OtO Photonics

Megrez & Megrez-NIR Series Product Sheet

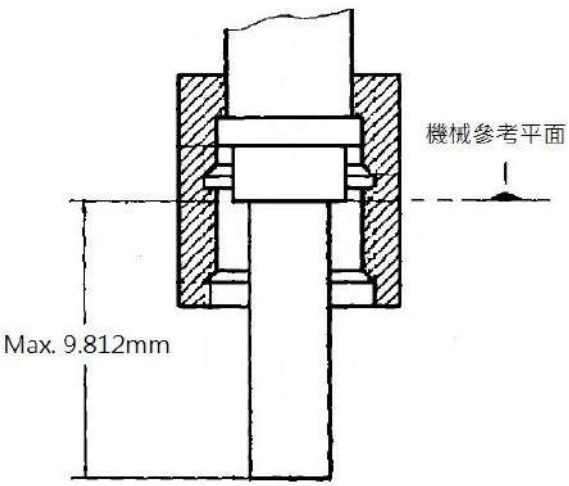
Introduction

The Megrez & Megrez-NIR (MG & MG-NIR) Series spectrometers feature CCD or InGaAs image sensors couple with 32-bit RISC microcontrollers. They employ a TRT-Czerny-Turner optical bench that delivers high optical resolution, high sensitivity, low dispersion, and high-speed spectrum response. Their high optical resolution and responsive wavelength ranges make them especially suitable for probing and testing applications for chlorophyll fluorescence (VIS), laser diode, and VCSEL LED (NIR). The MG Series also feature cooling to prevent the effects of temperature on sensors.

The MG & MG-NIR Series are powered by USB via the USB connection with a computer. In addition, these spectrometers provide an interface with eight I/O pins for connecting external devices.

This document provides detailed information about the MG & MG-NIR Series and how to work with them. With RISC microcontrollers, the MG & MG-NIR Series spectrometers can be be operated by users using the software provided by OtO Photonics.

Precautions

Illustration	Description
	Screw in the fiber optic connector with fingers. Do not use any tool to tighten it. Using tools such as wrenches to tighten the connector may cause the connector to press against and damage the inlet slit of the spectrometer. Such damage is not covered by the warranty. In cases where the connector needs to be firmly in place for long-term use, it is advised to apply a little glue to where the SMA905 connector is connected to the spectrometer.
	The SMA905 connectors on all spectrometers made by OtO Photonics is manufactured in accordance with international standards. Customers should ensure that the ferrule length of the fiber used is not longer than 9.812mm to avoid damaging the slid in the SMA950 connector. Such damage is not covered by the warranty.

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Overview

► 1.1 MG & MG-NIR Products

	Model	Wavelength range (nm)				SNR		Dynamic Range*1		A/D	Stray Light	Thermal Stability Test
		V32	NIRT6	NIRT7	NIRT8							
		625 - 818	1522 - 1578	790 - 960	1060 - 1200							
MG Series	MG1060S	√		√		500		5000		16 Bits	<0.2%	<0.002 nm/°C
MG-NIR Series	MG2870S		√		√	High Gain	Low Gain	High Gain	Low Gain			
						2700	4900	7700	10000			

*1 : The dynamic range is calculated using the average dark noise value of multiple spectrometers

