OtO Photonics

Dual Spectrometer (DS) Series
Product sheet

Description

DS series spectrometers comprise two Czerny-Turner optical cavities receiving light via a single input optical fiber and internal Y-splitter fiber.

Customers can specify the two optical cavities based upon OtO Photonics' ***SmartEngine*** (non-cooled silicon), ***EagleEye*** (TE-cooled silicon) or ***SideWinder*** (non-cooled or TE-Cooled InGaAs) models.

DS offers designers ultimate flexibility, being able to select slit width, grating, spectral range and sensor for each optical cavity.

It is therefore possible to specify full 180nm to 1700nm operation or combine narrower spectral ranges of interest with high optical resolution, high sensitivity, low stray light, and fast spectral response.

The DS series optical bench provides a rigid platform with outstanding thermal and humidity cycling performance together with excellent shock and vibration stability of resolution and wavelength shift.

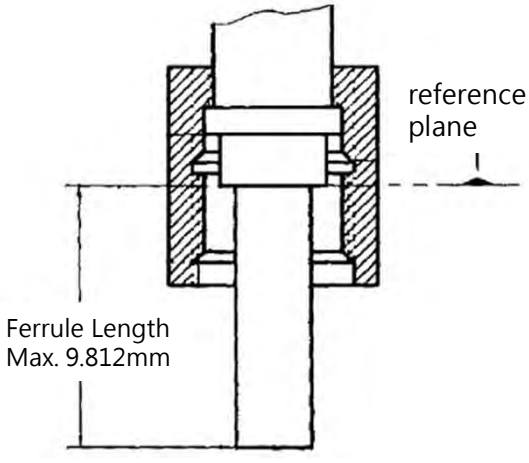
The compact size is very flexible for system integration.

Communication and power for DS series is provided by a USB Type-B port for each sensor and there are also two independent external interface extension ports providing 6 I/Os.

OtO Photonics' SpectraSmart spectral measurement software allows users to interface with both optical cavities via a single software interface and spectra can be combined into a single continuous readout by optimizing integration times.

A Windows SDK is included along with example code and a driver library.

Attention

Picture	Description
	To prevent over-tightening and damaging the slit of the spectrometer please ONLY hand tighten the SMA905 connector. **Do not** use any tool to tighten the optical fiber and SMA905 connector. If stable long-term operation is required we recommend application of adhesive to the connector after hand tightening.
	The design of the optical interface is based on IEC 874-2:1993. To prevent damage to the slit in the spectrometer, the ferrule length of SMA905 connector **must shorter than 9.812mm.**

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Dual Spectrometer (DS) Series

