

OtO Photonics

AA Series Datasheet



Description

AirAlliance™ Series (AA Series) Spectrometer is equipped with Wi-Fi wireless communication module and designed based on mainstream spectrometer product of OtO photonics. Due to the Wi-Fi function, optimized optical engine, the advantage of miniaturized mechanism and simple optical layout, AA Series Spectrometer shows outstanding of elastic using and will bring you an unsurpassed level of flexibility.

The user can choose the type depend on the need of spectral response range, sensitivity, signal noise ratio and portability. AA Series Spectrometer is built with one linear CCD or CMOS (AA2030) type sensor. The optical bench is very rigid and stable for measurement system, provide the high optical resolution, high sensitivity, low stray light, and fast spectral response.

Optical engines of AA2030/2040 are identical with SE2030/2040. Due to Czerny-Turner optical design, the performances of resolution, sensitivity, stray light, spectral response are extremely excellent.

AA Series electronics operation is controlled by the RISC controller. So the user can communicate to the main program through the PC software and the protocol provided by OtO Photonics. We provide the related information and the detailed instructions of how to operate with AA Series in this guide. The optical detector used in AA Series spectrometer is a high-sensitivity Sony/Hamamatsu CCD/CMOS array sensor. (For complete details on these detector, please visit Sony/Hamamatsu web site)

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AA Series-003 Rev.1
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Attention

Picture	Description
	<p>To prevent over tightening and <u>damaging of the slit</u> in the spectrometer. Please Hand tightening the optical fiber only. Do not use any tool including wrench to tighten up the optical fiber and SMA905 connector.</p> <p>Apply adhesive to optical fiber connector after hand tightening is recommended if the fiber needs to be fixed robustly for a long time operation.</p>

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Overview

1.1 Lineup of AA Series

Model	Spectral Response Range (nm)						SNR ^{*1}	Dynamic Range ^{*2}	A/D	Stray Light	Thermal Stability
	DUVN	FUV	V2	FUVN	VNIR	NIR1					
	200	180	330	180	350	790					
	∞	∞	∞	∞	∞	∞					
	1025	850	850	1100	1020	1010					
AA2030	√		√		√	√	330	3450 / 3000	16 Bits	<0.2%	<0.04nm/°C
AA2040	√		√		√		200	2200			

*1 : Single acquisition

*2 : 65535/Dark Noise(average)

1.2 Efficiency Output Comparison

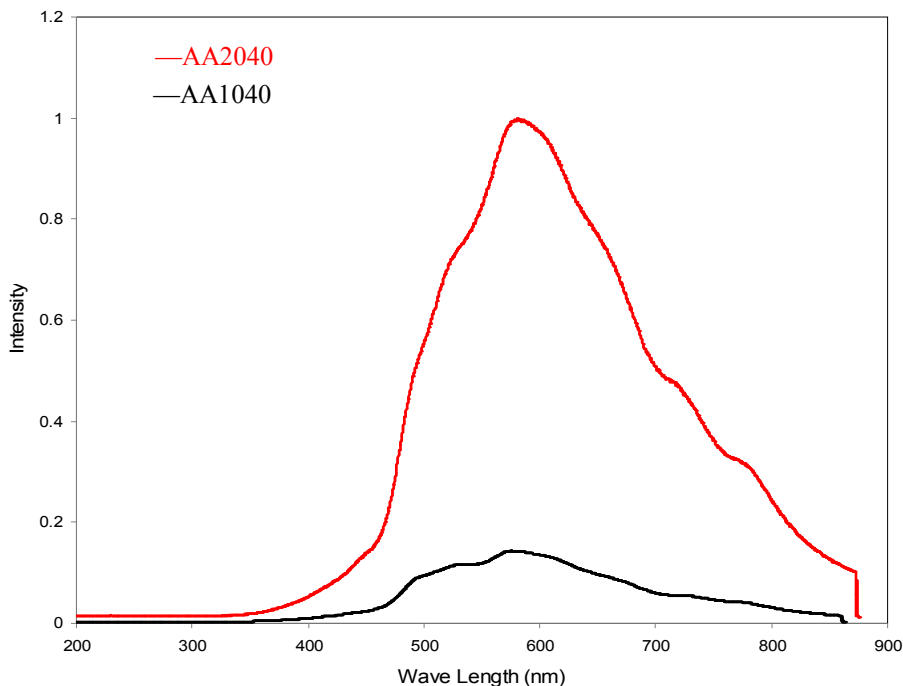


Fig. 1: AA2040 and AA1040 Comparison Plot

- New optical design spectrometer of AA2040 shows 7.5 times efficiency toward AA1040 spectrometer.