► 1.2 Response Curves

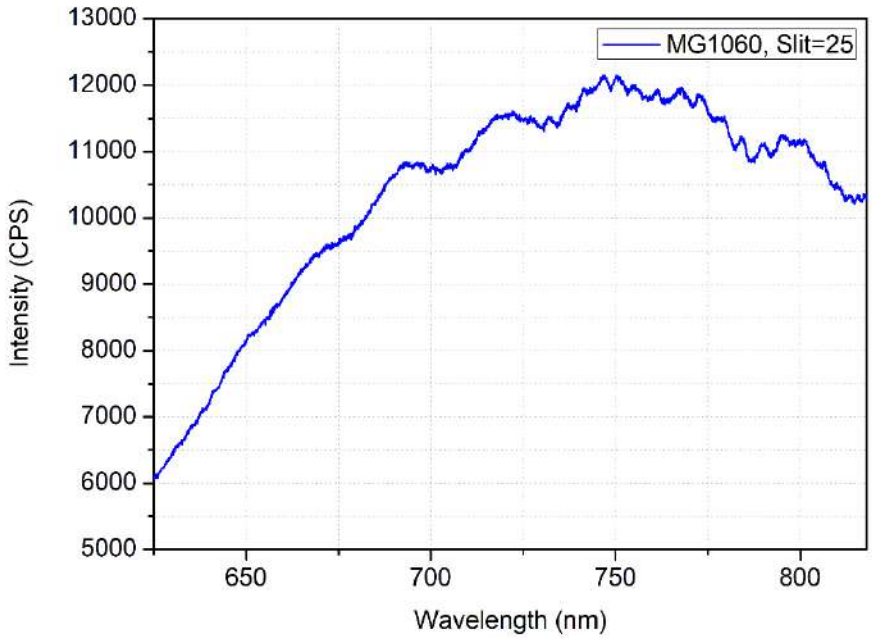


Figure 1. MG1060 response curve for halogen lamp

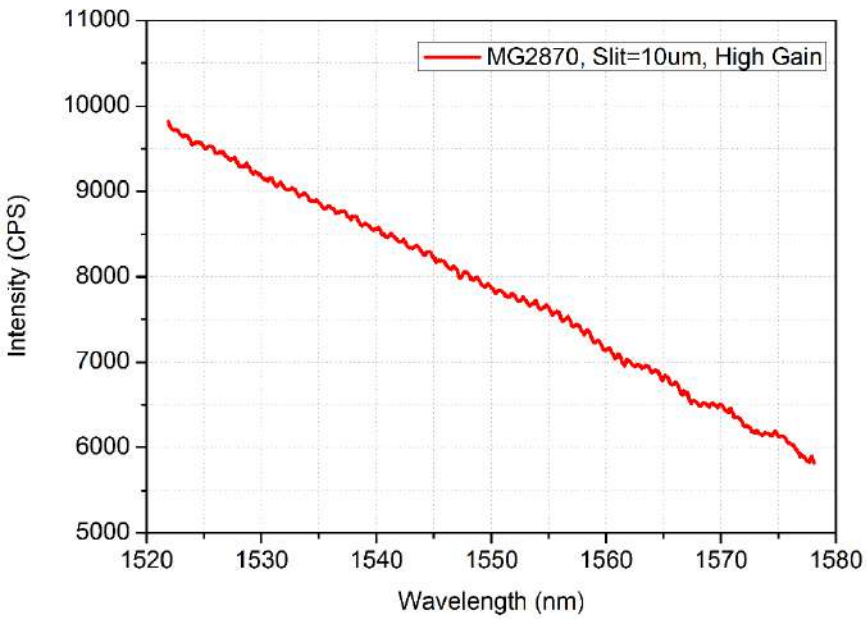


Figure 2. MG2870 response curve for halogen lamp

Key Features

► 2.1 Characteristics

- MG-VIS supports customizable wavelength range within 180-1100nm
- MG-NIR supports customizable wavelength range within 900-1700nm/900-2200nm
- Ultra-high resolution: MG-V32 <0.35nm (slid width: 25um)
  MG-NIRT6 <0. 25nm (slid width: 10um)
- Available in two types of image sensors for different applications:
  - 2048-pixel CCD sensor
  - 256-/512-pixel InGaAs sensor
- Customizable modular components: grating, image sensor, and inlet slit width
- Integration time: MG1060: 5ms-24s; MG2870: 0.1ms-24s
- 16 bit, 15MHz A/D converter
- USB 2.0 @ 480 Mbps (High Speed)
- An 8-pin external I/O port for connecting external devices
  - 6 digital input/output data acquisition pins
- Plug-n-Play computer application support
- Ultra-precise continuous exposure, holding up to 4,000 records of spectrum data in memory
- Flash ROM storage
  - Wavelength calibration coefficients
  - Linear calibration coefficients
  - Intensity calibration coefficients