Overview

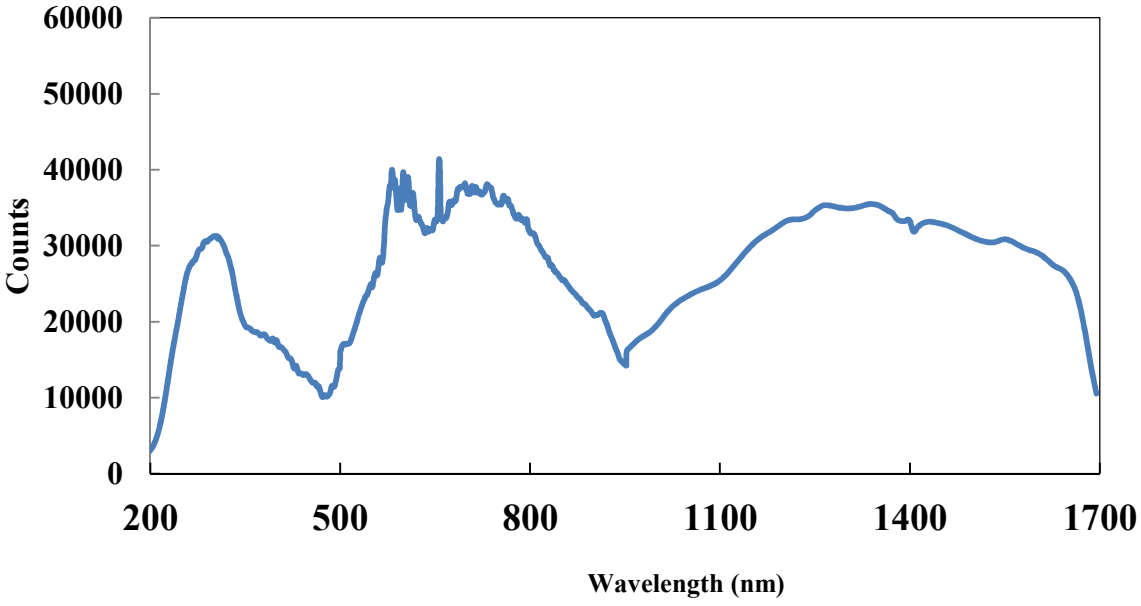
► 1.1 Lineup of DS Series

DS series is combined with one UV-VIS or VIS spectrometer and one NIR spectrometer. Clients are able to choose spectrometers according the table below.
e.g. DS2686= EE2060 + SW2860

Model			Spectral Response Range (nm)						SNR*1		Dynamic Range*2		Stray Light
			DUVN	FUV	FUVN	VNIR	NIR1	NIRC	mode		mode		
			200 ~ 1025	180 ~ 850	180 ~ 1100	350 ~ 1020	790 ~ 1010	900 ~ 1700	High Gain	Low Gain	High Gain	Low Gain	
DS Series	UV-VIS	SE1030/2030	√	√	√	√	√		330		3450/3000		0.2%
		SE1040/2040	√*3			√			200		2220		0.2%
		SE1050/2050					√		500		4400		0.45%
		SE1060/2060		√	√	√			500		4700		0.2%
		SE1070/2070	√			√	√		400		2200		0.2%
		SE1080/2080	√			√	√		350		2200		0.2%
		SE1090/2090		√	√	√			500		3120		0.45%
	UV-VIS+TEC	EE2053*4				√	√		500		4700		0.45%
		EE2063*4	√	√	√				500		4096		0.45%
	NIR	SW2520						√	2000	4000	4100	60000	0.2%
		SW2530						√					
		SW2540						√					
	NIR+TEC	SW2860 (TEC -1 Stage)*4						√	2700	4100	4256	5461	

*1 : Single acquisition
*2 : 65535/Dark Noise(average)
*3 : For SE2040, 275~1100nm only
*4: TECooling 1 stage, Default : 0 ° C at Ambient of 25 ° C

► 1.2 Intensity test



- Intensity test of DS2252-VNIRxNIRA (Integrated SE2020-VNIR and SW2520-NIRA, SE2020 has been phased out)。

Main Features

► 2.1 Feature

- Wavelength range: from 180 to 1700 nm
- Optical resolution: from 0.9 to 10.5nm, depending on the combination of various slits and gratings.
- A variety of sensor can be chosen for specific application:
  - High speed, high sensitivity, back-thinned
  - CCD, CMOS and InGaAs
  - TECooling CCD and TECooling InGaAs Sensor
- Modular configuration with various grating, sensor, and slit options
- Integration times from 0.2 ms to 65 seconds, depending on sensors
- 16 bit, 15MHz A/D Converter
- USB 2.0 @ 480 Mbps (High speed)
- 8-pin connector for interfacing to external
  - 6 user programmable digital I/O
- Plug-n-play interface for PC application
- Extremely precise continuous multiple exposures, providing up to 5,000 spectra buffering
- Flash ROM storage for
  - Wavelength Calibration Coefficients
  - Linearity Correction Coefficients
  - Intensity Calibration Coefficients

