OtO Photonics

Pocket Hawk (PH) Series
Product sheet

Description

PH series spectrometers combine CCD or CMOS linear array sensors and 32-bit RISC controllers with optimized optical design enabling a miniaturized package.

The design features an external motherboard to enhance heat dissipation whilst the compact size and selection of mounting holes provide system integrators with flexible options.

PH series spectrometers feature a Crossed Czerny-Turner optical design and provide high optical resolution, high sensitivity, low stray light and fast spectral response.

Communication and power interface with the PH-NIR series is via micro-USB with an additional 8-pin extension port or 4pin I/Os.

The PH series 32-bit RISC controller can be addressed using OtO Photonics' *SpectraSmart* fully-featured spectral measurement software which includes Windows SDK and other example code.

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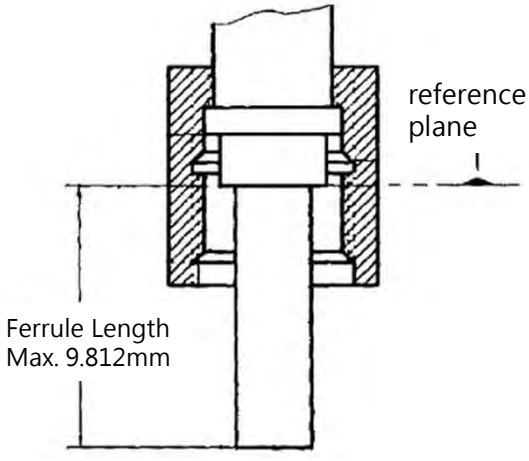
Attention

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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Main Features

► 1.1 Feature

- Optical resolution: Depending on the combination of various slits and gratings.
- PH1014/2014 High sensitivity 3000 pixel CCD sensor
- PH1034/2034 UV enhance 512 pixel CMOS sensor
- Modular configuration with various slit options
- PH101//2014 Minimum Integration times 1.5 ms
- PH1034/2034 Minimum Integration times 0.1 ms
- 16 bit, 15MHz A/D Converter
- Micro USB 2.0 @ 480 Mbps (High speed)
- 4pin customized USB connector
- 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 4,000 spectra buffering
- Flash ROM storage for
  - Wavelength Calibration Coefficients
  - Linearity Correction Coefficients
  - Intensity Calibration Coefficients

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► 1.2 Specification

SPEC		Content	
		PH1014/2014	PH1034/2034
CCD		High sensitivity 3000 pixel CCD sensor	UV enhance 512 pixel CMOS sensor
Parameters of Optical System		f/# : 4.5, NA :0.11, Focal Length(R1-R2) :39-44 (It is recommended that the Incident NA should larger than the NA of spectrometer.)	
Dark Noise (Upper Limit)		40	24
Dynamic Range (avg.)*1		2200:1	5650
SNR*2		200	330
Spectrometer		Crossed Czerny-Turner Optical Structure 2nd & 3rd order rejection	
Dimension		65(L) x 65(W) x 29.8(H) mm	
Grating		Various grating options	
Wavelength		330-1050nm	200-1050nm
Slit Size		10, 25, 50, 100, 200 um	
Integration Time		1.5ms	0.1ms
Wavelength Repeatability		NA	NA
Wavelength accuracy		NA	NA
Resolution(FWHM)		From 2.2 nm to 12 nm, depending on different modular configuration	
Thermal Stability		NA	
Environmental Conditions	Storage	-30˚C to +70˚C	
	Operation	0˚C to +50˚C	
	Humidity	0% - 90% non-condensing	
Interfaces		Micro USB 2.0 @ 480 Mbps (High speed)	
Input Fiber Connector		SMA905: Φ3.20±0.01mm	
Recommend Tightening Torque		0.15 Nm (Mating Part : 5mm thick, Flatness 0.1mm, Aluminum sheet)	
Power		Supply voltage: 4.75V-5.25V	

