FL 26BW

User Manual

V1.0.0

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Contents

1. Introduction

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Tucsen Photonics Co., Ltd.

1.2. Safety and warning information

Operation and Use

 Caution	● Do not drop, disassemble, repair or replace internal components on your own. such action may damage the camera components or cause personal injury. ● In the event of spillage on the equipment, please the equipment and immediately contact the nearest dealer or manufacturer for technical assistance. ● Do not touch the device with wet hands, as it may cause electric shock. ● Do not let children touch the device without supervision. ● Ensure that the temperature of the camera is within the specified temperature range for use to avoid damage.

Installation and maintenance

 Caution	● Please do not install it in dusty and dirty areas or near air conditioning or heaters to reduce the risk of camera damage. ● Avoid installation and operation in extreme environments such as vibration, high temperature, humidity, dust, strong magnetic fields, explosive/corrosive gases or gases. ● Do not apply excessive vibration and impact to the equipment. This may damage the equipment. ● Do not install equipment under unstable lighting conditions. Severe lighting changes can affect the quality of the images generated by the device, avoiding high-energy lasers directly hitting the camera chip. ● Do not use solvents or diluents to clean the surface of the equipment, as this will damage the surface of the casing. ● Please ensure that there is at least 10 cm of space around the device ventilation opening to ensure airflow flow. Do not block the ventilation openings of the equipment during use, otherwise it may cause internal temperature to be too high and damage the equipment.

Power

 Caution	● Please use the original power adapter of the camera, as using an mismatched power source may damage the camera. ● If the voltage applied to the camera is greater than or less than the nominal voltage of the camera, the camera may be damaged or malfunction. ● Please refer to the specification table for the nominal voltage of the camera.

2. Product specifications

2.1. Packaging List

Item Name	Specification	Quantity	Image
CMOS scientific grade camera	FL 26BW	1	
Power adapter	12V/8A	1	
Power adapter power cord	Three core 250V/2.5A	1	
USB 3.0 data cable	2 m	1	
USB flash drive	Software and Drivers	1	
Silver color pan head Phillips with washer mechanism screws (Cross recessed pan head with washer screws)	M3*14mm	2	
Single head hexagonal studs	M3*6+3mm; Diameter of opposite side: Φ4.7mm	2	

2.2. Quantum efficiency curve

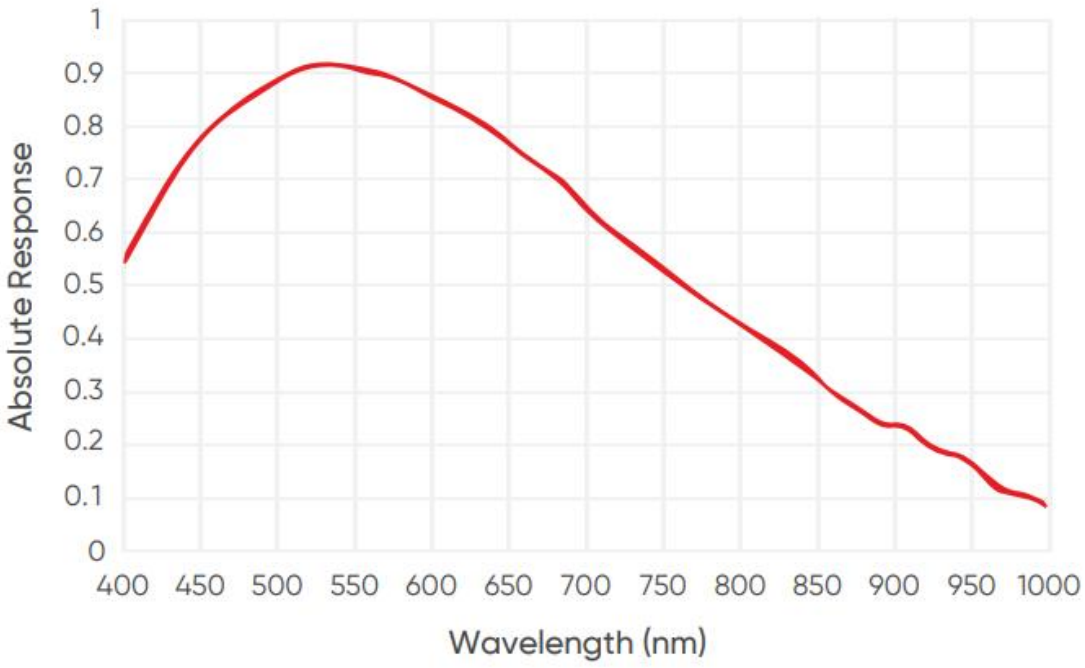


Figure 2- 1 Quantum efficiency curve of FL 26BW

2.3. Window curve

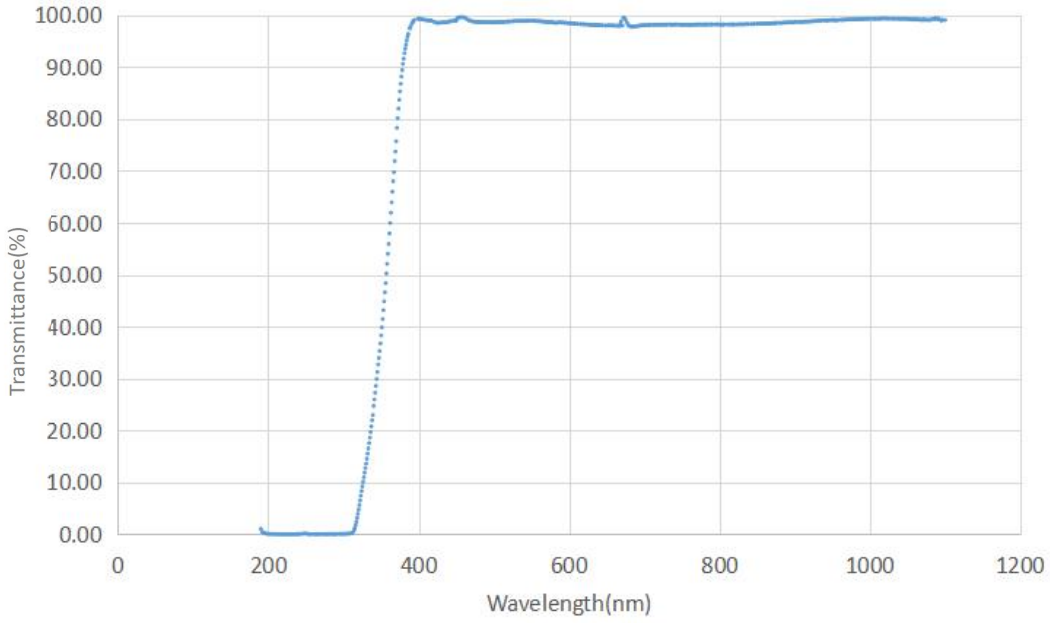


Figure 2- 2 Transmission curve of a standard glass window

2.4. Camera power and signal connection

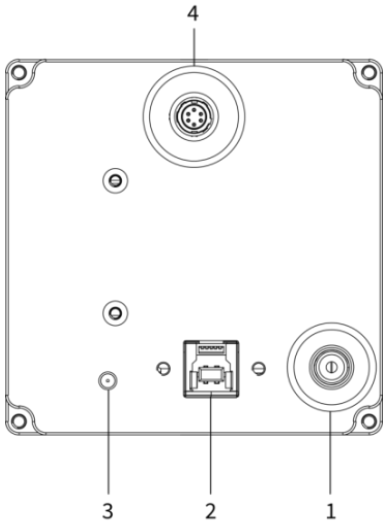
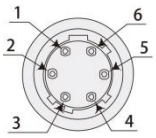


Figure 2- 3 Camera interface diagram

No.	Name	Fuction
1	DC12V	Power interface
2	USB 3.0 interface	Camera data transfer
3	Indicator light	Indicate the camera status, press F2 to control the light on or off of the indicator light Red: Camera powered on Orange *: Normal operation
4	External trigger interface	External Trigger Input and Output: Hirose-6-pin trigger interface , Model No: HR10A-7R-6PB(73):  Pin1：Trigger In, Pin2，Pin3：GND, Pin4：Exposure Start Default corresponds to Port3 of the software Pin5：Readout End Default corresponds to Port1 of the software Pin6：Global Exposure Default corresponds to Port2 of the software

***Note:**

If the software has been shut down but the camera light remains orange, it indicates that the camera has not been fully released and needs to be completely exited from the camera thread or be restarted before the indicator light will return to red.

3. Features and Functions

3.1. Camera Introduction

The FL 26BW camera utilizes a SONY back-illuminated CMOS chip for excellent imaging performance. The camera has a quantum efficiency of 92%, a low readout noise of 0.9 e-, and no glow. The dark current level is as low as 0.0005 e-/p/s, equivalent to that of a depth-cooled CCD, which provides good performance support for long-exposure imaging. The FL 26BW camera has an excellent dynamic range of 16,000:1, which is more than four times that of similar CCDs, greatly expanding the signal measurement range. It also supports defective pixel correction (DPC), which makes the background more uniform and quantitative analysis more accurate. The camera also offers a flexible Binning mode, which further enhances imaging sensitivity and dynamic range. The camera also features a highly reliable refrigeration chamber with stable cooling performance and no condensation problems even after prolonged use. Its compact design facilitates the integration of the instrument system and makes it easier to carry and install.

3.2. Structure and operation of CMOS

Complementary Metal Oxide Semiconductor (CMOS) cameras have the advantages of low power consumption, fast readout, and it is more integrated with better energy efficiency. CMOS cameras are widely used in medical imaging, microscopic observation, and industrial inspection. CMOS cameras are flexible and scalable in various applications due to their easy integration.

The structure of a CMOS camera sensor usually consists of the following parts:

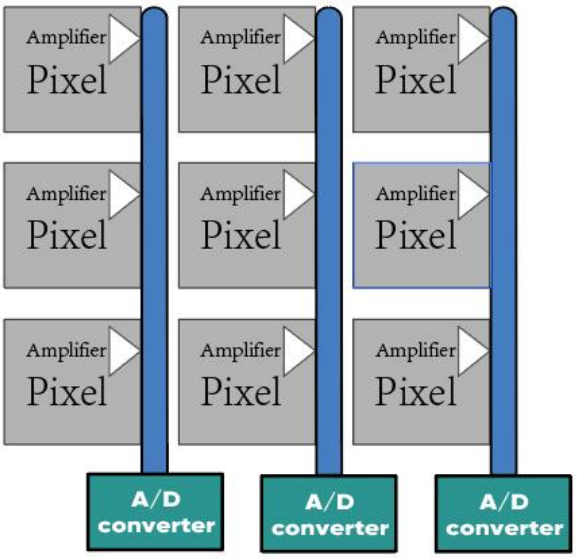


Figure 3- 1 CMOS camera sensor structure

The charge on each image element of a CMOS sensor is first converted to a voltage signal by a transistor and then transferred to a row of A/D converter arrays for output via a column transfer line.

The CMOS camera operates as follows:

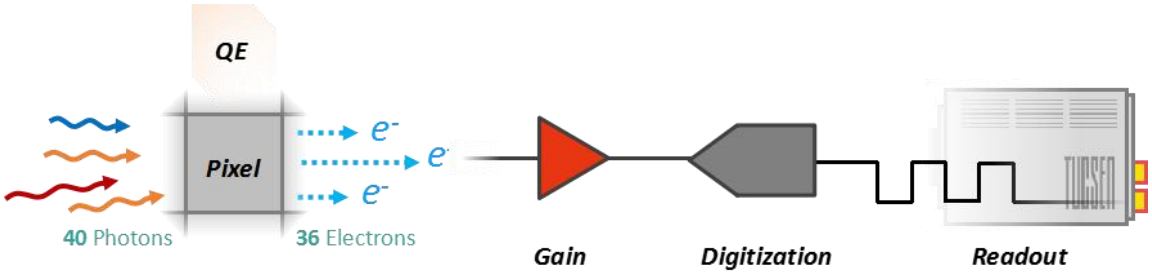


Figure 3- 2 CMOS operation process

1) Light signal capture: When photosensitive units are exposed to light, the light is converted into charge signals and stored in each unit.
2) Signal amplification: The charge signals from each photosensitive unit are amplified by corresponding gain amplifiers and converted into voltage signals.
3) Digitization: The amplified analog signals are converted into digital signals by an ADC for processing and storage.
4) Image processing: The digital signals undergo various algorithmic processes such as denoising, enhancement, and color correction through the image processing unit.
5) Data output: Processed image data can be transmitted to computers or other devices for display, analysis, and storage through various interfaces such as USB, Ethernet, etc.