► 2.2 Specifications

Features		Specifications		
		MG1060S	MG2870S	
Image sensor		2048-pixel back-thinned CCD	512-pixel InGaAs sensor	
Dark noise		16	High gain	Low gain
			8.5	6.5
Dynamic range		5000	High gain	Low gain
			7700	10000
SNR		500	High gain	Low gain
			2700	4900
Wavelength range		Customizable range within 180-1100nm	Customizable range within 900-1700nm	
Optical system characteristics		f/#: 5, NA: 0.1, Focal Length (R1-R2): 85-101.5 Recommendation: the inlet numerical aperture (NA) of the user's design should be higher than that of the spectrometer		
Optical bench		Czerny-Turner optical bench, 2nd and 3rd harmonics removed		
Dimensions		199(L) x 170(W) x 64.5(H) mm		
Grating		1000g 900nm	600g 1200nm 830g 1200nm	
Slit width		10/25μm		
Integration time		5ms-24s	0.1ms-24s	
Resolution		Depending on the combination of slid width, grating, and wavelnegth range		
Fiber optic interface		SMA905, FCPC		
Environmental requirements	Storage temperature	-30°C to +70°C		
	Operating temperature	0°C to +50°C		
	Relative humidity	0% - 90% (non-condensing)		
Data transfer interface		USB 2.0 @ 480 Mbps (High Speed)		
Power specifications		Powered by USB: 300mA at +5VDC Supported voltage: 4.75-5.25V		

Mechanical Designs

► 3.1 Mechanical Drawing

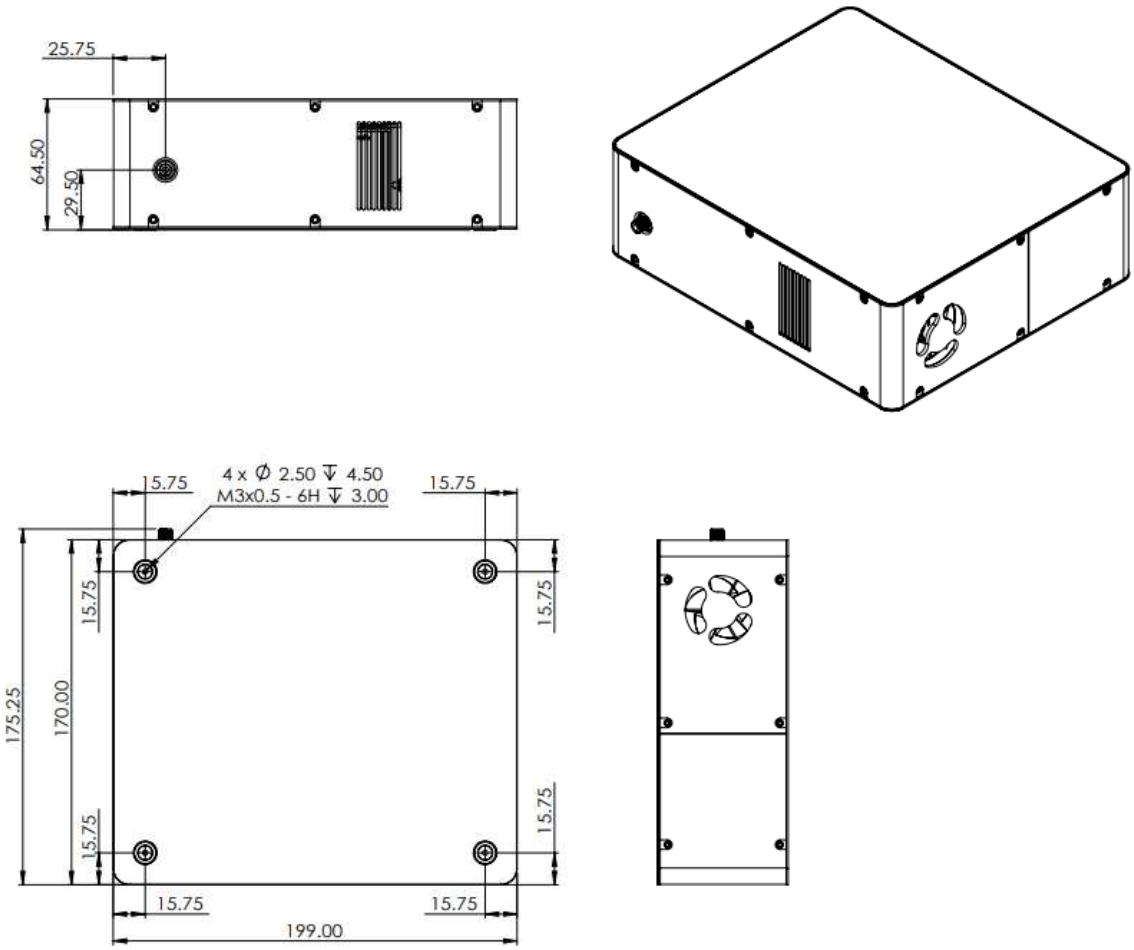


Figure 4. MG & MG-NIR Series Dimensions (SMA905)