► 2.2 Specification

SPEC	DS Series									
	SE 2030	SE 2040	SE 2050	SE 2060	SE 2070	SE 2080	SE 2090	SW 2520	SW 2530	SW 2540
Sensor	2048	2048	2048	2048	3648	4096	2048	128	256	512
	CMOS	CCD	CCD	CCD	CCD	CMOS	CCD	InGaAs		
Dark Noise (Upper Limit)	30*1 36*2	34	20	20	40	50	29	13.5		
Dynamic Range*3	3450*1 3000*2	2200	4700	4700	2200	2200	3540	6000 (Low Gain) 4100 (High Gain)		
SNR*4	330	200	500	500	400	350	500	4000 (Low Gain) 2000 (High Gain)		
Structure	DS series; Czerny-Turner Optical Structure 2nd & 3rd order rejection									
Grating	15 grating options ; spectral range from UV to NIR							2 grating options ; NIR spectral range		
Wave-length	From 180 to 1100 nm with a variety of wavelength range							From 900 to 1700 nm with a variety of wavelength range		
Slit Size	10, 25, 50, 100, 200,300 um							10, 25, 50, 100. 200 um		
Integration Time	0.2ms ~ 65sec, depending on sensors							50 µs ~ 15sec, depending on sensors		

*1: Sensor clock rate 2.5MHz
*2 :Sensor clock rate 10MHz
*3 : 65535/Dark Noise(average)
*4 : Single acquisition

Dual Spectrometer (DS) Series

SPEC	DS-TECooling Series		
	EE2053	EE2063	SW2860
Sensor	2048 Pixels	2048 Pixels	256 Pixels
	NIR-Enhanced Back thinned TEC sensor	UV-Enhanced Low noise type Back thinned TEC sensor	NIR InGaAs TEC Sensor
Dark Noise (Upper Limit)	20	25	12.5(Low Gain) 13.5(High Gain)
Dynamic Range*3	4700	4000	5242(Low Gain) 4854(High Gain)
SNR*4	500	500	4100(Low Gain) 2700(High Gain)
Structure	DS series; Czerny-Turner Optical Structure 2nd & 3rd order rejection		
Grating	15 grating options ; spectral range from UV to NIR		2 grating options ; NIR spectral range
Wave-length	From 180 to 1100 nm with a variety of wavelength range		From 900 to 1700 nm with a variety of wavelength range
Slit Size	10, 25, 50, 100. 200 um		
Integration Time	5ms ~ 65sec, depending on sensors		50 μs ~ 15sec, depending on sensors

*1: Sensor clock rate 2.5MHz
*2 :Sensor clock rate 10MHz
*3 : 65535/Dark Noise(average)
*4 : Single acquisition

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Dual Spectrometer (DS) Series

SPEC		Content	
		DS Series	
		SE/EE Series	SW Series
Wavelength Repeatability		+/- 0.05 nm Continuous 100 measurements (Hg-Ar Light Source)	+/- 0.2 nm Continuous 100 measurements (Hg-Ar Light Source)
Wavelength accuracy		± 0.3 nm (Testing environment is based on SE1020-050-VNIR's parameter, and accuracy may be up to ± 1.0nm according to different environment such as severe temperature change and long-time vibration. OtO can offer free software for WL calibration if customer needed.)	± 1 nm (Testing environment is based on SW2530-050-NIR's parameter, and accuracy may be up to ± 1.5nm according to different environment such as severe temperature change and long-time vibration. OtO can offer free software for WL calibration if customer needed.)
Resolution(FWHM)		From 0.2 nm to 10.5 nm, depending on different modular configuration	From 2 nm to 8 nm, depending on different modular configuration
Thermal Stability		<0.04nm/˚C	<0.069nm/˚C
Environmental Conditions	Storage	-30˚C to +70˚C	
	Operation	0˚C to +50˚C	
	Humidity	0% - 90% non-condensing	
Interfaces		USB 2.0 @ 480 Mbps (High speed)	
Input Fiber Connector		SMA 905	
Power		Power requirement (VBUS): 300mA at +5 VDC Supply voltage: 4.75-5.25 Power-up time : < 4s Maximum USB input power Vcc : +5.25VDC Maximum I/O signal voltage : +5.5VDC TEC Power requirement: 500mA at 5VDC	