3.3. Shutter Mode

The FL 26BW camera supports Rolling shutter readout and Global Reset readout. In Rolling shutter readout, the camera reads out rows sequentially, with different rows exposed at the same time, but with different starting exposure time points between rows, and the difference in exposure time points between neighboring rows is also known as the line time (T_{line}).

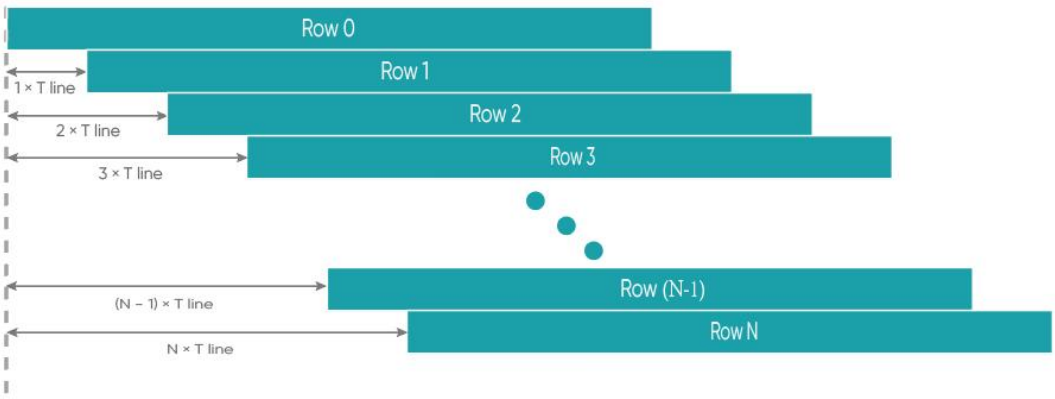


Figure 3- 3 Rolling shutter diagram

When the camera is in rolling shutter mode, if it is not synchronized with an external light source or if a flickering light source is used, you may get streaky pictures, which is especially noticeable when the exposure time is short (please refer to the FAQs content to solve this problem).

The Global Reset readout allows a camera with a rolling shutter chip to achieve the effect of a global shutter camera. The Global Reset function first resets the entire chip's pixel array simultaneously by clearing it to zero, then exposes all rows at the same time, and then reads out the data row by row at the end of the exposure, with the corresponding exposure time incremented row by row. Ideally, the light source should be turned off immediately after the first line of exposure to avoid uneven brightness images. This mode is suitable for applications that require signal synchronization, and can be used to photograph objects that change transiently.

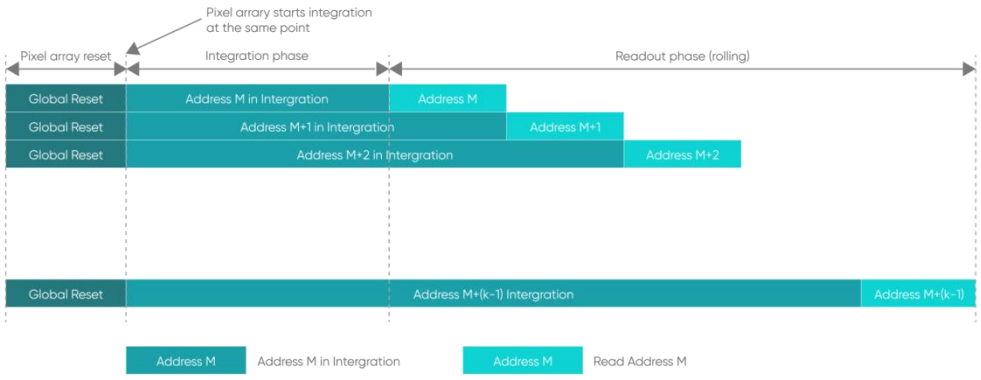


Figure 3- 4 Global Reset diagram

3.4. Front-Illuminated and Back-Illuminated CMOS Technology

Cameras based upon CMOS technology typically use two types of chips: front-illuminated (FSI) and back-illuminated (BSI). In front-illuminated cameras, light entering the pixels must pass through metal circuit structures before being detected. Due to the non-transparency of metal circuit structures, early cameras had only about 30-40% quantum efficiency (QE). Later, with the introduction of microlenses, light was focused through the conductors onto the photosensitive silicon, increasing QE to around 70%. Some advanced front-illuminated cameras can even achieve a peak QE of around 84%.

Back-illuminated cameras reverse this sensor design by placing the metal circuitry behind the photosensitive silicon layer, allowing incident photons to directly strike the thin photosensitive silicon layer. This process innovation significantly increases the peak QE of back-illuminated cameras and improves imaging quality in low-light environments. Due to the thin photosensitive silicon layer of back-illuminated pixels, there are higher process requirements and production difficulties compared to front-illuminated ones.

FL 26BW camera adopts a back-illuminated chip, achieving a peak QE of around 92%.

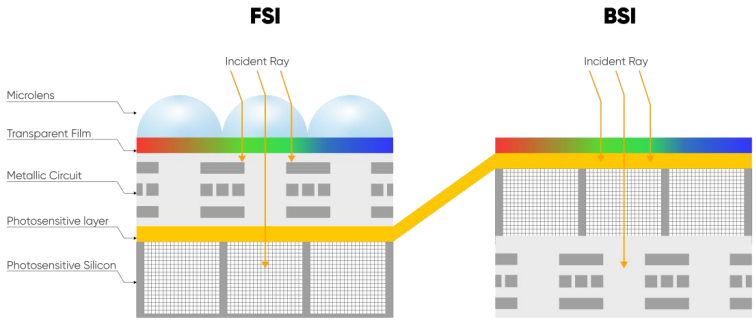


Figure 3- 5 Front-Illuminated and Back-Illuminated diagram.

3.5. Readout Noise

Readout noise is the noise introduced by the readout of the signal through the circuit. In CCD camera, since the readout circuit is the same for all pixels, the standard deviation (σ) for each pixel is generally consistent. Therefore, in CCD camera parameter tables, a single value—the root mean square (RMS) of the standard deviation of all pixels—can represent the readout noise.

However, each pixel in CMOS corresponds to a different readout circuit, forming a distribution curve, shown in Figure 3-6. To illustrate the characteristics of this curve, CMOS camera parameter tables typically provide two values—median and RMS. The median is the median of the standard deviations of all pixels, while the RMS is the root mean square of the standard deviations of all pixels. Since there are usually a few pixels with exceptionally high readout noise on the CMOS camera chip—having less impact on the median than on the RMS—median values are generally lower than RMS values.

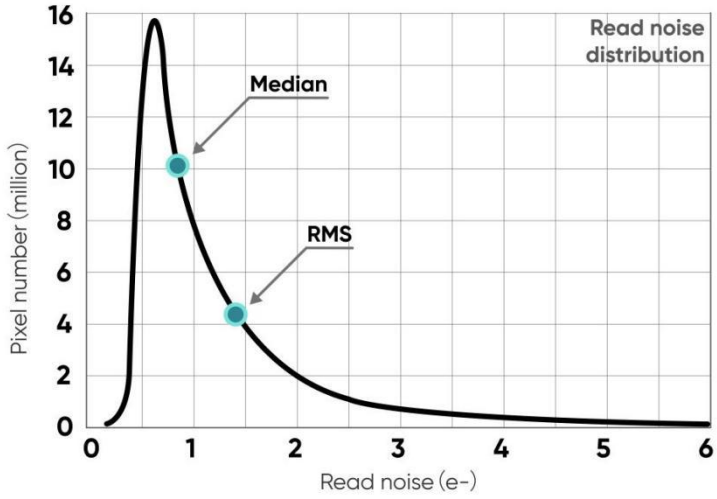


Figure 3- 6 Readout noise distribution of a CMOS camera

To measure and calculate readout noise from images, it's necessary to eliminate or minimize the influence of thermal noise and photon shot noise, retaining only the readout noise generated during the circuit readout process. Therefore, when measuring readout noise, it's typically done in an environment without light signals, with the exposure time set to the minimum value (to minimize the accumulation of dark current) to obtain dark-field images (called dark images). By capturing N such images, each pixel obtains N readout values—their standard deviation (σ) reflects the value of the readout noise for the corresponding pixel.

3.6. Defective Pixel Correction (DPC)

There are always a few abnormal values on the CMOS camera chip. Through the camera's

Defective Pixel Correction (DPC) function, these abnormal points can be corrected, removing defective pixels from the image. However, this may cause flickering pixels in some single-molecule imaging applications. It is not recommended to use the DPC function for these applications or to use only the weakest correction level.

The FL 26BW adopts dynamic defective pixel correction, correcting using a 3x3 matrix of pixels. Currently, four correction levels are available, each corresponding to different thresholds, thereby controlling the intensity of defective pixel correction.

3.7. Gain Mode

The FL 26BW camera can be selected with four gains, Gain0, Gain1, Gain2 and Gain3, and there are differences in readout noise and saturation capacity under different gains, so it is necessary to select the appropriate mode according to the actual scene to obtain high-quality imaging results.

Table 3- 1 Typical Gain Parameter Table *

Gain	Gain0	Gain1	Gain2	Gain3
System Gain (DN/e-)	1.28	3.98	8.0	20
Full Well Capacity (e-)	49000	15700	7800	3000
Readout Noise (e-)	2.7(Median) 3.3(RMS)	1.0(Median) 1.3(RMS)	0.95(Median) 1.2(RMS)	0.85(Median) 1.0(RMS)

***Note:**

1) *The values in this table are typical values only and may vary between cameras, please refer to the factory photoelectric report.*
2) *The system gain is also referred to as the conversion gain in the factory optoelectronic report.*

3.8. Region of Interest (ROI) Readout

In imaging applications, ROI (Region of Interest) defines a subregion of interest within the camera sensor's resolution range, and selecting an ROI allows only the images within this subregion to be read out. Rolling shutter cameras can increase the camera's readout speed by reducing the number of rows. The software sets preset subregions and also supports manual settings, where the row window must be a multiple of 4, and the column window must be a multiple of 8.

