W}/\text{cm}^2$ (microwatts per square centimeter) to $\mu\text{mol}/\text{m}^2/\text{s}$ (micromoles per square meter per second) – the measurement unit more commonly used for PAR analysis.