*1 : 65535/Dark Noise(average)
*2 : Single acquisition

► 1.3 Wavelength Response

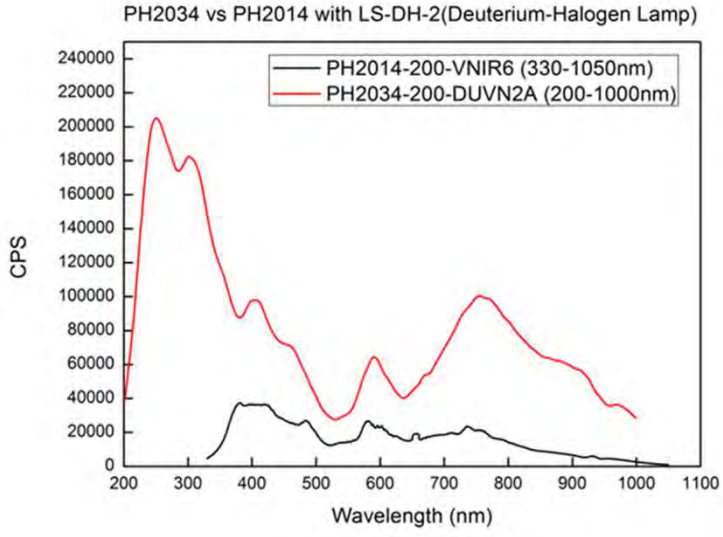

Fig. 1: PH2014 VS PH2034 Wavelength Response

► 1.4 Lineup of PH Series

Model	Spectral Response Range (nm)			SNR	A/D	Stray Light	Thermal Stability
	VNIR6	DUVN2 DUVN2A	V23				
	330 ~ 1050	200 ~ 1050	450 ~ 750				
PH1014 /PH2014	√			200	16 bits	<0.2%	<0.04nm/℃
PH1034 /PH2034		√	√	330		<0.2% (450-750nm: <0.45%)	