The typical measured frame rates(fps) of the FL 26BW camera under USB 3.0 for different ROI areas are shown in Table 3-2:

Table 3- 2 Measured frame rates for typical ROI areas at 6240x4168 (Standard) resolution for the FL 26BW

Resolution	Column(Pixel)	Row(Pixel)	Rolling	GlobalReset
6240x4168 （Standard）	6240	4168	6.5	6.5
	6240	2084	13.0	13.0
	6240	1040	25.6	25.6
	6240	520	48.5	48.3
	6240	260	85.8	84.8
	6240	128	148.0	138.1
	6240	32	272.2	255.4
	32	32	272.2	255.4

Table 3- 3 Measured frame rates for typical ROI areas at 6240x4168 (Low Noise) resolution for the FL 26BW

Resolution	Column(Pixel)	Row(Pixel)	Rolling	GlobalReset
6240x4168 （Low Noise）	6240	4168	3.4	3.4
	6240	2084	6.7	6.7
	6240	1040	13.0	13.0
	6240	520	24.3	23.9
	6240	260	43.3	42.7
	6240	128	71.9	69.9
	6240	32	136.8	129.9
	32	32	136.8	129.9

Table 3- 4 Measured frame rates for typical ROI areas at 3120x2084(SenBin) resolution for the FL 26BW

Resolution	Column(Pixel)	Row(Pixel)	Rolling	Global Reset
3120x2084(SenBin)	3120	2084	35.5	35.5
	3120	1040	71.0	71.0
	3120	520	142.0	141.0
	3120	260	265.3	260.4
	3120	128	473.4	459.6
	3120	64	764.3	728.8
	3120	32	1103.6	1031.6
	32	32	1103.6	1031.6

Note:

1) *The minimum supported ROI for FL 26BW on Mosaic V3 is: 32 (columns) x 32 (rows).*
2) *The frame rate is affected by the configuration of the computer system, it is recommended to use it on a computer with an i5 processor or above and a 64bit system.*
3) *When high-speed image acquisition is required, it is recommended to uncheck Auto Color Scale and close the Image Adjustment module;*
4) *The test frame rate in the above table is the measured maximum value under the shortest exposure time.*

3.9. Binning Readout

Binning is a readout mode that recombines the camera's pixels, which can be used to increase sensitivity, but at the same time results in a loss of resolution. For example, a 2 x 2 binning is where every 4 pixels (2 rows and 2 columns) are combined into one "big pixel" and the camera outputs a pixel intensity value.

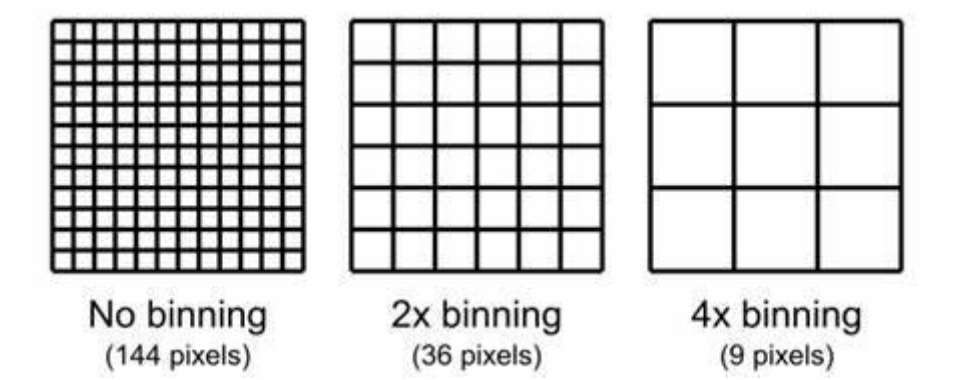


Figure 3- 7 Schematic diagram of binning

Binning can be implemented at the chip level, by the camera's FPGA, or by the camera's operating software. Pixel merging can increase the signal-to-noise ratio, which allows for the detection of weaker signals, improved image quality, or shorter exposure times. However, the effective pixel size of the camera also increases, which may reduce the camera's resolution of target details.

The software Binning seclection on Mosaic V3 is shown below:

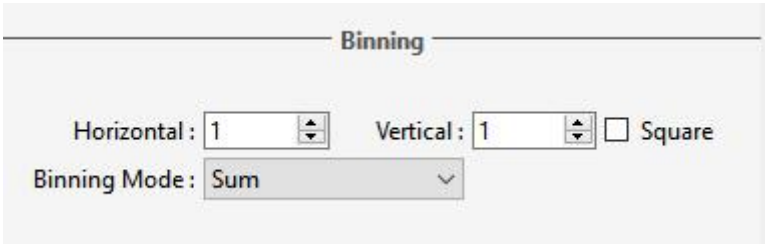


Figure 3- 8

The FL 26BW camera also supports Chip Binning, which can be selected at the resolution option (SenBin), and with this method the frame rate can be improved to some extent:

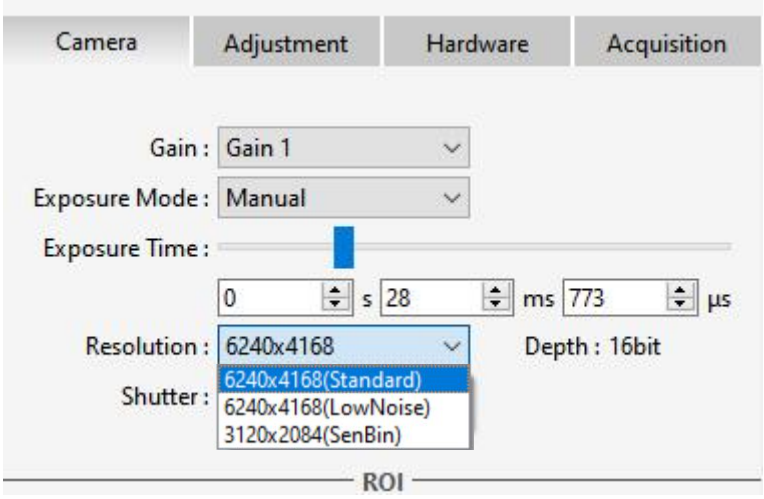


Figure 3- 9

The corresponding measured frame rate (fps) at each resolution is shown in the table below:

Table 3- 5 The measured values of frame rate at different resolutions

Resolution	Rolling/GlobalReset
6240x4168（standard）	6.5
6240x4168（Low Noise）	3.41
3120x2084(SenBin)	35.5

3.10. Timestamp

The camera accurately reads the start time of each frame with 1μs time accuracy. In Mosaic V3 version software, use [.sen] format to save the picture, the timestamp information will be displayed in the picture information, support exporting the picture information to [.csv] format file.

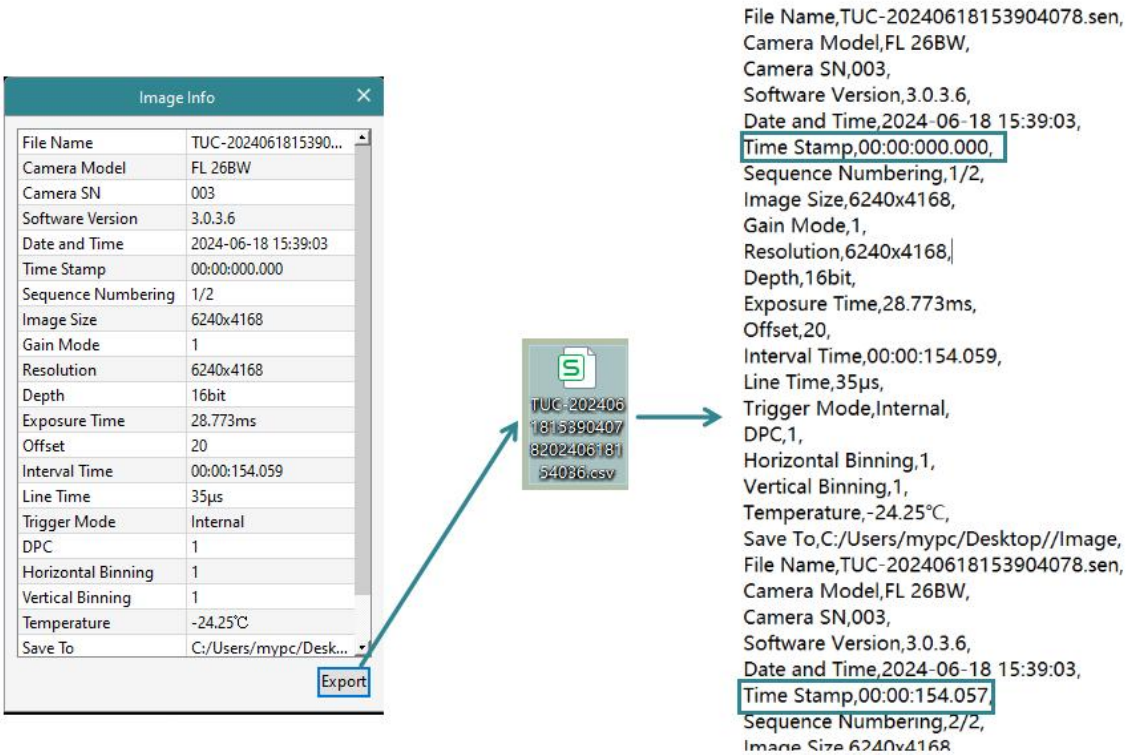


Figure 3- 10 Timestamp Export Schematic

Note:

Applications requiring timestamp functionality generally have high time precision requirements, and it is recommended to use the To RAM image storage mode.

3.11. Frame Rate Calculation

The camera's frame rate is affected by readout time and exposure time. Refer to the following calculation for the theoretical frame rate.

Typical frame rate calculation for USB3.0 in Rolling shutter mode:

Hn: The number of rows selected in the horizontal direction;

Vn: The number of rows selected in vertical direction;

T_{line}: Line time;

T_{exp}: Exposure time;

$Y_{U3\text{-}Standard}$: 6.5 fps (maximum frame rate of Standard mode under USB3.0);

$Y_{U3\text{-}SenBin}$: 35.5 fps (maximum frame rate of Standard mode under USB3.0).

Table 3- 6 Frame rate calculation in Rolling shutter mode

Gain mode	Line Time (T_{line})	Calculation formula	Horizontal (Hn)	Vertiacal (Vn)	Frame rate (fps)
Standard	34.67μs	$\min\{1/(Vn/4168/Y_{U3\text{-}Standard}),1/(T_{line}*(Vn+74))\}$	6240	4168	6.5
				2084	13
				1040	25.6
				520	48.5
				260	85.8
				128	148
				32	272.2
Low Noise	69.3μs	$1/(T_{line}*(Vn+74))$	6240	4168	3.4
				2084	6.7
				1040	13
				520	24.3
				260	43.3
				128	71.9
				32	136.8
SenBin	12.58μs	$\min\{1/(Vn/3000/Y_{U3\text{-}SenBin}),1/(T_{line}*(Vn+40))\}$	3120	2084	35.5
				1040	71
				520	142
				260	265.3
				128	473.4
				64	764.3
				32	1103.6

Typical frame rate calculation for USB3.0 in Global Reset shutter mode:

Hn: The number of rows selected in the horizontal direction;

Vn: The number of rows selected in vertical direction;

T_{line}: Line time;

T_{exp}: Exposure time;

$Y_{U3\text{-}Standard}$: 6.5 fps (maximum frame rate of Standard mode under USB3.0);

$Y_{U3\text{-}SenBin}$: 35.5 fps (maximum frame rate of Standard mode under USB3.0).

Table 3- 7 Frame Rate Calculation in Global Reset Shutter Mode

Gain mode	Line Time (T_{line})	Calculation formula	Horizontal (Hn)	Vertiacal (Vn)	Frame rate (fps)
Standard	34.67μs	$\min\{1/(Vn/4168/Y_{U3\text{-}Standard}),1/(T_{line}*(Vn+80))\}$	6240	4168	6.5
				2084	13
				1040	25.6
				520	48.3
				260	84.8
				128	138.1
				32	255.4
Low Noise	69.3μs	$1/(T_{line}*(Vn+78)+T_{exp})$	6240	4168	3.4
				2084	6.7
				1040	13
				520	23.9
				260	42.7
				128	69.9
				32	129.9
SenBin	12.58μs	$\min\{1/(Vn/3000/Y_{U3\text{-}SenBin}),1/(T_{line}*(Vn+45)+T_{exp})\}$	3120	2084	35.5
				1040	71
				520	141
				260	260.4
				128	459.6
				64	728.8
				32	1031.6

Note:

1） The frame rate table value is the calculated value under the minimum exposure time,

when the set exposure time (T_{exp}) is greater than the readout time, Rolling mode frame rate = 1/ T_{exp} (s);

2） The above formula is for reference, Standard mode frame rate is affected by both Sensor and bandwidth (U3 bandwidth is about 330M/s), the actual frame rate is based on the minimum value calculated by the two formulas;

3） The frame rate is also affected by the computer system configuration, etc. At the same time, to prevent frame loss, the actual frame rate may be less than the calculated value.