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Structure

► 3.1 Mechanical Diagram

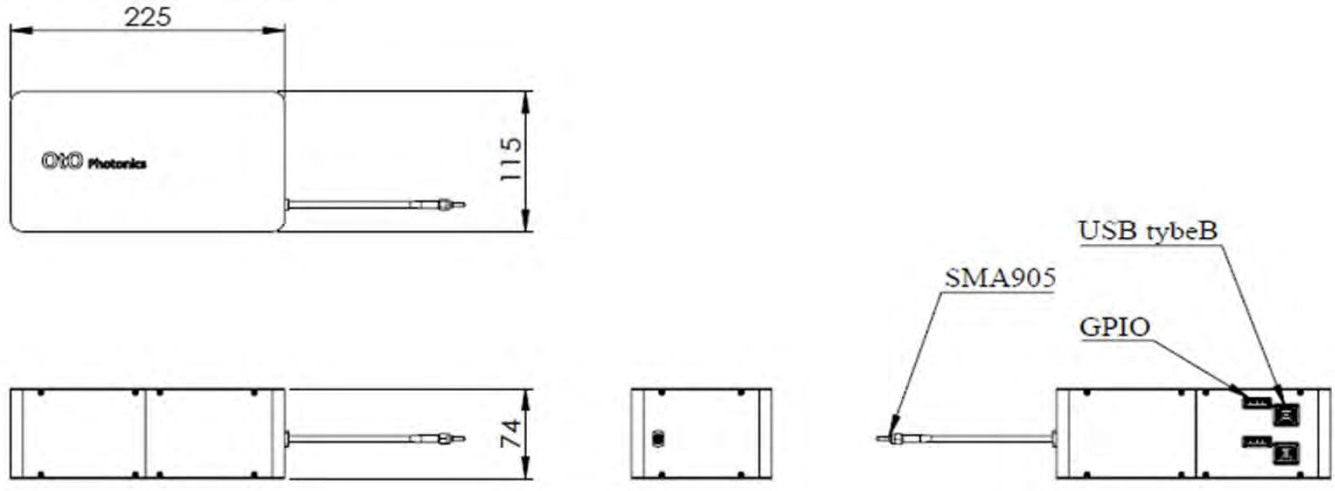

Fig. 1a: DS Series outer dimensions

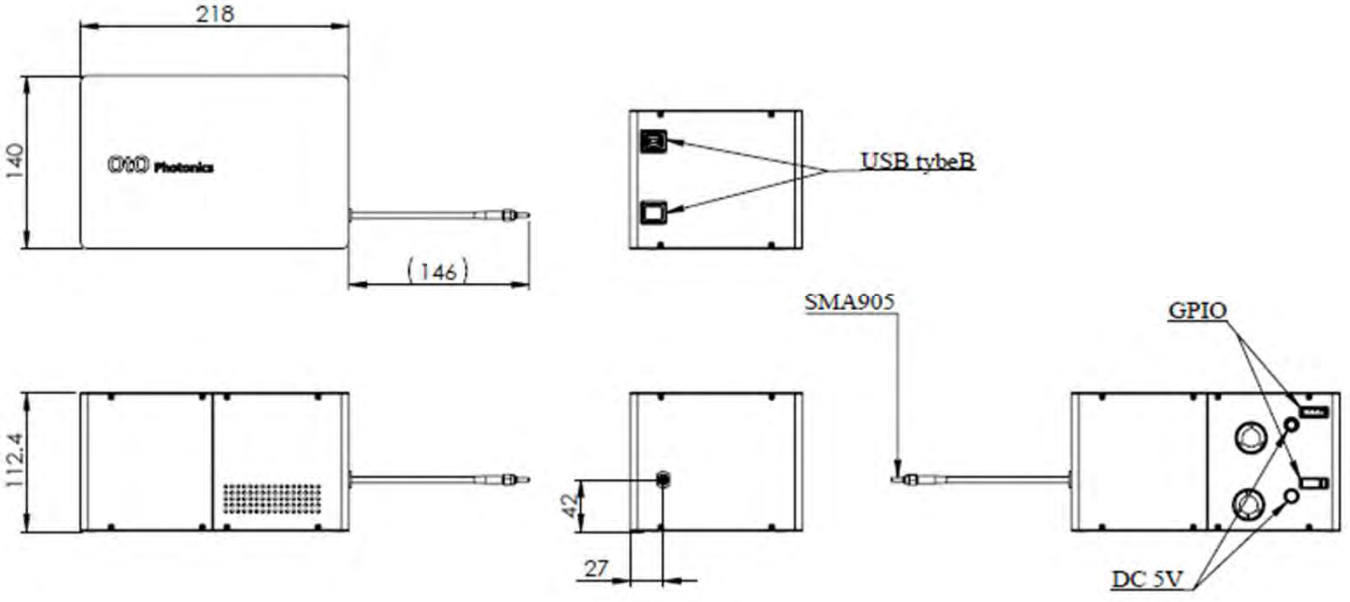

Fig. 1b :DS-TEC Series outer dimensions

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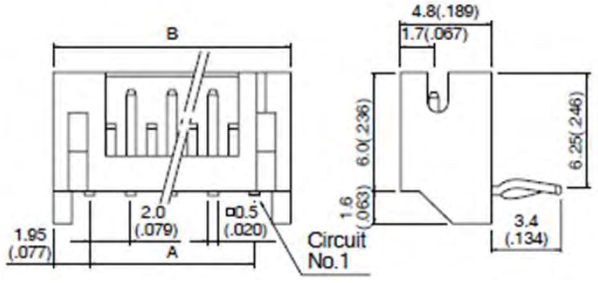
► 3.2 Electrical Pinout

The following listed is the pin description for the DS Series Extension Connectors. The Back Extension Ports are 8 pin 2.0mm connectors.

Side entry type



Cir-cuits	Model No.		Dimensions mm(in.)		Q'ty / box	
	Top entry type	Side entry type	A	B	Top entry type	Side entry type
8	B 8B-PH-K-S	S 8B-PH-K-S	14.0(.551)	17.9(.705)	500	250

Fig. 2 : Back Extension Port 2.0 mm 8 pin drawing

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Back Extension Port Pin# Description Alt Function

*All I/Os are TTL-level input/output

Pin No.	Direction	Pin Name	Function Description
1	Power	5V Output	When connecting to PC USB port, this pin is also connected to VBUS. This pin can provide around 0.1A power for external device.