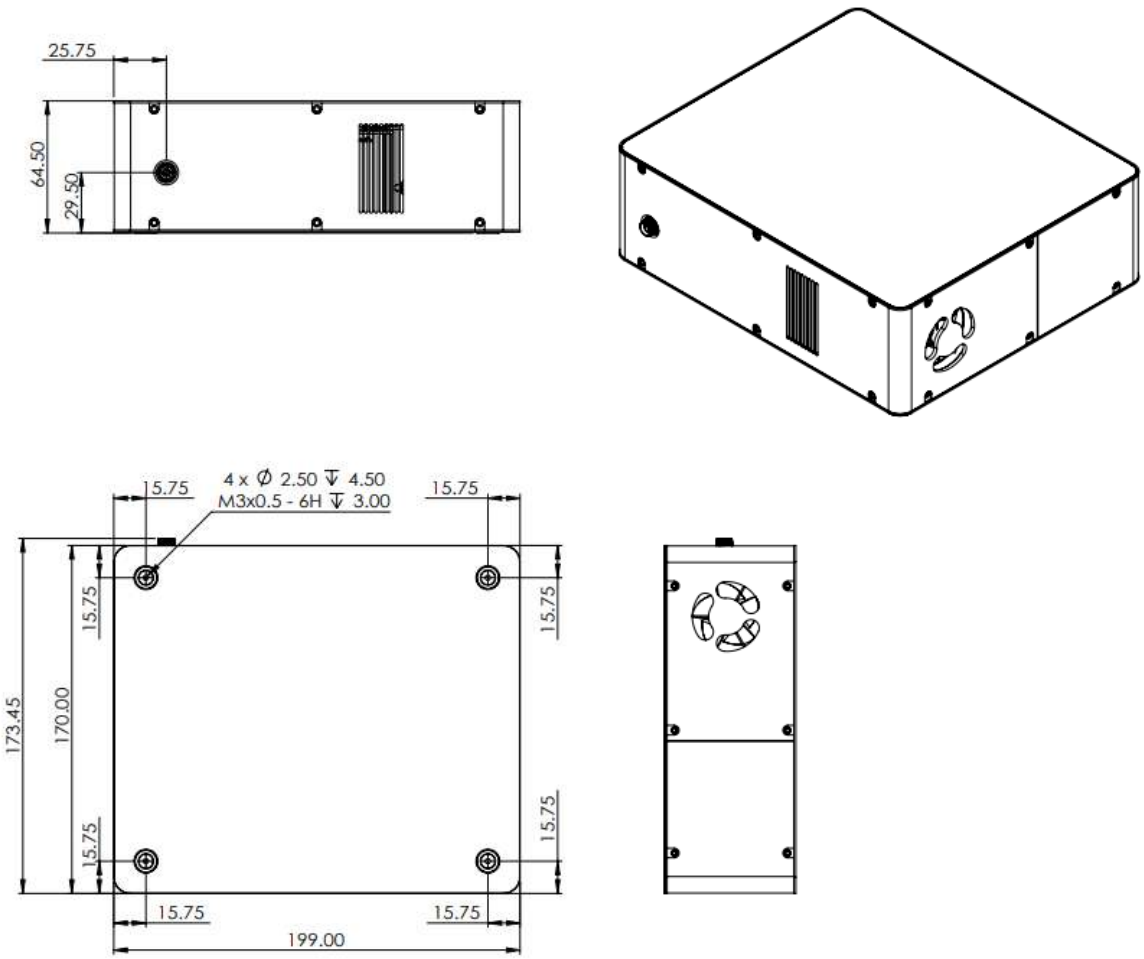
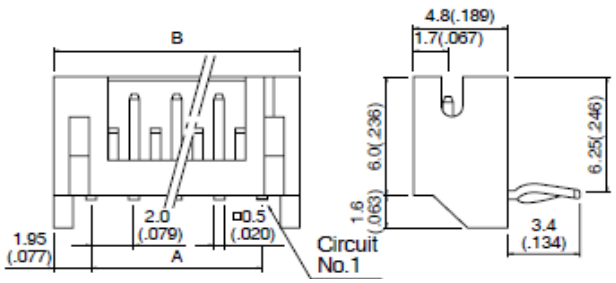


Figure 5. MG & MG-NIR Series Dimensions (FC/PC)

► 3.2 Electronic Output Pin Assignments

The MG & MG-NIR Series provide an 8-pin 2.0 mm rear external I/O port.