■ Main Features

▶ 2.1 Feature

- Built-in Wi-Fi module, compatible with 2.4GHz 802.11b/g/n.
- Able to connect with Android system smartphone or tablet.
- Wi-Fi Operation mode can be set as the AP or Client mode
 - AP mode : AA series can connect up to 5 devices to the machine at the same time.
 - Client mode : The number of connect devices is depending on DHCP setting of AP.
- Spectral Response Range (nm)
 - 180~1100 nm
- Optical resolution:
 - 0.2 ~ 10.5 nm, depending on the combination of various slits from 10um to 300um and gratings.
- External port interface :
 - 8 pin connector
- Integration times
 - 0.2 ms ~ 65 second (depending on sensors)
- Calibration Coefficients stored in Flash ROM
 - Wavelength Calibration Coefficients
 - Linearity Correction Coefficients
 - Intensity calibration coefficients
- Able to modular configuration with various grating, sensor, and slit options.

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► 2.2 Specification

Specification	Content	
	AA2030	AA2040
Spectrometer	Czerny-Turner Optical Structure 2nd & 3rd order rejection	
Dimension	130(L) x 86.5(W) x 33.75(H) mm	
Grating	15 grating options spectral range from UV to NIR	
Parameters of Optical System	f/# : 5 NA :0.1 Focal Length(R1-R2) :60-60	
Detector	CMOS Hamamatsu S11639	CCD Sony ILX554B
Wavelength	From 180 to 1100 nm with a variety of wavelength range	
Slit size	10, 25, 50, 100, 200, 300 um	
Integration time	0.2ms ~ 65sec	
Dark Noise (Upper Limit)	30* ¹ 36* ²	34
Dynamic range (avg.)* ³	3450:1* ¹ 3000:1* ²	2200:1
Signal to noise ratio* ⁴	330	200
Wavelength repeatability	+/- 0.05 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.)	

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Specification	Value	
	AA2030	AA2040
Resolution (FWHM)	From 0.2 nm to 10.5 nm, depending on different modular configuration	
Input fiber connector	SMA905: $\Phi 3.18 \pm 0.005$ mm	
	SMA905: $\Phi 3.20 \pm 0.01$ mm	
Wi-Fi Board	WGM110	
Compatible	2.4GHz 802.11b/g/n	
Operation mode	AP mode : Connect devices up to 5 devices Client mode : The number of connect devices is depending on DHCP setting of AP.	
Wi-Fi Operation Range	~30 meter	
Wi-Fi transfer interphase	UART (up to 230400 bps)	
Transfer Rate	~4.6 fps	
Wi-Fi Blue LED	Blinking: Wi-Fi operation	
Green LED	Power On indicator	
Red LED	Blinking: on charging	
Orange LED	low battery indicator	
Interfaces	USB 2.0 type B@ 480 Mbps	
Power	Li-ion Battery 3300mAh, charge from USB Power Consumption :2W (400mA @5V)(4 hours operation) Supply voltage : 5V +/- 5% Maximum USB input power Vcc : +5.25VDC Maximum I/O signal voltage : +5.5VDC	

- Customized design for your various special requirements including higher resolution, specific wavelength range, higher SNR, special gratings or sensors not in the list, specific software or hardware design, or special exposure modes, is welcome and will be elaborately built and tested by our R&D team.