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Structure

► 2.1 Mechanical Diagram

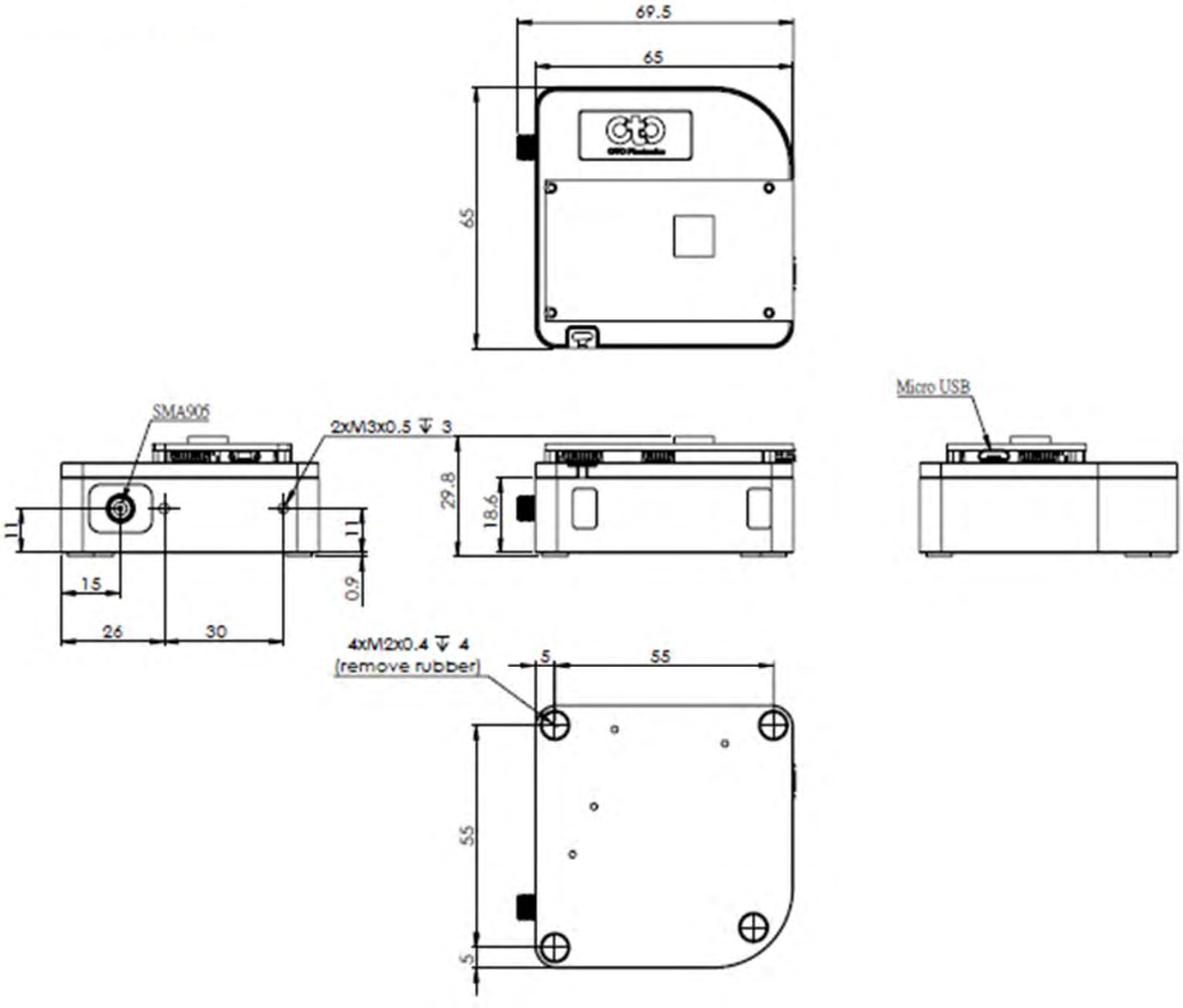

Fig. 1: PH Series outer dimensions

► 2.2 Electrical Pinout

The following listed is the pin description for the PH Series Extension Connectors. There are two Extension Port (8 pin 1.0mm connector for GPIO, one of them is for OtO debug use), one Micro USB, one USB(4 pin, for special use)

● Pin orientation

Looking PH Series connector side, from right to left are GPIO Extension Port, Micro USB, USB

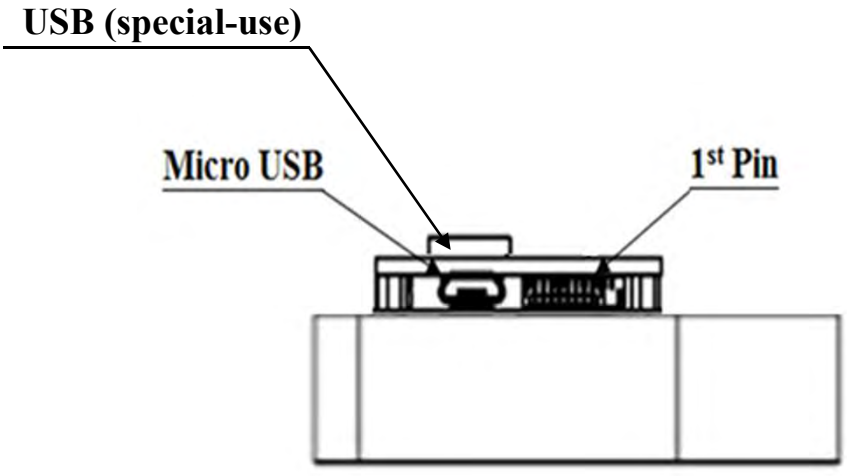

Fig. 3 : PH Series: the front-view of connector mechanical graph

Back Extension Port Pin# Description Alt Function

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

Pin No.	Direction	Pin Name	Function Description
1	Power	3.3V	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

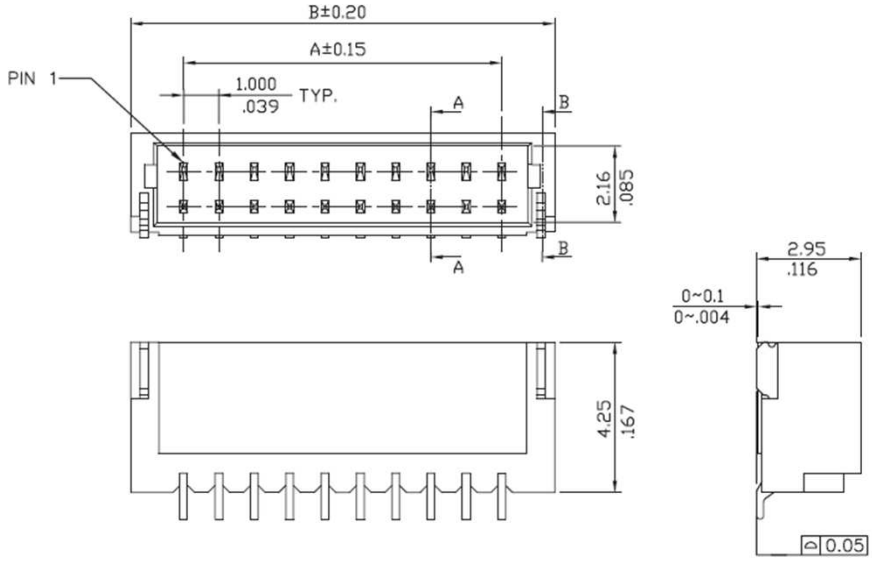

Fig. 4 : Back Extension Port 1.0 mm 8 pin drawing

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USB Port (Special –use)