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

Figure 6. The 8-pin 2.0 mm rear external I/O port

External Ports

The following pictures show the external ports on the MG & MG-NIR series. Viewing from left to right: the PC USB and the rear external ports.

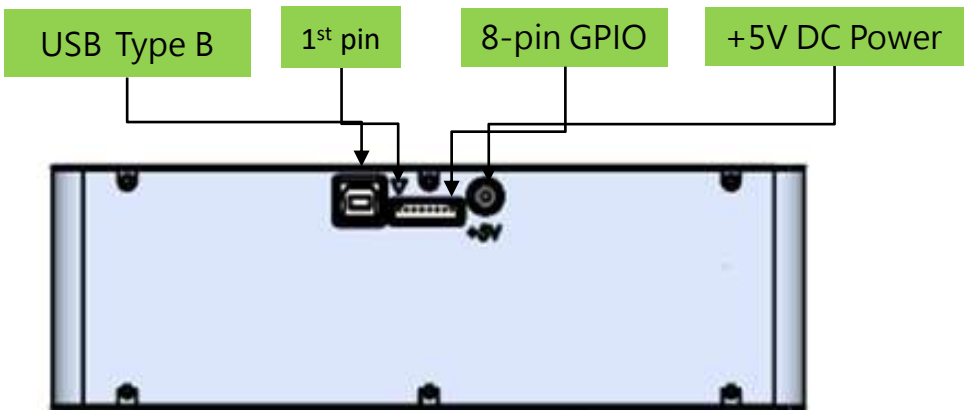


Figure 7. External ports on the MG & MG-NIR Series.

Pin Assignments on the External I/O Port

Pin number	I/O direction	Pin name	Description
1	Power	5V Input/Output	When the spectrometer is connected via USB to a computer, this pin connects to the VBUS so that the spectrometer can provide 0.1A of power to the external device
2	Output	TX	UART TX. TX is the output from the RISC microcontroller
3	Input	RX	UART RX. RX is the input to the RISC microcontroller
4	Output	GPIO0	General purpose output #0
5	Output	GPIO1	General purpose output #1
6	Output	LS_ON	Lamp on
7	Input	Trigger_IN	External trigger signal
8	GND	GND	Grounding

► 3.3 Sensor Overview

- **Sensor / System Noise**

The three key factors that affect the noise level of the output signal are: stability of the light source, electronic noise, and the sensor noise. Excluding the effect of the external light source, the first thing to check is the dark noise of the measurement system. Dark noise is defined as the voltage output (Vout RMS) over a period of 10 ms integration time in a completely dark environment. So the dark noise level is solely determined by the electronic noise in the readout and the CCD sensor itself.

Another way to determine the quality of the signal is signal-to-noise ratio (SNR). SNR is defined as the maximum signal level (65535) divided by RMS. Higher SNR means the signal is cleaner, and differences between signals are more discernible when signal levels are low.

- **Signal Averaging**

In general, there are two ways to obtain a smooth curve for a signal: signal averaging and boxcar filter. Signal averaging can reduce the influence of noise on individual pixels. It is natural that increasing the number of samples taken for averaging creates a better averaged curve, but then it takes more time get the final spectrum. On the time-based curve, the signal-to-noise ratio (SNR) increases in proportion to the square root of the number of samples taken. For example, if the number of samples taken is 100, the SNR is increased 10 times.

The second method, boxcar filter, uses neighboring pixels for averaging to get a smooth curve for the signal, but it negatively impacts the optical resolution. This method is not recommended if you need to find the peak values of the signal. These two methods can be combined together in a single measurement if required.

Operations

► 4.1 Pixel Signal Intensity

The spectrometer is shipped with a baseline signal intensity at 1,000 counts. In cases where the user needs to modify this baseline intensity, it can be done using control commands. There is a command for the user to adjust the AFE OFFSET. Another way to change the baseline signal intensity is to use the "background removal" feature in the software. Which one to use depends on the way the user wants to use the baseline signal intensity.

► 4.2 Digital Input/Output

General purpose input/output (GPIO)

The MG & MG-NIR Series come with six 3.3V digital input/output pins that can be used for data acquisition on the 8-pin external I/O port. Using software, these I/O pins can be defined for different application purposes. To support some OEM customization needs, the MG & MG-NIR Series provide the flexibility to use a special clock generator (such as single pulse or PWM).