■ Structure

▶ 3.1 Mechanical Diagram - AA2030/2040

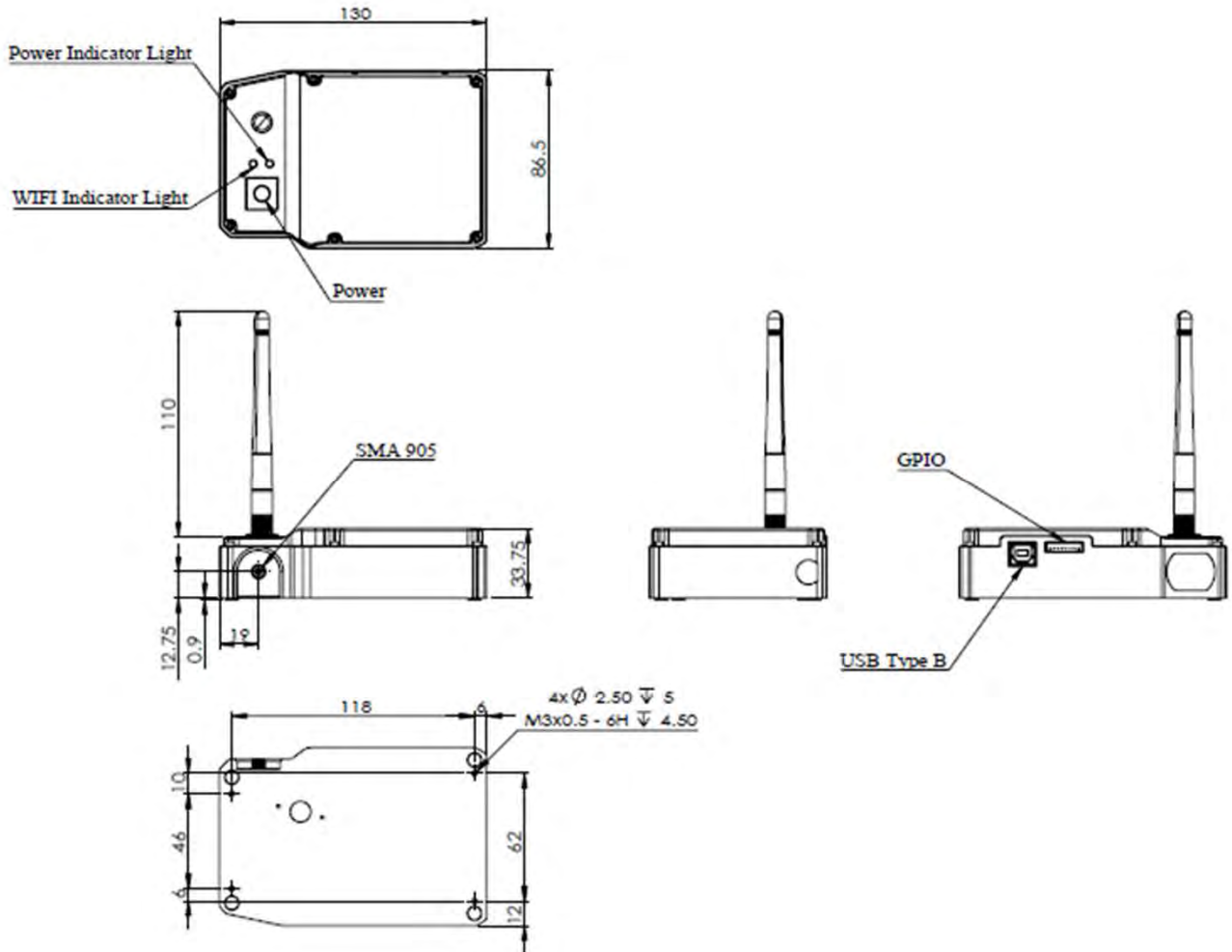


Fig. 2: AA2030/2040 outer dimensions

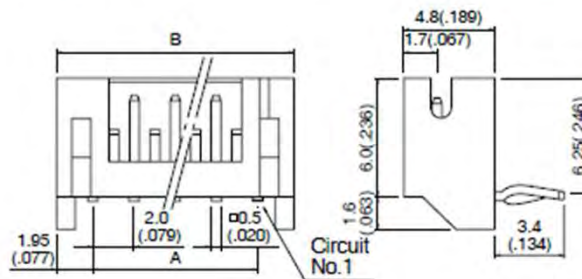
AA2030/2040 LED indicator description

LED Indicator	color	description
Power Indicator Light	green	Power on
	red	Blinking: on charging
	orange	low battery
Wi-Fi Indicator Light	blue	Blinking: Wi-Fi operation

► 3.2 Electrical Pinout-AA2030/2040

The following listed is the pin description for the AA2030/2040 Series Extension Connectors. The Back Extension Port is a 8 pin 2.0mm connector.

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. 3 : 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 AA2020/2030/2040 connector side, from left to right are PC USB Type B and Back Extension Port.

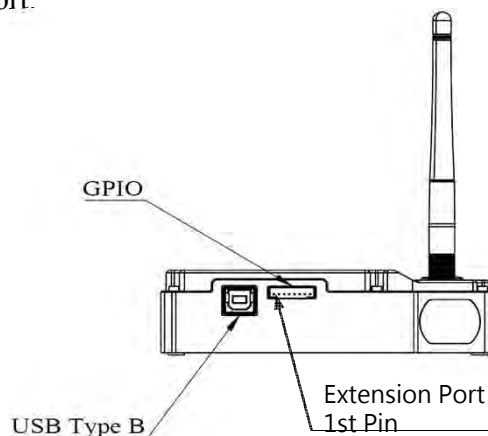


Fig. 4 : Front-view of connector mechanical graph of AA2030/2040

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► 3.3 CCD Overview

● CCD /CMOS DETECTOR

Sony ILX554B and Hamamatsu S11639 are rectangular reduction type CCD/ CMOS linear image sensor designed for optical measuring equipment use. A built-in timing generator and clock-drivers ensure single 5V power supply for use.