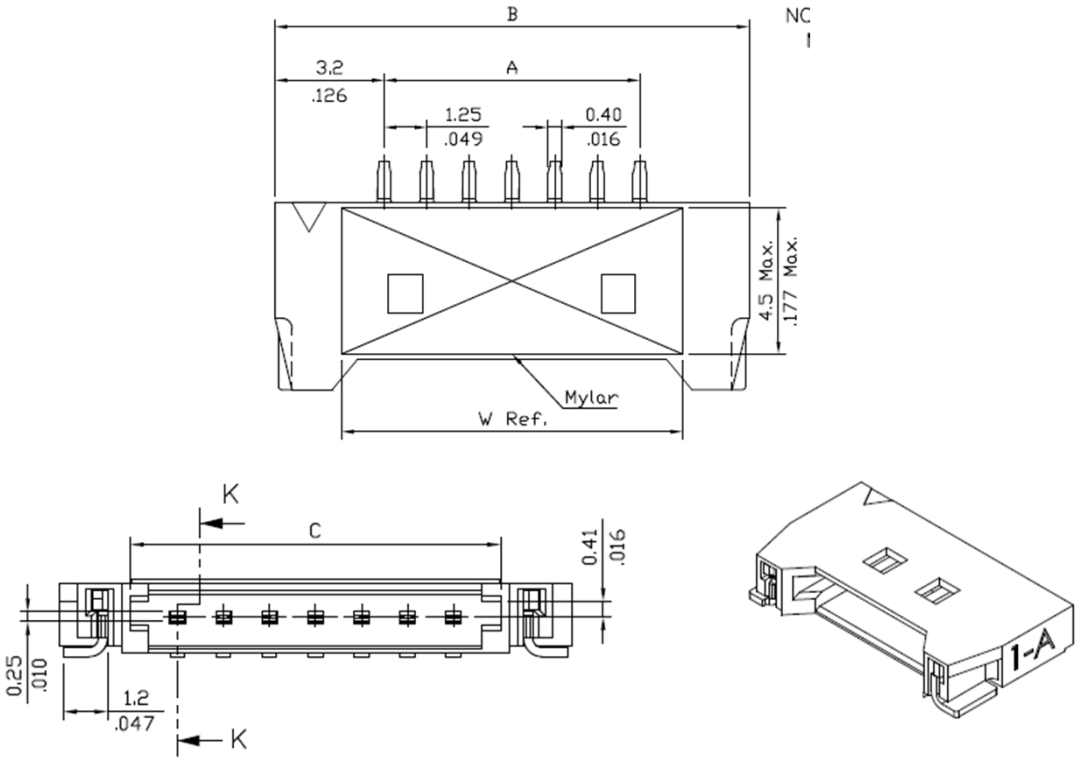

Fig. 5: USB(Special-use) 1.0 mm 4 pin drawing

☐ Pin# Description

Pin No.	Direction	Pin Name
1	+5V	+5V
2	Data-	USB-
3	Data+	USB+
4	GND	GND

CCD/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 CCD 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 CCD 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

► 3.1 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.

- The following is a description of all of the pixels

Pixel	Description
1–13	Dummy pixels
14–31	Optical black pixels
32	Dummy pixels
33–3032	Optical active pixels
3033-3038	Dummy pixels

► 3.2 Digital Inputs & Outputs

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

PH 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), PH Series provides the flexibility to implement this.

USB Port Interface Communications and Control Information

► 4.1 Overview

PH 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 PH Series via the USB interface. This information is only pertinent to users who wish to not utilize SpectraSmart software to interface to PH Series.

● Hardware Description

PH 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.

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 PH Series Spectrometer

Description: To connect Windows host to PH Series

a.Function Name: UAI_SpectrometerOpen

b.Arguments:

dev: 8 PH 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.

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☐ 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. PH 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. PH 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 PH 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 PH Series will be returned. The minimum integration time is in micro-second and the maximum Integration time is in milli-second.

☐ **Close PH Series Spectrometer**

Description: To connect Windows host to PH 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.