2	Output	TX	UART TX. TX is the output from the RISC controller.
3	Input	RX	UART RX. RX is the input for the RISC controller.
4	Output	GPIO0	General Purpose Output 0.
5	Output	GPIO1	General Purpose Output 1.
6	Output	LS_ON	Light Source Turn ON.
7	Input	Trigger_IN	External Trigger Input Signal.
8	GND	GND	GND

- **Pin orientation**

Looking at Front of DS Series connector side, from left to right are Back Extension Port and PC USB.

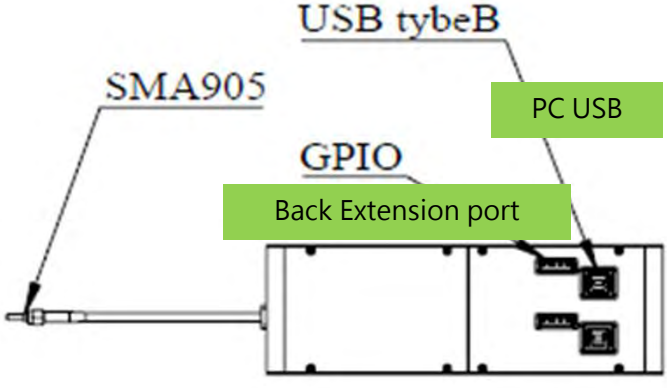

Fig. 3 : DS Series: the front-view of connector mechanical graph

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SENSOR/SYSTEM NOISE

There are three major sources impact the Vout signal reading. One is the light source stability, the second is the electronics noise, and the other is detector noise. If we don't consider the outer light source influence, we can check the dark noise performance of this system first. The dark noise we define here is the RMS of Vout signal under 1ms integration time in dark condition. So the dark noise will be only contributed by electronics readout noise and the sensor.