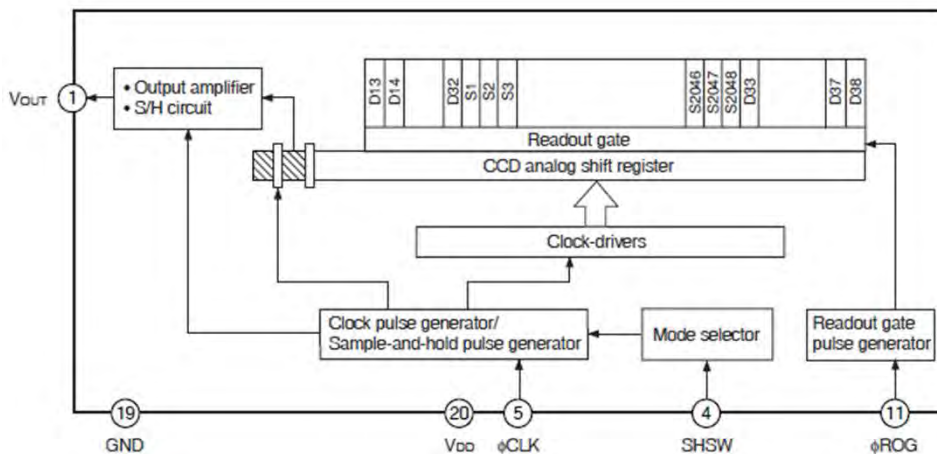


Fig. 5: ILX554B CCD Block Diagram

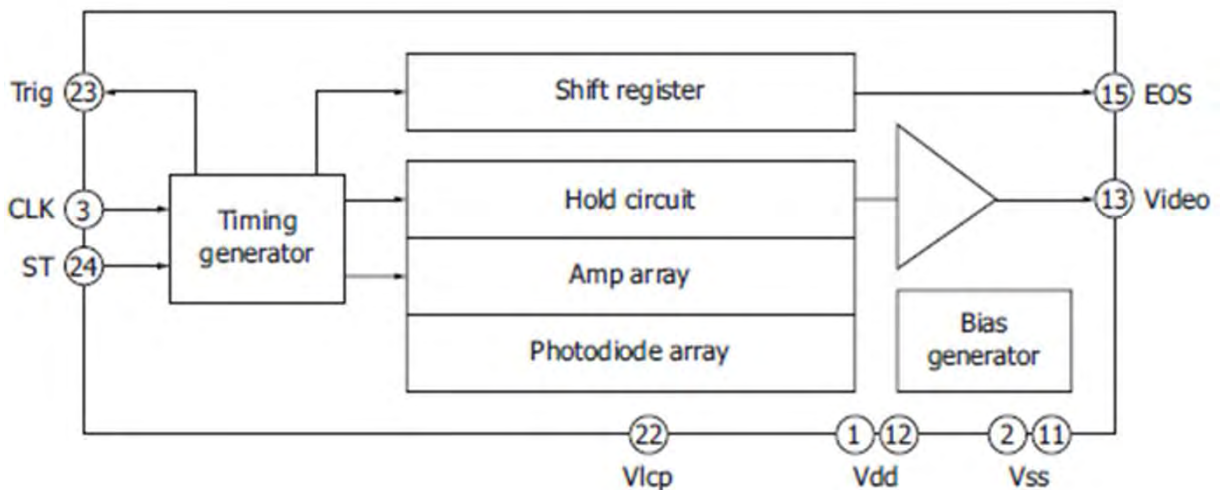


Fig. 6: S11639 CMOS Block Diagram

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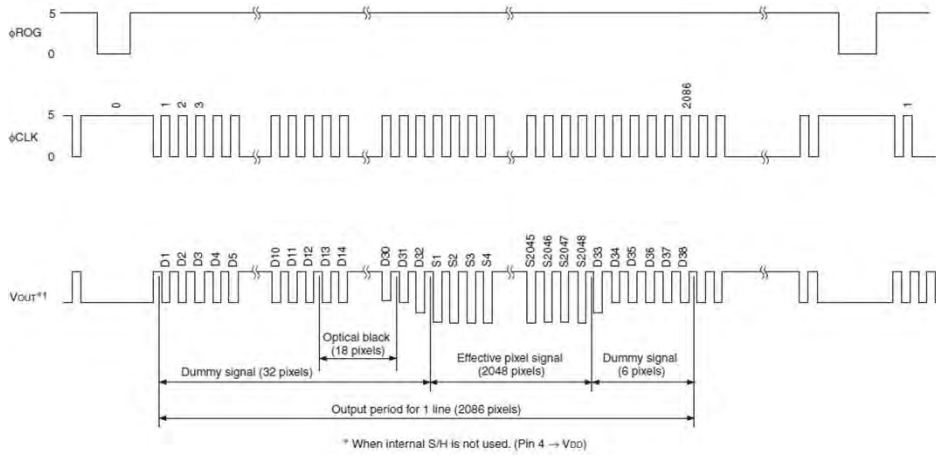