3.12. Incident Photon Calculation

Scientific camera imaging involves the conversion of photons, electrons, voltage, and grayscale values. Therefore, it is possible to reverse calculate the incident number of photons from the grayscale values. The calculation formula is as follows:

$$P = \frac{(DN - Offset)/K}{Q(\lambda)}$$

Where:P represents the incident number of photons.DN is the grayscale value of the light signal. K is the system gain (refer to Table 3-1), with units of (DN/e-), Q(λ) corresponds to the quantum efficiency at the wavelength. Offset s the camera's background value in DN.

3.13. Acquisition Mode

3.13.1. Live Mode

Live mode is suitable for real-time preview, providing data stream output. Images are continuously output like a flowing stream. In this mode, users can freely modify settings such as exposure time, gain mode, region of interest, etc., for real-time preview and image capture operations.

After successfully installing Mosaic V3 software and drivers, the default trigger mode of the hardware is "internal trigger" (live mode), users can click Live/Stop to control the camera to turn on and off the live mode, and click Capture to get the image.

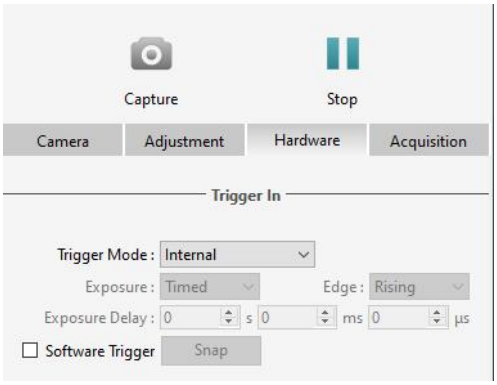


Figure 3- 11

Users can set the exposure time, working mode and other camera parameters, and preview them in real time through the preview window to get a suitable image.

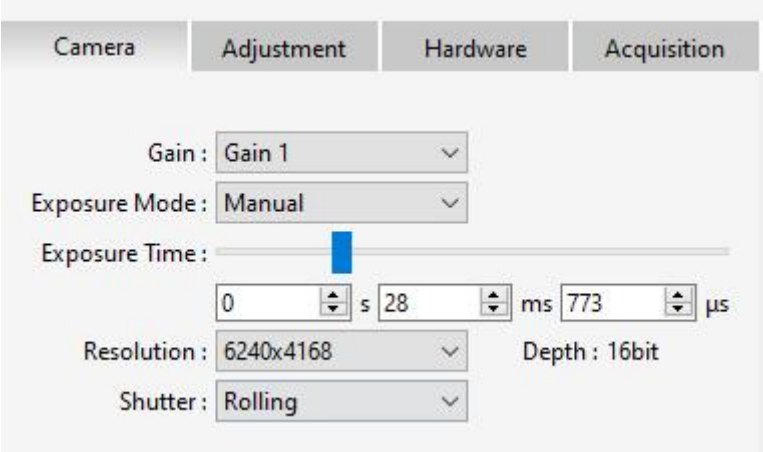


Figure 3- 12

In the acquisition module, users can set the save path, file name, total number of frames and other information, and the image can be taken after the setting is completed.

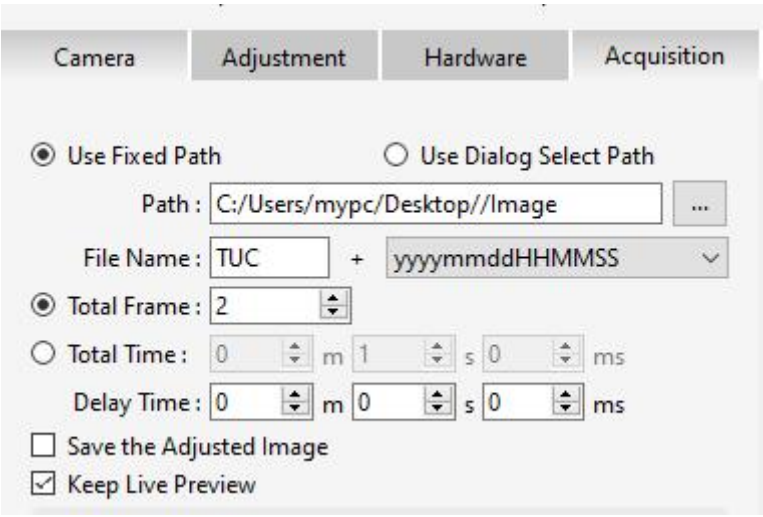


Figure 3- 13

3.13.2. Software Trigger Mode

When the camera is in Software trigger mode, the software gives the camera a command to take a picture, and when the camera receives the signal, it starts the exposure and outputs the image.

Mosaic V3 software trigger mode, after checking the software trigger, if you need to save a picture, click on the Capture to enter the waiting trigger state, and then click on the **Snap** after the camera began to expose, and at the end of the exposure of the output of a frame, each time you click on the **Snap** of the output of only one picture.

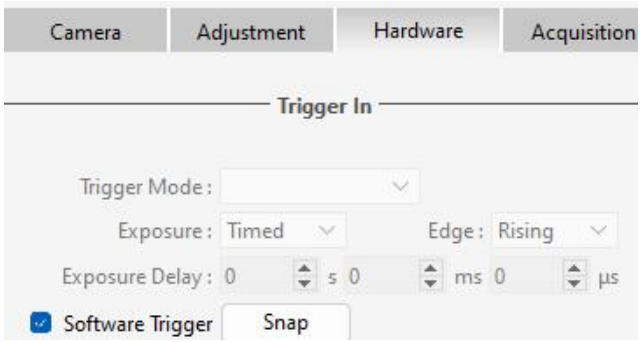


Figure 3- 14

3.13.3. Hardware Trigger Mode

Hardware trigger is a mode that waits for an external trigger level signal to expose and store the image.

Mosaic V3 hardware trigger mode settings, after entering the external trigger mode, contains the following configurations: Trigger mode, frame/signal, exposure, edge, exposure delay, etc., frame/signal can control the number of triggers out of the picture, after receiving the trigger signal will be in accordance with the number of sheets set to continue to pick up the picture.

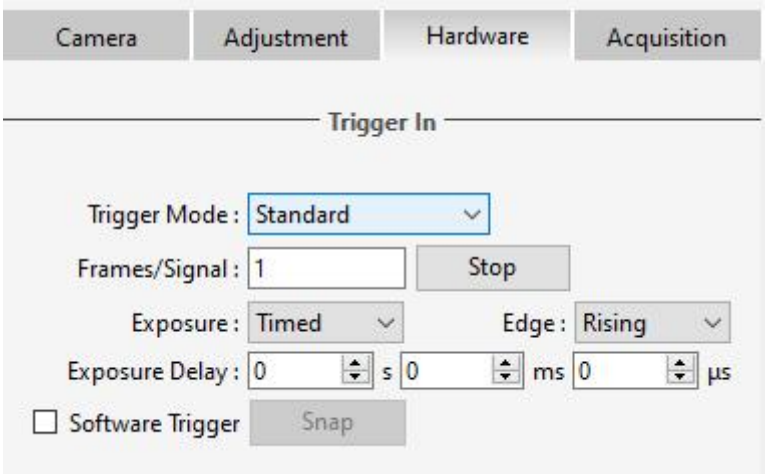


Figure 3- 15

3.13.3.1. Hardware Trigger input circuit

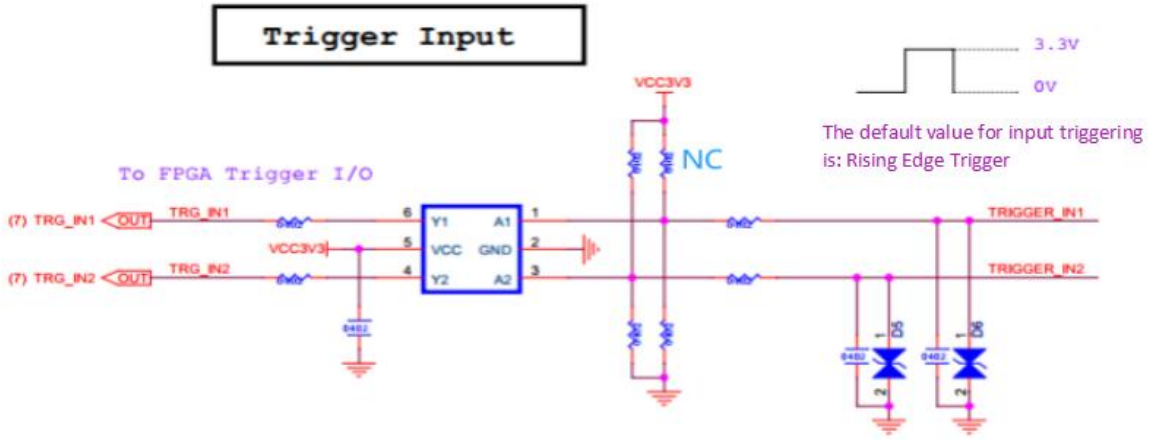


Figure 3- 16 Hardware trigger input circuit

Note:

1) *Recommended external trigger input high level is 2.6 ~ 3.3 V, maximum must not exceed 5.0 V, exceeding the maximum limit voltage will likely cause permanent damage, recommended low level < 0.6 V.*

2) *The camera recognizes level signals with pulse widths greater than 1 µs.*

3.13.3.2. Trigger Delay and Jitter

As shown in the figure below, when the external trigger level signal arrives, there will be a delay of nanoseconds T_{iso} when it first passes through the hardware circuit.After the delay of the hardware circuit, the camera receives the trigger signal to the first line to start the formal exposure has a delay of 8 line cycles T_{logic}.Therefore, the total delay time of the external trigger input to the beginning of the exposure $T_{idelay}=T_{iso} + T_{logic}$

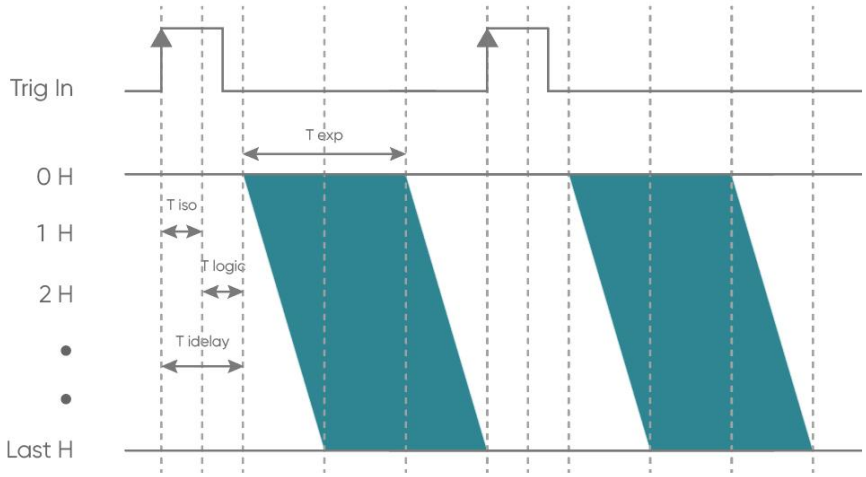


Figure 3- 17 Rolling Mode Trigger Delay Schematic

The schematic diagram in Global Reset mode is shown below:

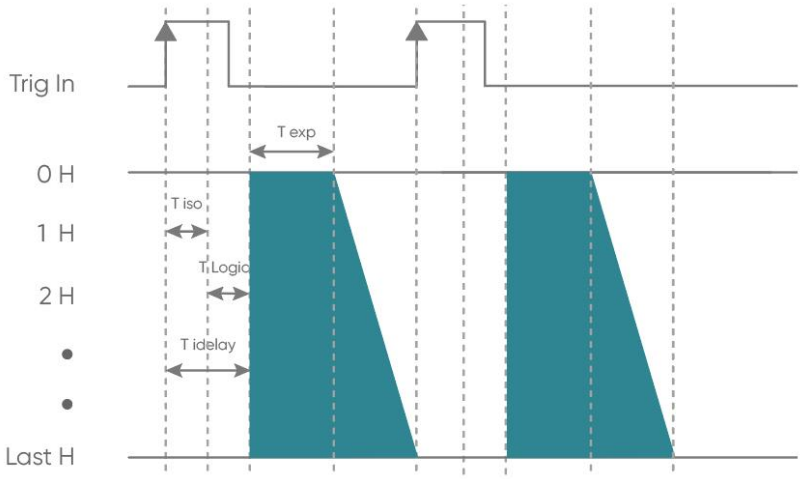


Figure 3- 18 Global Reset Mode Trigger Delay Diagram

T_{exp}: exposure time; T_{iso}: hardware circuit delay; T_{logic}: trigger jitter; T_{idelay}: total delay time; 1H: one T_{line}

3.13.3.3. Standard Trigger Mode

Standard Trigger Mode: When the camera is in the open stream state, the image responds to the external trigger signal only after the readout is finished;

Supports setting to level trigger and edge trigger. In level trigger mode, the start and end of the exposure is controlled by inputting the rising or falling level of an external trigger signal, and the length of the exposure is determined by the duration of the level. Level trigger mode is not for continuous shooting, and is often used to take pictures of stationary or slow moving objects.