The other major parameter to define the noise performance is the SNR. The SNR we define here is the ratio of the full signal (65535 counts) to the RMS value under the full signal condition. The higher SNR performance indicates the readout signal is more stable. It will be helpful for the low signal differentiation.

SIGNAL AVERAGING

The software-SpectraSmart provides two options for the signal curve operations. The first one is the signal averaging. By the averaging method, we can reduce the noise impact on each pixel. Surely, more sampling points will bring the better averaging performance. But it will need more time to get one spectra. When we use the time-base type of signal averaging, the S:N increases by the square root of the number of samples. Thus, a S:N is readily 10x achieved by averaging 100 spectra.

The other curve smoothing is boxcar filter. It can average the adjacent points to show the smoother curve, but it will lower optical resolution. So if the target signal is peak type, the boxcar may not be suitable for this.

These two methods can be enabled at the same time if the measurement target is suitable for this operation. But if the user would like to check all the original data and performance, time-based average or boxcar smoothing needs to be un-checked. The default setting for these two average methods is un-checked.

Internal Operation

► 4.1 Pixel Definition

The baseline signal is around 1,000 counts in our current system. We can provide the tool/command to manually adjust the baseline. (adjust the AFE OFFSET) The other baseline adjustment method is to enable the background removal from the software. It depends on the user how to use the baseline. Normal output signal is not obtained immediately after device switch on. Use the output signal added 22500 pulses or above to CLK clock pulse.

► 4.2 Digital Inputs & Outputs

- **General Purpose Inputs/Outputs (GPIO)**

DS Series has 6 user programmable 3.3V digital Input/Output pins, which can be accessed at the 8-pin Extension connector. Through software, the state of these I/O pins can be defined and used for multi-purpose applications. If the user needs the special timing generation (like single pulse or PWM), DS Series provides the flexibility to implement this.

GPIO Recommended Operating Levels:

VIL(max) = 0.8V

VIH(min) = 2.0V

GPIO Absolute Maximum/Minimum Ratings are as follows:

VIN(min) = -0.3V

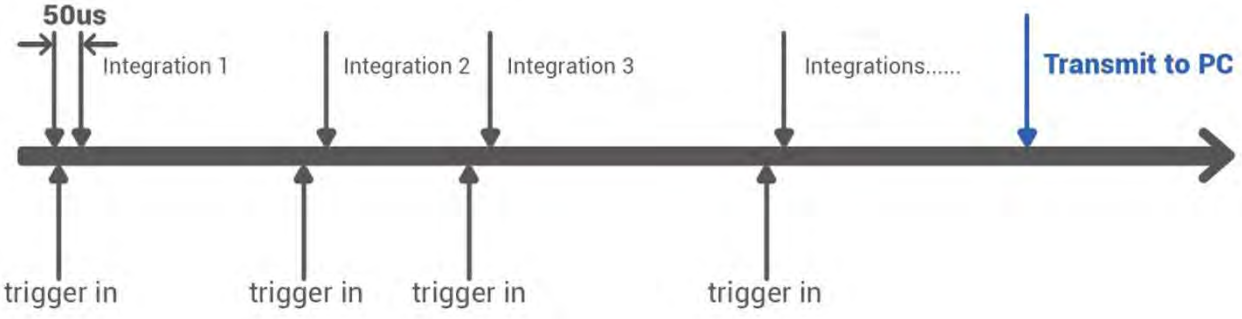
VIN(max) = 5.5V

- **Communication and Interface**

USB 2.0

480-Mbit **U**niversal **S**erial **B**us is the standard and popular communication interface in PC. Our PC software allows connecting multiple DS Series via USB and monitors multiple DS Series spectra. The low power requirement allows operating the DS Series through the USB cable and VBUS.