Fig.7: CCD ILX554B SH operation timing waveform

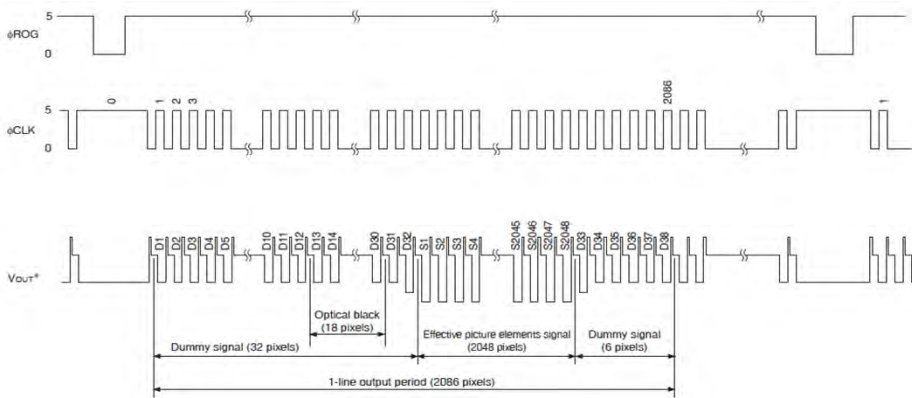


Fig.8: CCD LX554B CDS operation timing waveform

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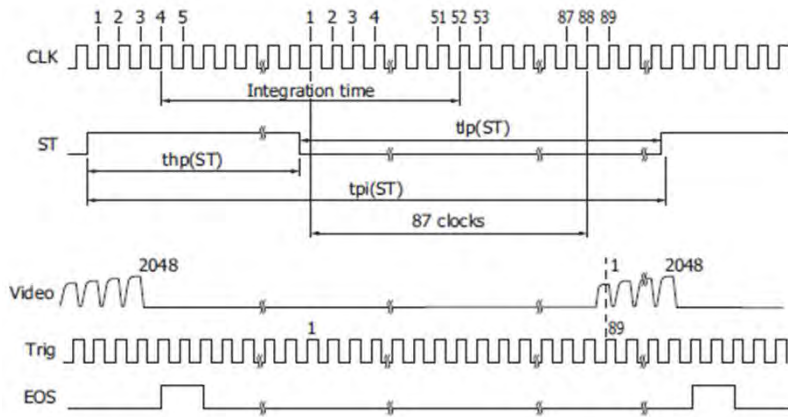


Fig.9: CMOS S11639 operation timing waveform

There are two operation modes in this Sony CCD. One is sample & hold mode, the other is the CDS mode. Fig.8 timing chart is running without the sample/hold mode. There is one reset level during each clock cycle. AA Series is operated under this mode. The corresponding AFE (Analog Front End) device needs to be run at CDS mode. (Correlated Double Sample) Fig 7 & 8 is AA2040 and Fig.9 is AA2030 operation timing waveform.

The CCD operation sequence is exposed-transferred-readout. We need to perform the integration time first, then, read the Vout in the next cycle. The operation is like pipeline. The Vout signal shows in the top waveform actually is the exposed result in the previous cycle. The output signal is almost proportion to the integration time. When the light power or integration time is long enough to fully charge the pixel, the CCD output will be saturated. Per the characteristic of this CCD sensor, like ILX554B CCD, the over-saturated condition will cause the signal to be reversed.

● 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

▶ 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.

- The following table is a description of all of the pixels

AA2040	
Pixel	Description
1–12	Dummy pixels
13–30	Optical black pixels
31–32	Dummy pixels
33–2080	Optical black pixels
2081-2086	Dummy pixels

▶ 4.2 Digital Inputs & Outputs

● General Purpose Inputs/Outputs (GPIO)

AA2030/2040 has 6 user programmable 3.3V digital Input/Output pins, which can be accessed at the 6 or 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), AA Series provides the flexibility to implement this.

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GPIO Recommended Operating Levels:

$$V_{IL}(\max) = 0.8V$$

$$V_{IH}(\min) = 2.0V$$

GPIO Absolute Maximum/Minimum Ratings are as follows:

$$V_{IN}(\min) = -0.3V$$

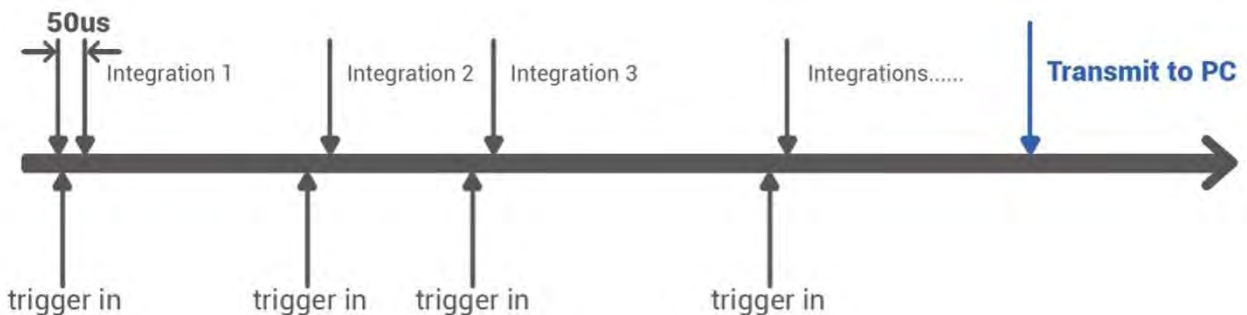
$$V_{IN}(\max) = 5.5V$$

- **Communication and Interface**

USB 2.0

480-Mbit Universal Serial Bus is the standard and popular communication interface in PC. Our PC software allows connecting multiple AA Series via USB and monitors multiple AA Series spectra. The low power requirement allows operating the AA 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

■ USB Port Interface Communications and Control Information

▶ 5.1 Overview

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

● Hardware Description

AA 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 64 MByte DDR and 64Mbits Flash.

● USB Info

AA Series USB Vendor ID number is 0x0638 and the Product ID is 0x0AAC. AA 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 AA Series Spectrometer

Description: To connect Windows host to AA Series

Function Name: UAI_SpectrometerOpen

Arguments:

dev: 8 AA 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.

Function Name: UAI_SpectromoduleGetFrameSize

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. AA Series will acquire a complete wavelength distribution.

Function Name: UAI_SpectrometerWavelengthAcquire

Arguments:

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

buffer: the storage buffer acquired data.

□ Acquire Spectra

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

Function Name: UAI_SpectrometerDataAcquire

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 AA Series will be returned.

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

❑ Close AA Series Spectrometer

Description: To connect Windows host to AA 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.

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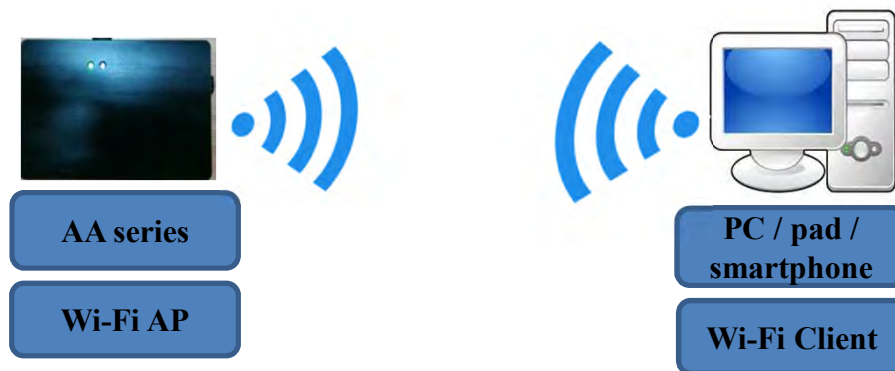
■ Wi-Fi Operation Mode

▶ 6.1 Wi-Fi Client Mode



AA series can be set as the Wi-Fi-Client mode through the OtO PC software. Once the AA Series is set Wi-Fi Client mode successfully, then it can be put at the operation area to monitor the spectrum. After the AA series is powered up, the Wi-Fi module will automatically link to the configured AP in the working area. When it's linked correctly, the user can use the computer to link to the AA Series. Start to measure the spectrum and do the application.

▶ 6.2 Wi-Fi AP mode

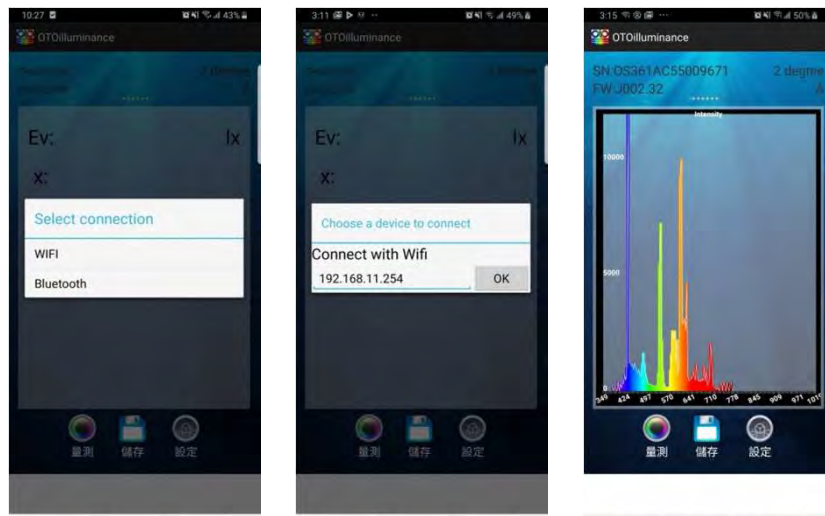


AA series be set as the Wi-Fi AP mode through the OtO PC software. Once the AA series is set Wi-Fi AP mode successfully, then it can be put at the operation area to monitor the spectrum. After the AA series is powered up, the user can use the laptop to change the Wi-Fi AP to the AA series, then link with it. The user can start to measure the spectrum and do the application.