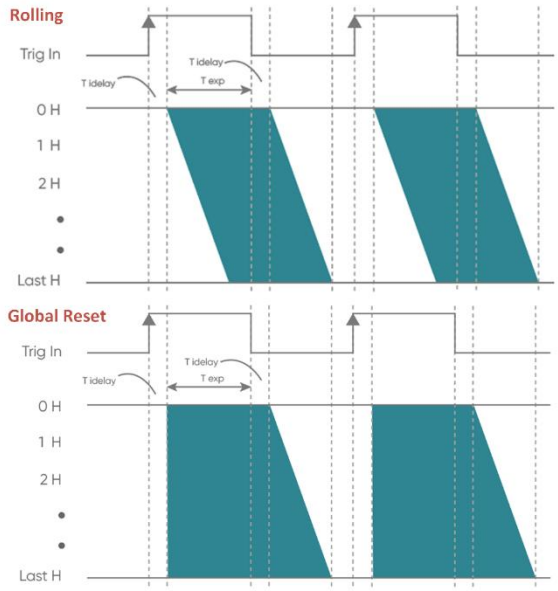


Figure 3- 19 Level Trigger Mode

The edge trigger mode, on the other hand, is set by setting the length of exposure time directly on the software interface. When using it, it should be noted that the time of each pulse cycle of the trigger signal (pulse width + pulse interval) must be greater than or equal to the total time used for the output of each image frame (i.e., the reciprocal of the frame rate), in order to ensure that a frame of the image is complete and error-free.

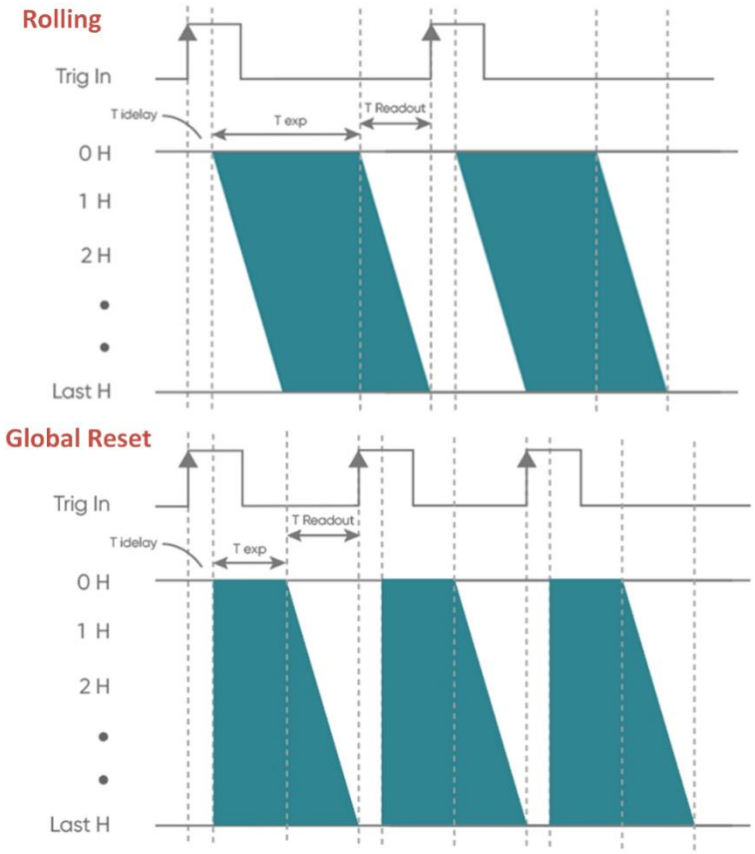


Figure 3- 20 Edge Trigger Mode

The FL 26BW camera supports single-trigger multi-frame acquisition, which can be modified by setting the frame/signal in the standard trigger mode (refer to Figure 3-15) to modify the number of triggers out of the picture, and set the number 2 as an example, and the trigger timing diagram is as follows:

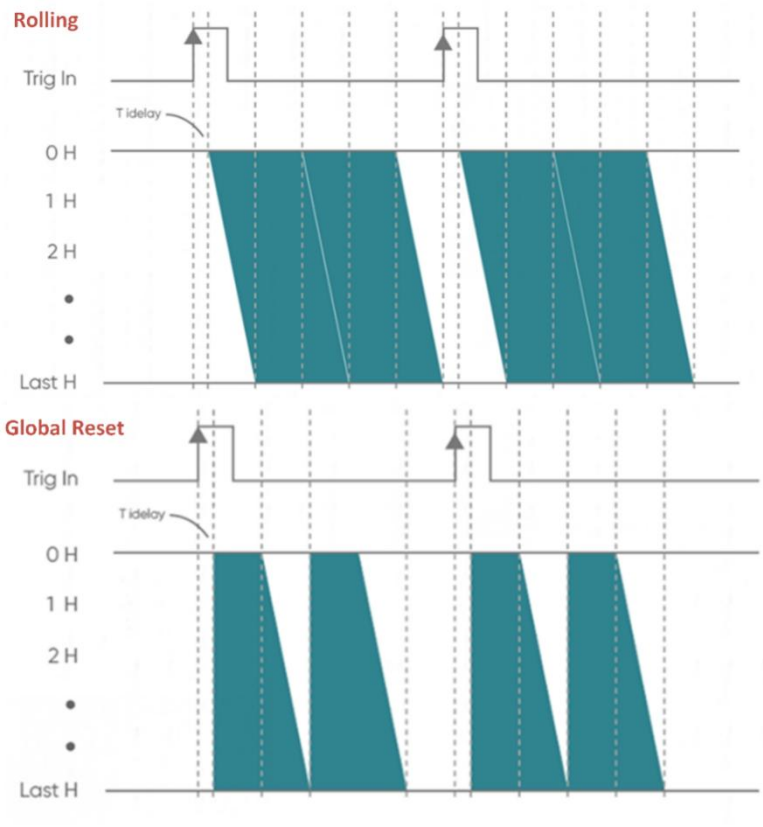


Figure 3- 21 Single-trigger multi-frame acquisition timing diagram

3.14. Trigger Output

3.14.1. Hardware Trigger output circuit

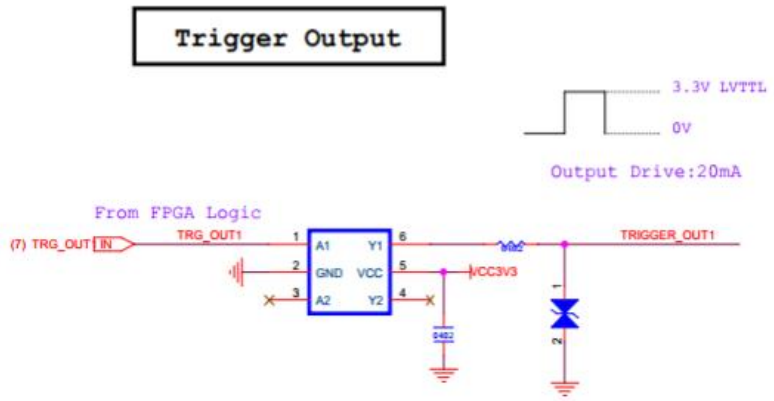


Figure 3- 22

Note:

The camera's external trigger output level is a fixed value of 3.3V and supports a maximum drive current of 20mA.

3.14.2. Trigger Output Sequence Diagram

The camera adopts the Hirose interface for trigger output, and the trigger output signal interface corresponds to pin4, pin5, and pin6, which can output signals of the following five timings.

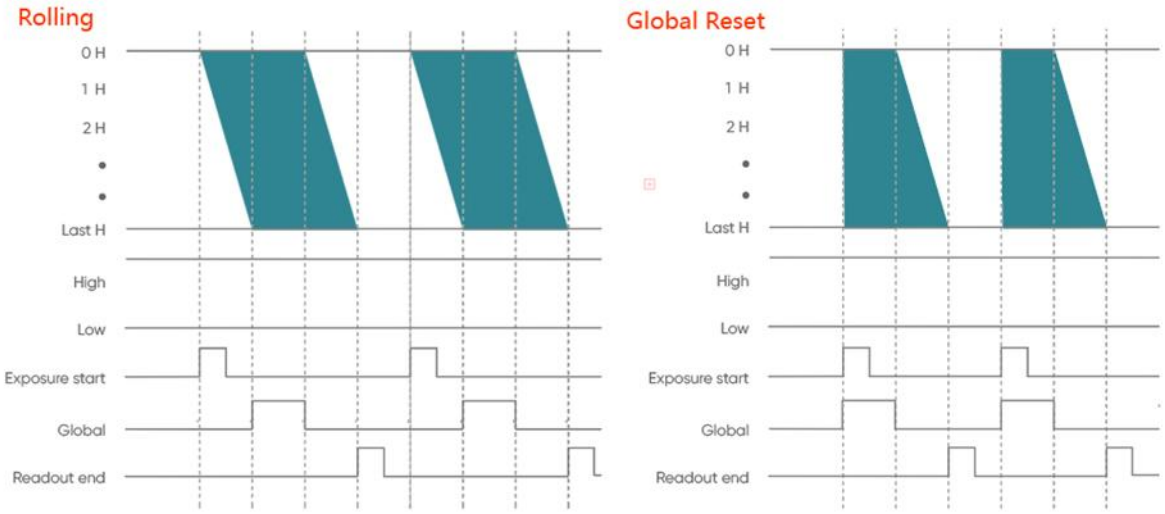


Figure 3- 23 Trigger output sequence diagram

- **High**: Always output high level;
- **Low**: Always output low level;
- **Exposure Start**: Exposure starts from the first line, the pulse width is 5ms by default and can be customized, the default output is at Pin4 interface, corresponding to Port3 of the software.
- **Readout End**: Starting from the last line of the end of the exposure, the pulse width is 5ms by default, which can be customized, and Pin5 output by default, which corresponds to Port1 of the software.
- **Global**: Exposure starts from the beginning of the last line and ends at the end of the first line (exposure time greater than the readout time is valid), and is output on the Pin6 connector by default, corresponding to Port2 of the software.