GPIO recommended voltages:

VIL(max) = 0.8V

VIH(min) = 2.0V

GPIO maximum/minimum voltages:

VIN(min) = -0.3V

VIN(max) = 5.5V

Data transfer interface

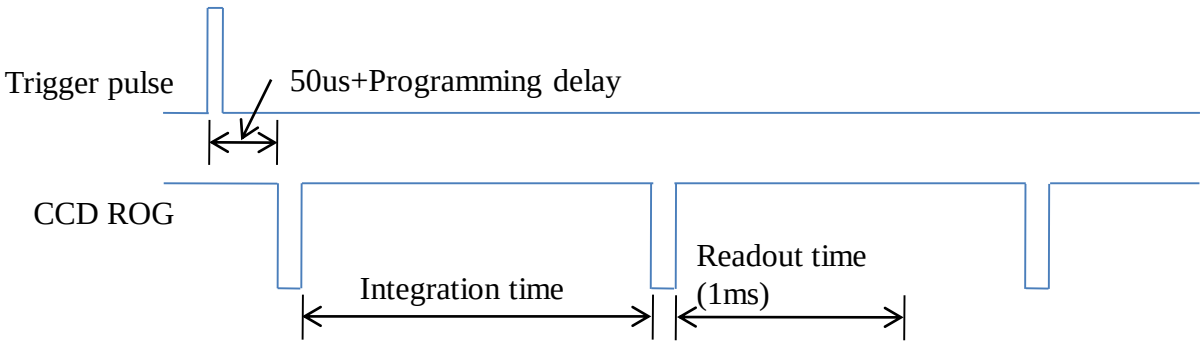
USB 2.0

The 480Mbit/s USB (Universal Serial Bus) is a widely used data transfer standard for computers. The spectrometer control software provided by OtO Photonics uses USB to connect to multiple MG & MG-NIR Series spectrometers. The energy-saving MG & MG-NIR Series can be powered via a USB cable over its VBUS line.

► 4.3 Trigger Modes

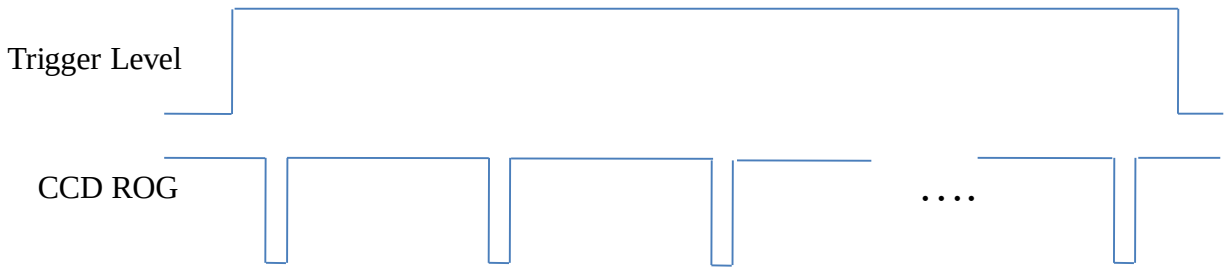
- **Single trigger/single capture**

In the single trigger/single capture mode (with preconfigured integration time), the spectrometer waits for a trigger pulse and captures the spectrum once upon receiving the trigger pulse. It can be triggered on a rising edge or a falling edge. An integration time programming delay can also be configured.



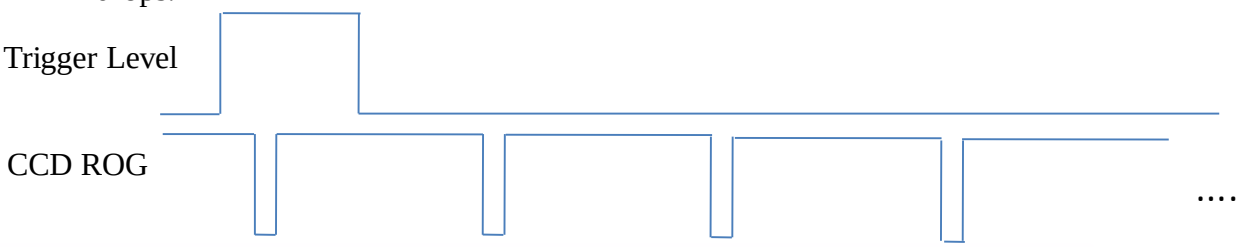
- **Software trigger**

In the software trigger mode (with preconfigured integration time), the spectrometer waits for the external trigger signal level to go up then starts and continues to capture the spectrum using preconfigured integration time till the signal level drops.