► 6.3 Connect with Android system device

It is able to connect and control AA series to measure the spectrum with Android system device such as smart phone or tablet. OtO can provide App and source code compatible with Android system to meet the need of customers.

□ Sample APP for Android system



□ Example of Source Code

```
public static Byte[] getFWVersion = { 0x09, 0x4F, 0x46, 0x56 };
public static Byte[] spectrumAcquire = { 0x09, 0x4F, 0x53, 0x51 };
public static Byte[] wavelengthAcquire = { 0x09, 0x4F, 0x57, 0x51 };
public static Byte[] getFramesize = { 0x09, 0x4F, 0x46, 0x4f };
public static Byte[] setAutoIntegrationTime = { 0x09, 0x4F, 0x61, 0x74 };
public static Byte[] getSerialNumber = { 0x09, 0x4F, 0x53, 0x4E };
public static Byte[] getModelName = { 0x09, 0x4F, 0x4D, 0x4E };
.....
```

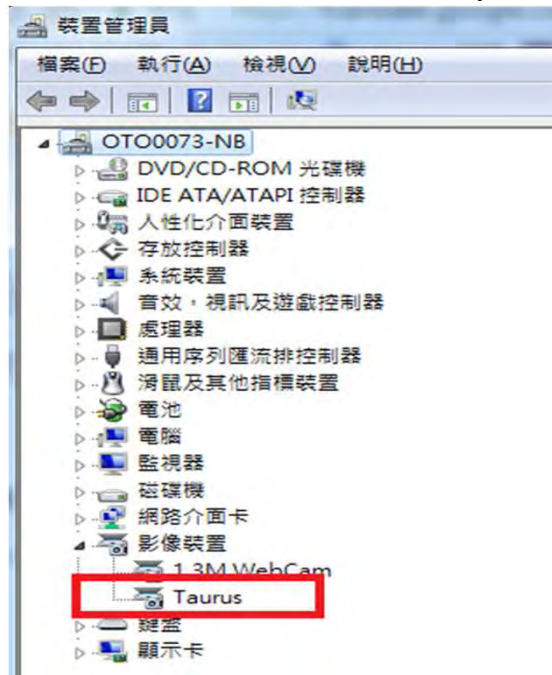
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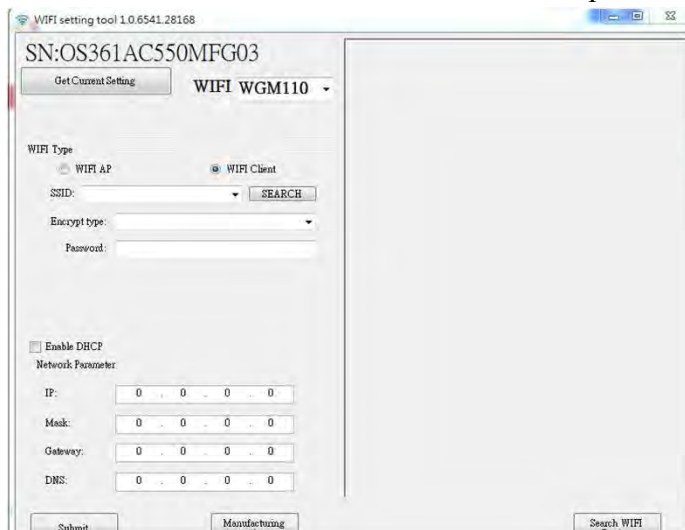
■ Wi-Fi Setting Tool Operation

▶ 7.1 Wi-Fi Setting Tool Operation

Step.1 Turn on AA Series spectrometer by connecting PC via USB. User will see there is one new device named “Taurus” in Device Manager which means AA series spectrometer connects with PC successfully.