3.15. Cooling

Camera cooling can effectively minimize the "dark current noise" and the effect of hot pixels. The camera adopts semiconductor refrigeration, using the Peltier effect, composed of N, P-type materials, a pair of thermocouples, when the thermocouples into the DC current, due

to the direction of the DC current into the different direction, will produce heat absorption and exothermic phenomenon at the junction of the couples. The cold end is close to the chip to cool down the chip to reduce the dark current; the hot end is connected to the metal heat-conducting block, and the heat generated will be dissipated through the corresponding way.

The FL 26BW camera is air-cooling. The air inlet and outlet markings in air-cooled mode are shown below.

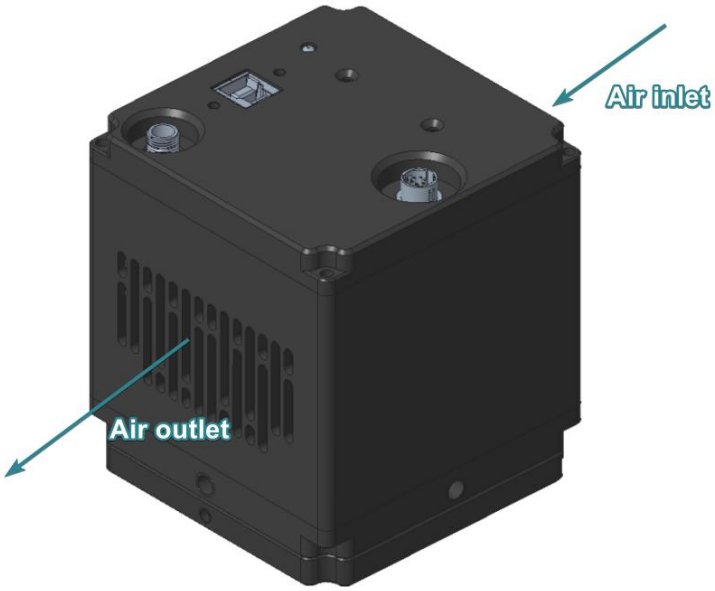


Figure 3- 24 Schematic diagram of FL 26BW air inlet and outlet

If the camera is used in an environment with high temperatures and high air humidity, the camera, due to the low internal temperature after refrigeration, the water vapor will condense into a fog that will adhere to the camera and will cause fogging to occur.

FL 26BW in the application scenario with high ambient temperature and humidity (e.g. >70%), with the cooling temperature lowering, the temperature difference within 47℃, there will be no dew condensation (default -25 ℃ will not be dew condensation); the temperature difference of 47~52 ℃ has a low risk of dew condensation, and the temperature difference of more than 52℃ has a high risk of dew condensation. (The above recommended values are affected by the actual environment temperature and humidity, for reference only).

Note:

The camera's default temperature is set to -25°C, allowing the user to adjust the temperature as low as -35°C, but when the temperature is set lower than -25°C, the camera window will

*be at "**Risk of fogging**!". Users can prevent fogging by increasing the sensor cooling temperature and reducing the ambient humidity.*

4. Installation

4.1. Camera installation

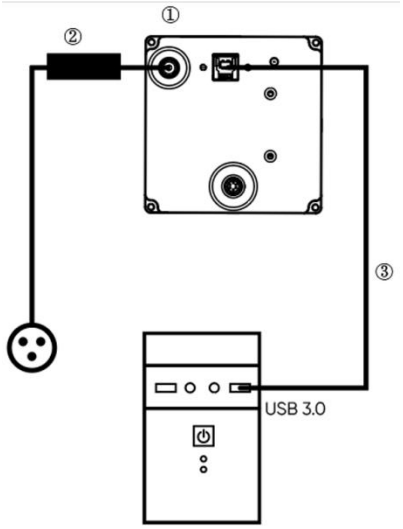


Figure 4- 1 FL 26BW Camera Connection Diagram

① FL 26BW Camera

② Power adapter

③ USB 3.0 data cable

Connect one end of the USB 3.0 data connection cable to the PC, the USB needs to be connected to the USB 3.0 port on the back of the host. The other end is connected to the CMOS camera, lock the screws, and then plug in the power cord, you can see the indicator light up in red.

Note:

1) To prevent overheating inside the camera, do not wrap the camera in cloth or any other material or block the camera's vents in any way.

2) If the camera is operated in a closed environment, in order to ensure the safety and cooling performance of the camera, please make sure that there is at least 10 cm of clearance between the air inlet and air outlet of the camera when installing the camera; if the camera is placed on a desktop or platform for use, please make sure that the air inlet of the camera does not face downward.

4.2. Camera USB driver installation

Operation steps:

(1) Connect the camera to the computer and open the matching USB drive;

(2) Double click to run the driver installation package;

(3) Follow the prompts to click [Next] for default installation;

Figure 4- 2

(4) Selecting the contents of the installation, by default check the box to install Microsoft runtime libraries vcredist_2008 and vcredist_2013, unchecking the box may result in the software or third-party plug-ins not working;

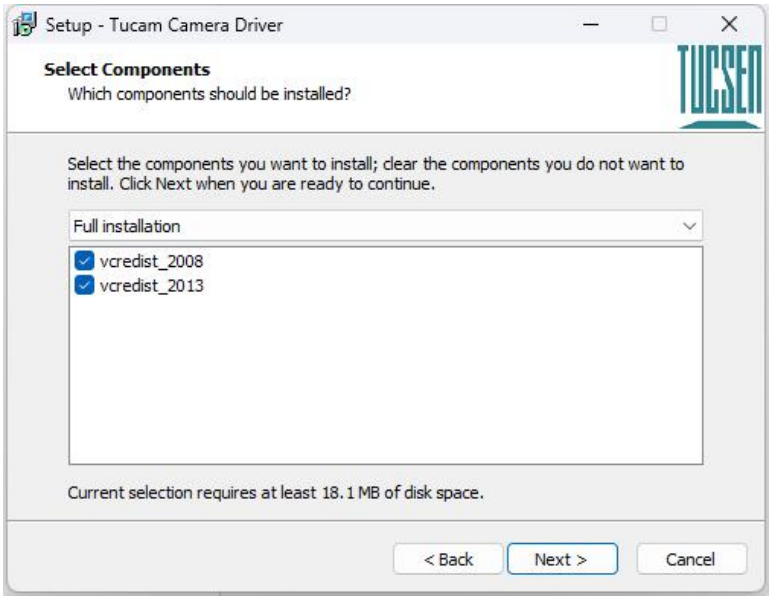


Figure 4- 3

(5) Waiting for the driver installation to be completed;

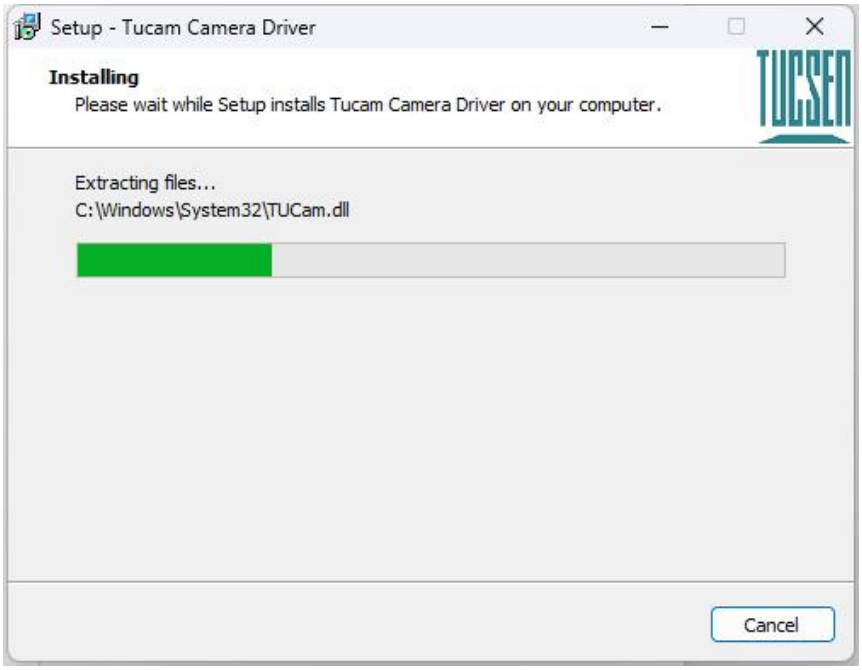


Figure 4- 4

(6) Click "Finish" to complete the driver installation;

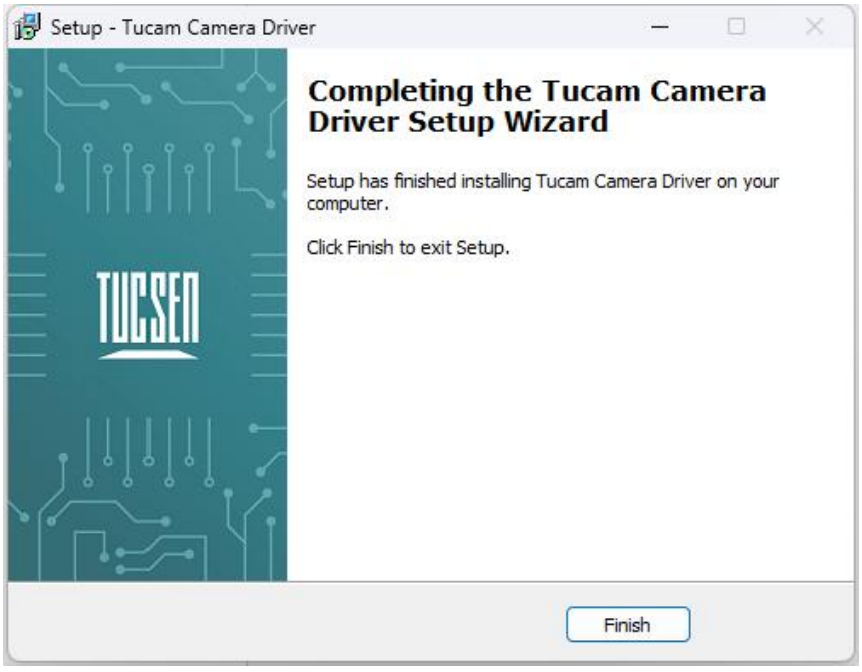


Figure 4- 5

After installing the camera USB 3.0 driver, open the device manager on the computer. When the driver is successfully installed, the camera will appear under the image device without any yellow markings, as shown in the picture. If a yellow symbol appears, it indicates that the driver needs to be reinstalled.