- **Extremely Precise Continuous Multiple Exposures**



- Arbitrary integration times
- Spectra are stored in the huge memory on our board, providing up to 4000 spectra buffering
- After all integrations are done, the spectra are transmitted to your PC

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USB Port Interface Communications and Control Information

► Overview

DS Series is a microcontroller-based Miniature Fiber Optic Spectrometer that can communicate via the Universal Serial Bus. This section contains the necessary programming information for controlling DS Series via the USB interface. This information is only pertinent to users who wish to not utilize SpectraSmart software to interface to DS Series.

● Hardware Description

DS Series utilizes a 32 bit RISC controller built in USB 2.0. Program code and data coefficients are stored in SPI Flash. The RISC controller supports 32 MByte DDR and 64 Mbits Flash.

USB Info

DS Series USB Vendor ID number is 0x0638 and the Product ID is 0x0AAC. DS Series is USB 2.0 compliance. The data exchange between host and spectrometer is via bulk streams. The detail USB information please refer USBIF @ http://www.usb.org.

INSTRUCTION SET

Application Programming Interface

The list of the APIs is shown in the following table followed by a detailed description of each function call.

☐ Open DS Series Spectrometer

Description: To connect Windows host to DS Series

a.Function Name: UAI_SpectrometerOpen

b.Arguments:

dev: 8 DS Series spectrometers can be attached to one host at the same time. dev is the device number to specify which one will be opened.

handle: the unique Windows identifier to operate devices. Windows will return the identification number which is necessary for further operation.

☐ Query Frame Size

Description: To get the data frame size of the spectrometer.

a.Function Name: UAI_SpectromoduleGetFrameSize

b.Arguments:

device_handle: a pointer to the device information structure which is returned

when device open.

size: a 16-bit unsigned integer will be returned to indicate the data length.

☐ Acquire Wavelength

Description: Initiates a wavelength acquisition. DS Series will acquire a complete wavelength distribution.

a.Function Name: UAI_SpectrometerWavelengthAcquire

b.Arguments:

device_handle: a pointer to the device information structure which is returned when

device open.

buffer: the storage buffer acquired data.

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☐ **Acquire Spectra**

Description: Initiates a spectra acquisition. DS Series will acquire a complete intensity distribution which corresponds to the wavelength which is acquired by OtO_UAI_SpectrometerWavelengthAcquire.

a. **Function Name:** UAI_SpectrometerDataAcquire

b. **Arguments:**

device_handle: a pointer to the device information structure which is returned when
device open.

integration_time_us: a 32-bit unsigned variable to determine the integration time
of the micro-seconds.

buffer: the storage buffer acquired data.

average: the spectrum could be averaged by several continuous acquisitions to
reduce the noise.

☐ **Query Wavelength Range**

Description: To get the minimum and maximum wavelength

a. **Function Name:** UAI_SpectromoduleGetWavelengthStart
Function Name: UAI_SpectromoduleGetWavelengthEnd

b. **Arguments:**

device_handle: a pointer to the device information structure which is returned when
device open.

lambda: a 32-bit floating type data which is indicate the minimum or maximum
wavelength, in nm, of DS Series will be returned.

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☐ **Query Integration Time Range**

Description: To get the minimum and maximum integration time.

a.Function Name: UAI_SpectromoduleGetMinimumIntegrationTime

Function Name: UAI_SpectromoduleGetMaximumIntegrationTime

b. Arguments:

device_handle: a pointer to the device information structure which is returned when device open.

Integration Time: a 16-bit integer type data which indicates the minimum or maximum integration time of DS Series will be returned. The minimum integration time is in micro-second and the maximum Integration time is in milli-second.

☐ **Close DS Series Spectrometer**

Description: To connect Windows host to DS Series

a.Function Name: UAI_SpectrometerClose

b.Arguments:

handle: the unique Windows identifier to operate devices. Windows will detach the device and any operation is invalid after this function is executed.