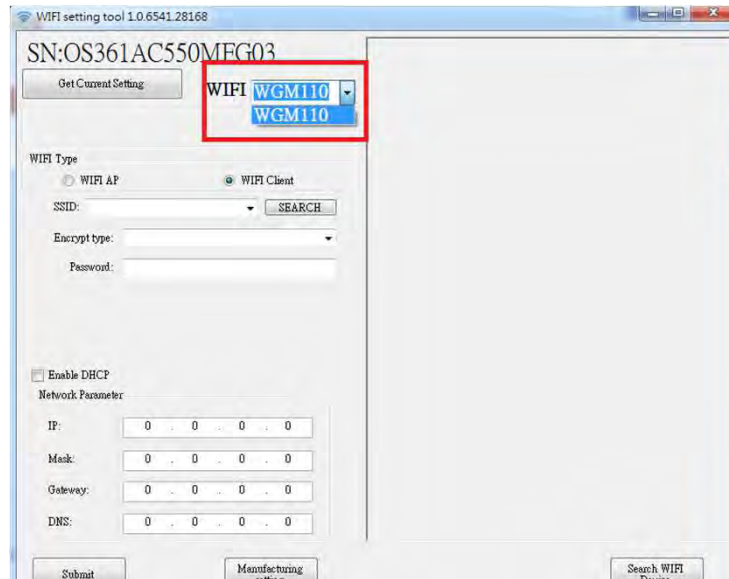
Step.2 Open WIFISetting tool.exe file, you will see the picture shown below. SN:OS361AC55XXXXXX is the serial number of the spectrometer.



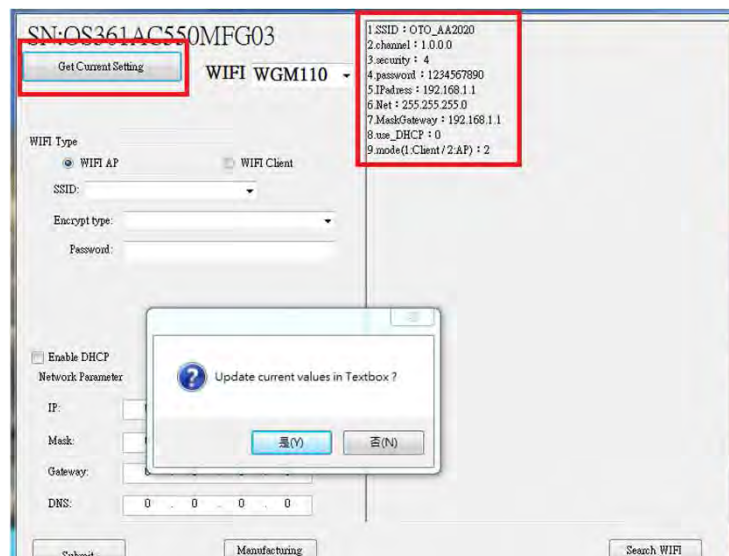
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Step.3 Select “WGM110” as the WIFI field



Step.4 Click “Get Current Setting” and the Wi-Fi setting parameters of current spectrometer will be shown in the right column window.

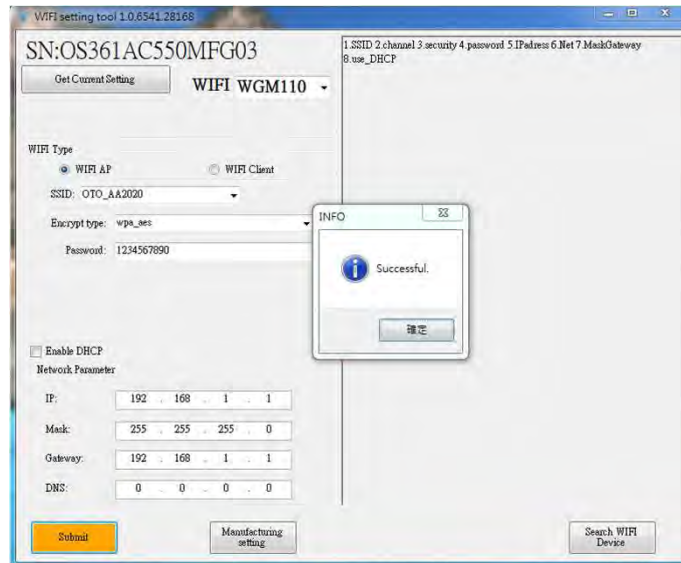


Step.5 User can choose if you would like to fill in those current parameters in the left column window.

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Step.6 When you finish setting, press “Submit”, you will see the picture shown below.



Step.7 Close WIFISetting tool.exe (If user want to set again, user must restart the program procedures) and check your PC’s wireless network device if OTO_AAxxxx is connected. When AAxxxx is connected, user can start the measurement via SpectraSmart or your own device.

Parameters Explanation

WIFI Type	Wi-Fi work type
WIFI AP	Access Point mode is used to connect to wireless clients(wireless adapter cards) such as laptops, desktops, and PDAs. Wireless clients can only communicate to AP's in Access Point mode
WIFI Client	AP Client or Wireless Client mode allows the Access Point to become a wireless client to another AP. In essence the AP has now become a wireless adapter card. User would use this mode to allow an AP to communicate with another AP
SSID	Service Set Identifier, The name of the wireless network
Encrypt type	Password encryption type
Password	Wireless network password
Enable DHCP	Enable or Disable DHCP. (when you enable DHCP, you will not be able to set the IP address)
Network Parameter	set IP address