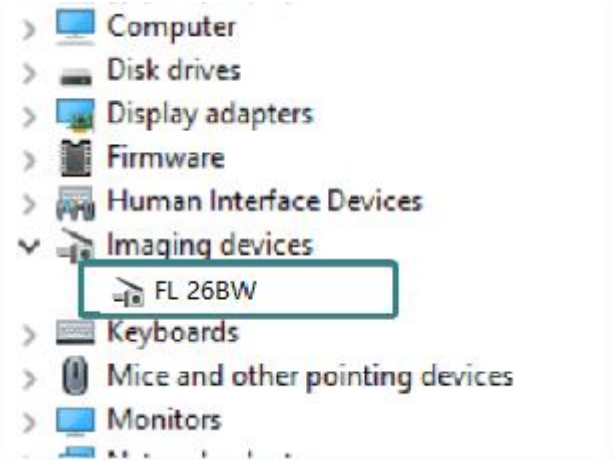


Figure 4- 6 Device Manager Display

4.3. Software installation and uninstallation

4.3.1. Installation

Operation steps:

(1) Open the supporting USB drive, double-click to run Mosaic V3 software;

(2) Select the installation path, default to C drive, users can customize the installation path according to their needs;

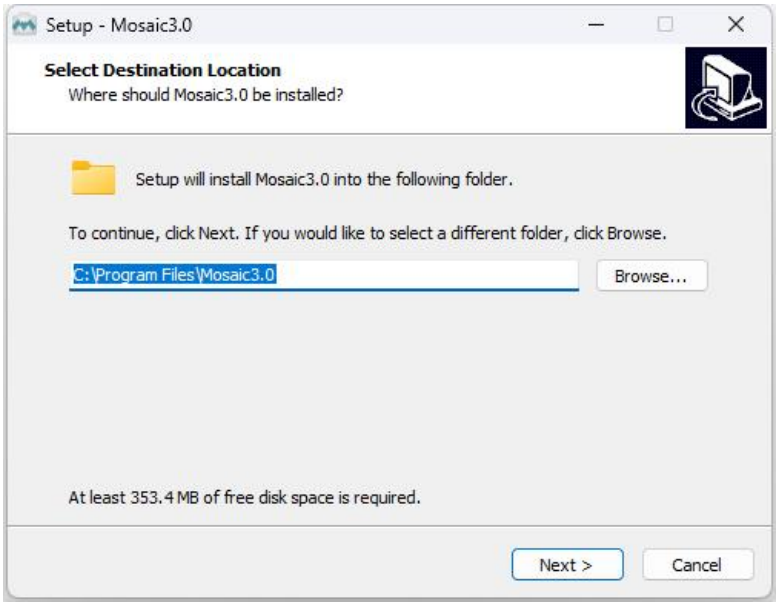


Figure 4- 7

(3) Select the installation content. By default, select the option to install drivers and Microsoft runtime library vc-redist_2015, canceling the installation can result in the camera not being recognized by the software;

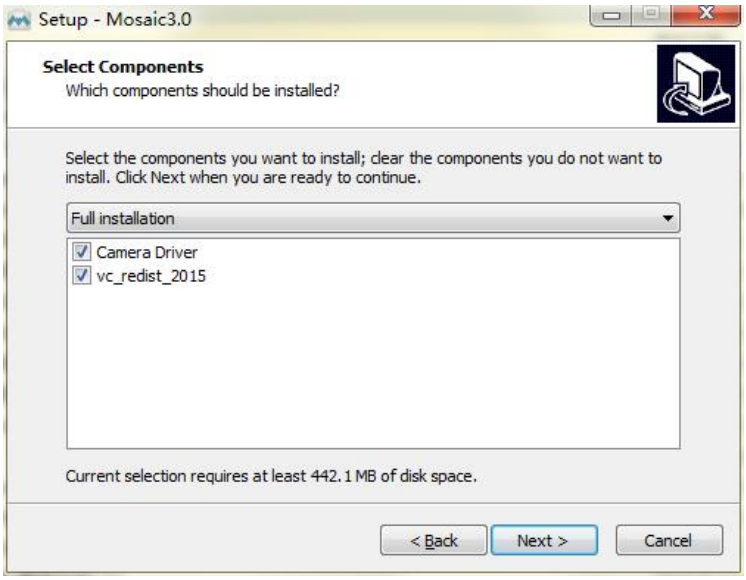


Figure 4- 8

(4) Configure installation parameters and select whether to generate desktop shortcuts;

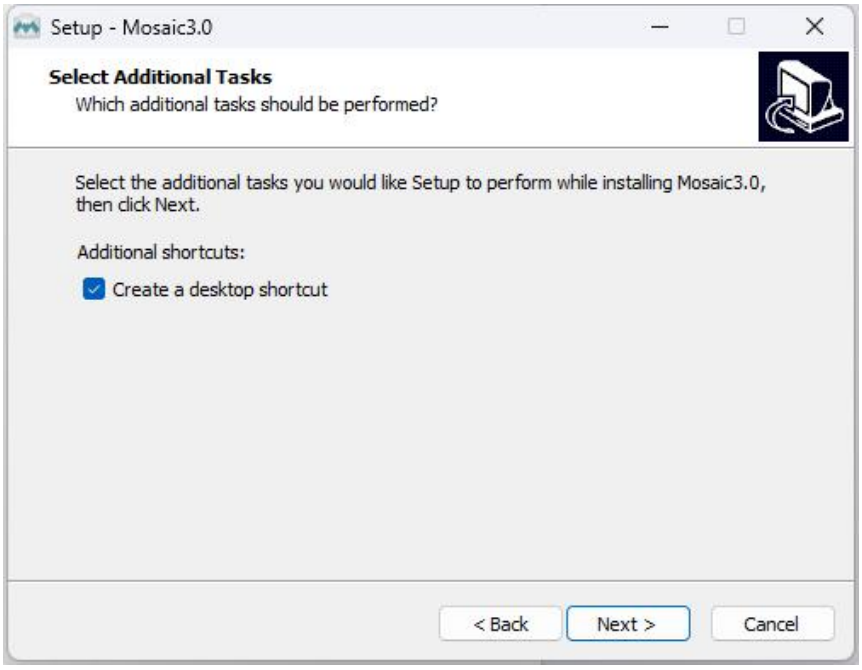


Figure 4- 9

(5) After confirming all installation parameters, click "Install" to start executing the installation action;

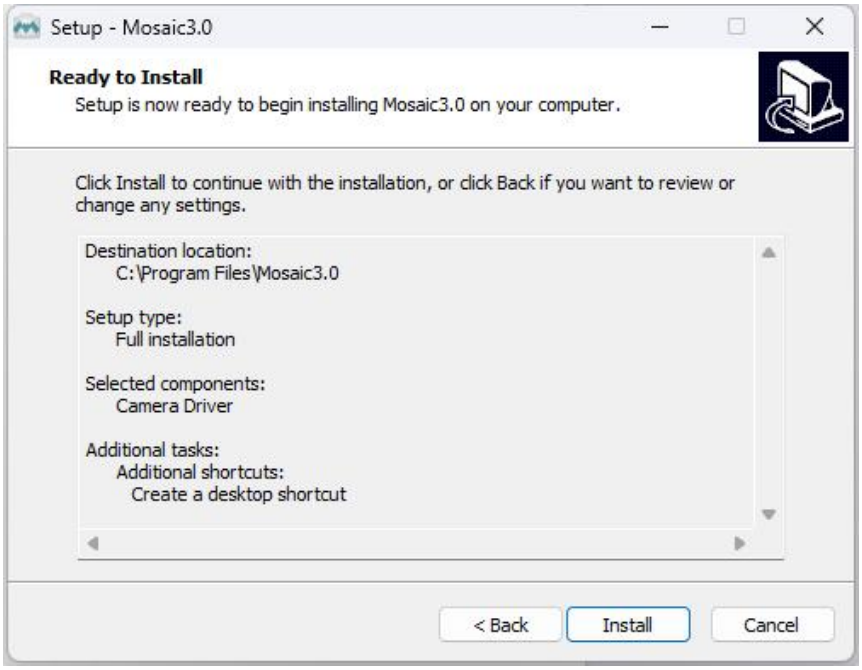


Figure 4- 10

(6) Waiting for installation to complete;

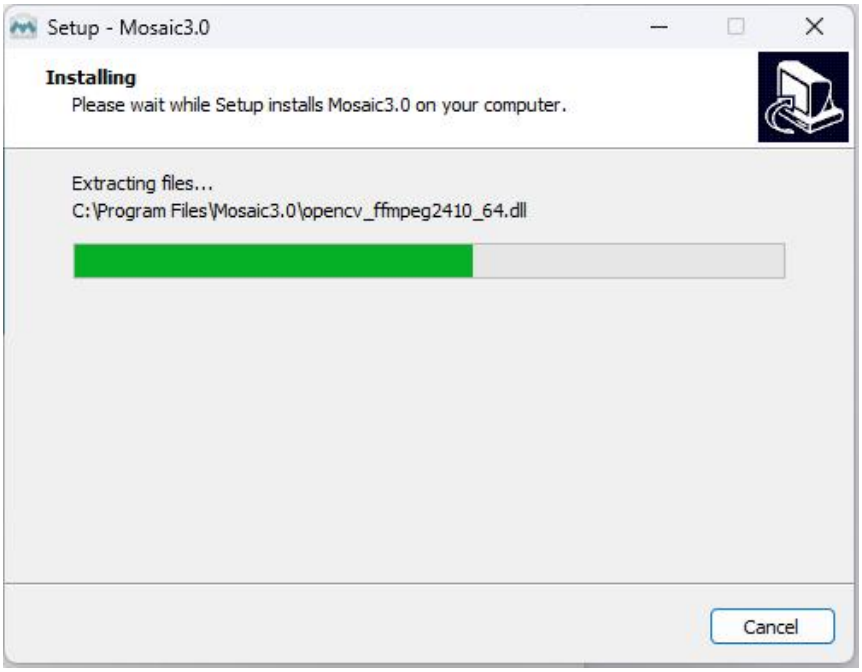


Figure 4- 11

4.3.2. Uninstallation

There are three ways to uninstall Mosaic software:

(1) By uninstalling through the installation package, the existing version on the computer will be uninstalled when the installation package runs, and the default C drive path will take effect;

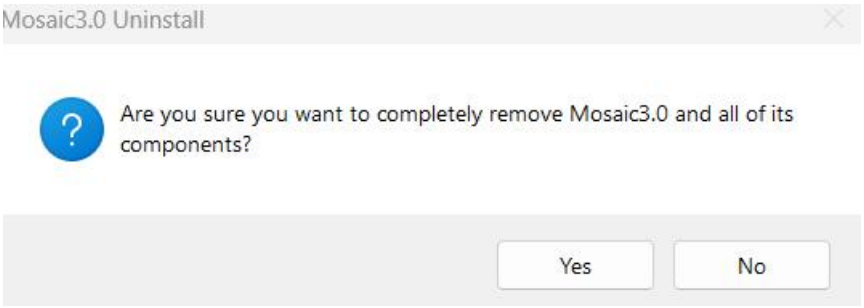


Figure 4- 12 Uninstallation via installer

(2) Under the installation path, find unins000.exe to uninstall, double-click uninstall;

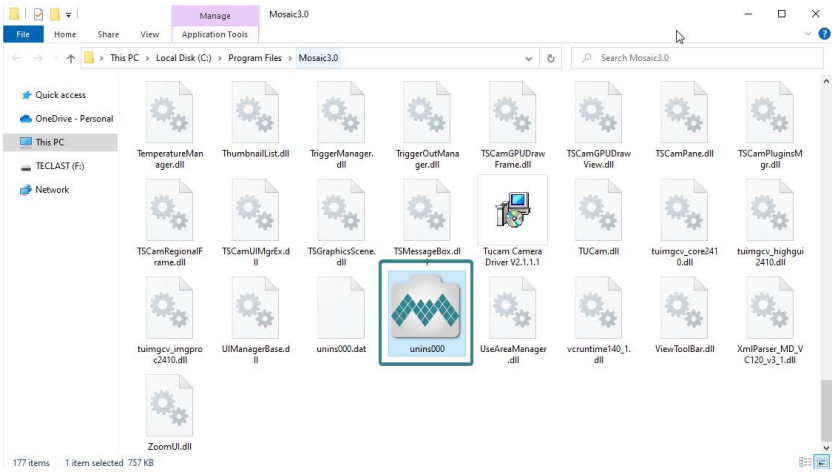


Figure 4- 13

(3) Uninstall from the computer program management interface;

Note:

After uninstalling and reinstalling the software, all software configuration information and calibration table data will be deleted.

5. Maintenance

Damage caused by unauthorized maintenance or procedures will void the warranty.

5.1. Regular inspections

The product status should be regularly checked, especially the integrity of the external power supply and main cable, as well as the integrity of the power cord. Do not use damaged equipment.

5.2. Electrical safety inspection

- It is recommended to check the insulation and protective grounding integrity of the AC/DC converter every year
- Do not use damaged equipment

5.3. Basic usage

1) Avoid opening the lens dust cap in a dusty environment;
2) Open the lens dust cap and mount the lens with the camera port facing downward to avoid dust falling on the surface of the windowpane;
3) If not used for a long time, please install the dust cover..

5.4. Window cleaning

When stains or spots are found in the images captured by the camera, please rule out whether the surface of the lens/microscope/objective at the camera interface is dirty.