- **Software trigger/multiple capture**

In the software trigger/multiple capture mode (with preconfigured integration time and software commands to capture the spectrum), the spectrometer continues to capture the spectrum with the preconfigured integration time even when the trigger pulse drops.



USB Data Transfer and Controls

► Overview

The MG & MG-NIR Series are compact spectrometers with an embedded microcontroller and supports USB data transfer. This section provides the computer programming details on how to control the MG & MG-NIR Series vial USB. This information is intended only for those who intend to develop their own software instead of using the standard software provided by OtO Photonics (SpectraSmart).

Hardware Description

The MG & MG-NIR Series leverage the built-in 32-bit RISC microcontroller in the USB 2.0 chip. The program codes and data are stored in the SPI Flash. This RISC microcontroller provides 64MByte of DDR and 64Mbits of Flash.

- **USB Information**

MG & MG-NIR Series USB Vendor ID: 0x0638; Product ID: 0x0AAC. The MG & MG-NIR Series support USB 2.0 connection and use USB bulk streams for data transfer between the spectrometer and the computer. For more information on USB, please visit the USBIF website: http://www.usb.org.

- **Programming Guide**

Application Programming Interface (API)

The following section provides a list of APIs and their functions.

☐ Open MG or MG-NIR Series Spectrometer

Description: Connecting the computer to an MG or MG-NIR Series spectrometer.

a.Function name: UAI_SpectrometerOpen

b.Parameters:

dev: Since one computer can connect up to eight MG or MG-NIR Series spectrometers simultaneously, the 'dev' parameter specifies which device to connect to.

handle: A unique identifier returned by the API to identify the connected spectrometer. Each connected device is assigned a different handle. This handle is used by the API to identify which device to control in subsequent operations.

☐ Get Frame Size

Description: Getting the frame size of the sensor in the spectrometer.
a.Function name: UAI_SpectromoduleGetFrameSize
b.Parameters:

device_handle: The unique identifier for the spectrometer to be controlled.
size: Returning the frame size in 32-bit format.

☐ Acquire Wavelengths

Description: Starting to acquire wavelengths. The MG or MG-NIR Series can acquire the complete distribution of wavelengths.
a.Function name: UAI_SpectrometerWavelengthAcquire
b.Parameters:

device_handle: The unique identifier for the spectrometer to be controlled.
buffer: The buffer to receive the data acquired.

☐ Acquire Spectrum

Description: Starting to acquire the spectrum. The MG or MG-NIR Series can acquire the complete spectrum corresponding to the data acquired by the "UAI_SpectrometerWavelengthAcquire" function.

a. **Function name:** UAI_SpectrometerDataAcquire
b. **Parameters:**

device_handle: The unique identifier for the spectrometer to be controlled.

integration_time_us: Specifying the integration time in 32-bit format (μs).

buffer: The buffer to receive the data acquired.

average: The number of samples to take for signal averaging to reduce noise.

☐ Get Wavelength Range

Description: Getting the supported maximum and minimum wavelengths.

a. Function name: UAI_SpectromoduleGetWavelengthStart

UAI_SpectromoduleGetWavelengthEnd

b. Parameters:

device_handle: The unique identifier for the spectrometer to be controlled.

lambda: Returning the maximum/minimum wavelength (nm) supported by the MG or MG-NIR Series in 32-bit format.

☐ Get Integration Time Range

Description: Getting the maximum/minimum integration time.

a.Function name: UAI_SpectromoduleGetMaximumIntegrationTime
UAI_SpectromoduleGetMinimumIntegrationTime

b.Parameters:

device_handle: The unique identifier for the spectrometer to be controlled.

Integration Time: Returning the maximum/minimum integration time supported by the MG or MG-NIR Series in 32-bit format. Note: The minimum integration time is specified in microseconds (μs). The maximum integration time is specified in miliseconds (ms).

☐ Close MG or MG-NIR Series Spectrometer

Description: Disconnect the computer from the MG or MG-NIR Series spectrometer.

a.Function name: UAI_SpectrometerClose

b.Parameters:

handle: The unique identifier for the spectrometer to be disconnected. The disconnected spectrometer will stop all of its operations when this command is executed.