If none of the above are true, it is certain that the camera itself brought it, and the window cleaning can be carried out according to the following steps:

1) Priority is given to the use of air blowing, the use of ear washing ball or air blowing off the general dust; together with the brush can remove most of the dust;
2) For stubborn oily dust, you need to prepare dust-free cotton swabs (or special mirror paper, non-woven fabric, etc.) and special tools such as anhydrous ethanol;
3) Use dust-free cotton swabs dipped in an appropriate amount of anhydrous ethanol to wipe along the surface of the window film, do not use too much force when wiping, and always in one direction, avoid back and forth wipe;
4) After wiping, use air blowers and other items to let the alcohol evaporate completely before continuing to use the window surface.

Note:

1) *If you cannot guarantee to complete the cleaning steps independently or do not have the required items, please be sure to contact us;*
2) *If the dirt still exists after following the above steps, try wiping again according to the above steps. If this does not solve the problem, consider that the chip is internally dirty. Please be sure to contact us at this time.*

6. Troubleshooting

6.1. The computer cannot recognize the camera

1) Verify that the camera is properly powered on and turned on;
2) Make sure the camera is properly connected to the computer;
3) Confirm that the driver is working properly and check if the image device recognizes the camera in the computer device manager.

6.2. Software pauses or freezes

1) The computer may have turned on the energy-saving mode, the system CPU performance is reduced, resulting in the software can not work properly, there are dropped frames or software jamming and so on. You can check to ensure that the computer is in high-performance mode.
2) The computer has opened too many applications, resulting in the computer CPU occupation is too high, the software CPU utilisation is low and can not work properly. Can close the redundant applications.
3) Abnormal data cable connection, when the data cable is loose, or extended by the transfer too long will also lead to abnormal software connection, can not work properly.

6.3. The camera cannot reach the target cooling temperature

1) Confirm the ambient temperature;
2) Confirm whether the air outlet is blocked;
3) Confirm whether the fan rotates normally.

6.4. The frame rate cannot reach the nominal level

1) Confirm whether the exposure time affects the frame rate, you can set the minimum exposure time to confirm the frame rate;
2) The frame rate in the table is the measured frame rate under the ideal bandwidth, the frame rate of the actual use of the scene will be affected by the data transmission, related to the type of data interface used, the length of the transmission line;
3) Make sure you are using the correct data transmission interface, USB needs to use USB3.0 interface, if you use a non-3.0 interface, the frame rate may not be able to reach the nominal frame rate;

4) If you are using USB3.0 interface, but adapted HUB/extension/expansion operation, it will also lead to failure to achieve the nominal frame rate.

7. FAQs

7.1. Why is the brightness of the captured image inconsistent with the preview window?

When using the camera for the first time and the target is dark, the software preview may show an all-black image. It is recommended to check Auto Left Scale (Auto Min) and Auto Right Scale(Auto Max) in the Histogram setting area, in which case the software preview will show the most suitable brightness and contrast. However, when you save the image, the default image saved by the software will not save the effect of auto colour gradation, resulting in inconsistency between the preview image and the captured image.

You can try the following solutions:

1) Disable the automatic colour gradation function of the software, the preview image will be consistent with the saved image;
2) Use professional image viewing tools such as ImageJ to open the tif image and adjust the colour gradation.
3) Use Mosaic V3 software to tick "Save the Adjusted Image" in the Capture section (can be used when you don't need the original image data value).

7.2. Stripe like flicker appears in the camera preview image

May be caused by an external light source that is not synchronized. There may be a strobe light source in the environment, which can be judged by extending the exposure time. If it is an ambient light source, turning off the illumination source is sufficient. If from an irradiated sample light source, a regulated light source is required for illumination.

8. After-sales Support

1) Obtain software-related information and technical support information from the official website [support] -> [FAQs].

2) Warranty:

- The quality assurance period starts from the date of shipment and lasts for a total of 24 months. During this period, any damage that meets the warranty requirements will be repaired free of charge;
- The warranty scope is limited to defects in product materials and manufacturing. Damage caused by self disassembly, water ingress, littering, or natural disasters is not covered by the warranty.

3) Contact technical support:

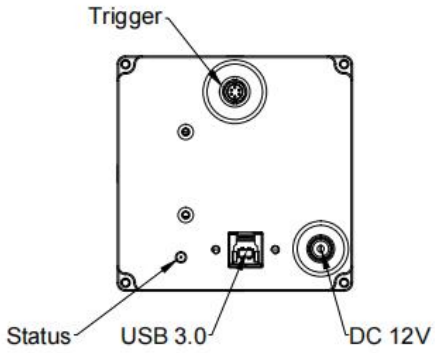
- TEL: +86-591-28055080-818
- Email: service@tucsen.com
- Or landing the official website to leave a message: http://www.tucsen.com.

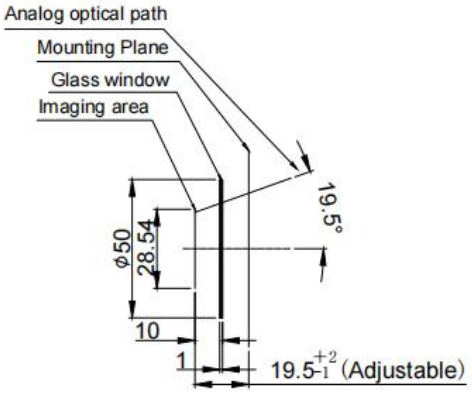
4) Please have the following information prepared:

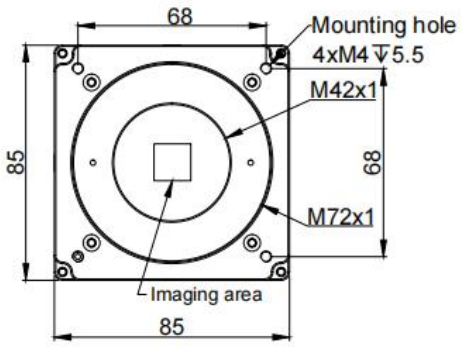
- Camera model and S/N (product serial number);
- Software version number and PC system information;
- Description of the problem and any images related to the problem.

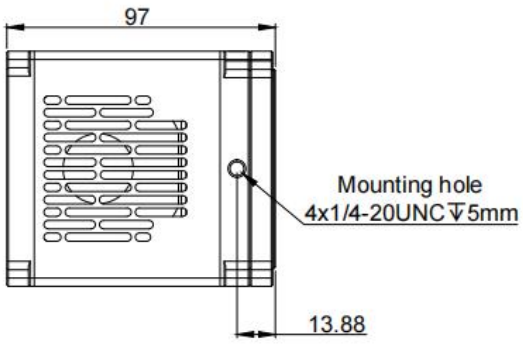
Appendix 1: Dimensions

Unit: mm, Diameter: ø.









Appendix 2: Specifications

Model	FL 26BW
Sensor Type	BSI CMOS
Sensor Model	SONY IMX571BLR-J
Peak QE	92% @ 530 nm
Color / Mono	Mono
Array Diagonal	28.3mm（1.8”）
Effective Area	23.4 mm × 15.6 mm
Resolution	6240 × 4168
Pixel Size	3.76 μm × 3.76 μm
Dark Current	< 0.0005 e-/p/s
Gain Mode	Gain 0, Gain 1, Gain 2, Gain 3
Full-Well Capacity	49 ke- @ Gain 0 15.7 ke- @ Gain 1 7.8 ke- @ Gain 2 3 ke- @ Gain 3
Readout Noise	2.7 e- @ Gain 0 1.0 e- @ Gain 1 0.95 e- @ Gain 2 0.85 e- @ Gain 3
Frame Rate	6.5 fps@6240 × 4168 (Standard) 3.4 fps fps@6240 × 4168 (Low Noise) 35.5fps@3120 × 2084(SenBin)
Shutter Type	Rolling, Global Reset
Exposure Time	34 μs ~ 60 min
Image correction	DPC
ROI	Support
Binning	2 × 2, 3 × 3, 4 × 4, 5 × 5, 6 × 6, 8 × 8, 16 × 16
Cooling Method	Air cooling
Max. Cooling	Below ambient temperature 47°C
Trigger Mode	Hardware, Software
Output Trigger Signals	Exposure start, Global, Readout end, High, Low

Trigger Interface	Hirose-6-Pin
SDK	C, C++, C#, Python
Software	Mosaic, SamplePro, LabVIEW, MATLAB, Micro-Manager2.0
Data Interface	USB 3.0
Optical Interface	M42, supports customization
Data Bit Depth	12bit, 14bit, 15bit, 16 bit
Power Supply	12 V/8A
Power Consumption	≤50W
Dimensions	85 mm x 85 mm x 97 mm
Weight	945 g
Operating System	Windows/Linux

Note: The parameters in this table are typical values and are subject to change without notice.

Appendix 3:Third party software applications

Provide plugins for third-party software (LabVIEW, Matlab, Micro-Manager, etc.). Please click the link to download the configuration:Tucsen camera software download - Tucsen

Appendix 4: Third party certification

Certificate of Compliance

Certificate No.: FQII-DZ-23018

Certificate Holder: FuJian Tucsen Photonics Co.,Ltd.

Address: Room E07, 1F of Comprehensive Building, NO.27 Jiayang Alley, Antai Sub-District Gulou District, Fuzhou, Fujian

Product Description: Scientific Camera

Model Reference: FL 26BW

Brand Name: TUCSEN

Report No.: (2023) DZ10056

Standard/Directive:

EC Electromagnetic Compatibility Directive 2014/30/EU
EN 55032: 2015+A11:2020+A1:2020 , EN 55035: 2017+A11:2020 ,
EN IEC 61000-3-2:2019+A1:2021 , EN 61000-3-3:2013+A1:2019+A2:2021

This certificate applies specifically to the sample investigated in our test report number only. The test results apply only to the particular sample tested and to the specific tests carried out.

The CE marking can be affixed on the product after preparation of necessary conformity documentation.

Zhang Chengjian
Authorized Signatory
Date of Issue: Nov.24 , 2023

FUJIAN INSPECTION AND RESEARCH INSTITUTE FOR PRODUCT QUALITY
No.6, Shuangfeng Road, Hongshan, Gulou District, Fuzhou, Fujian, China

SGS

Verification Report No.: CANEC24005670901 **Date:** May 28, 2024 Page 1 of 18

Client Name: FUJIAN TUCSEN PHOTONICS CO.,LTD

Client Address: ROOM E07, 1F OF COMPREHENSIVE BUILDING, NO. 27 JIAYANG ALLEY, ANTAI SUB-DISTRICT, GULOU DISTRICT, FUZHOU, FUJIAN

Sample Name: Scientific Camera

Tested Basic Model No.: FL 26BW

The above sample(s) and information were provided by the client.

SGS Job No.: XMP24-001241

Sample Receiving Date: Mar 26, 2024

Verification Period: Mar 26, 2024 ~ May 13, 2024

Verification Requested: With reference to RoHS Directive (EU) 2015/863 amending 2011/65/EU.

Verification Method(s): Please refer to next page(s).

Verification Result(s): Please refer to next page(s).

Test Result Summary:

Test Items	Conclusion
EU RoHS Directive (EU) 2015/863 amending Annex II to Directive 2011/65/EU - Lead, Mercury, Cadmium, Hexavalent chromium, Polybrominated biphenyls (PBB), Polybrominated diphenyl ethers (PBDE), Bis(2-ethylhexyl) phthalate (DEHP), Butyl benzyl phthalate (BBP), Dibutyl phthalate (DBP) and Diisobutyl phthalate (DIBP)	Pass

Signed for and on behalf of
SGS-CSTC Standards Technical Services Co., Ltd. Guangzhou Branch

Jenny Liao
Approved Signatory

scan to see the report
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Appendix 5: Update log

Version	Date	Modify Content
V1.0.0	2024-5-31	Create documents