Dhyana 401D
User Manual

V1.0.0

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Contents

1. Introduction

1.1. Disclaimer

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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 disconnect 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.

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

Standard Item Name	Specification	Quantity	Image
sCMOS scientific grade camera	Dhyana 401D	1	
USB3.0 data cable	2 m	1	
USB flash drive	Software and Drivers	1	

Optional Item Name	Specification	Quantity	Image
Hirose trigger cable	HR10A-7R-6PB(73)	1	
Level conversion box	Standard	1	

2.2. Quantum efficiency curve

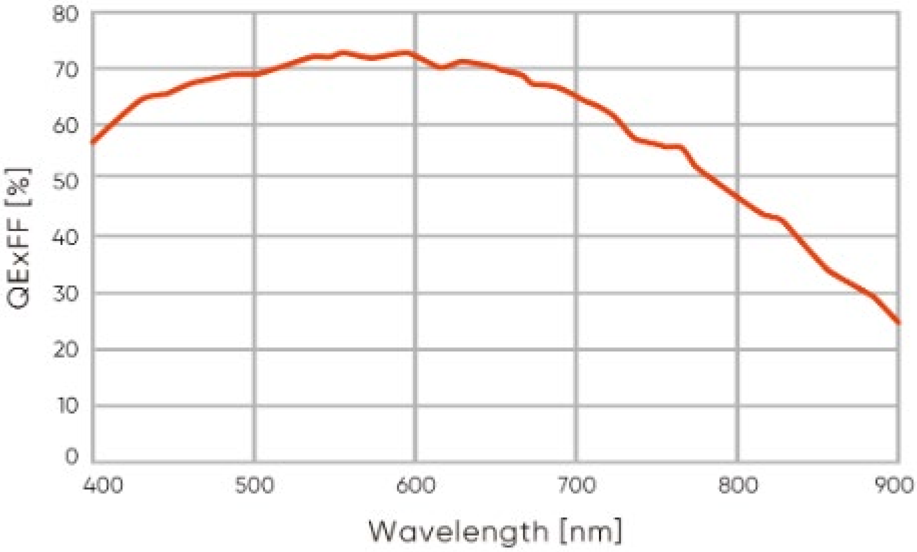


Figure 2-1 Quantum efficiency curve of Dhyana 401D

2.3. Window curve

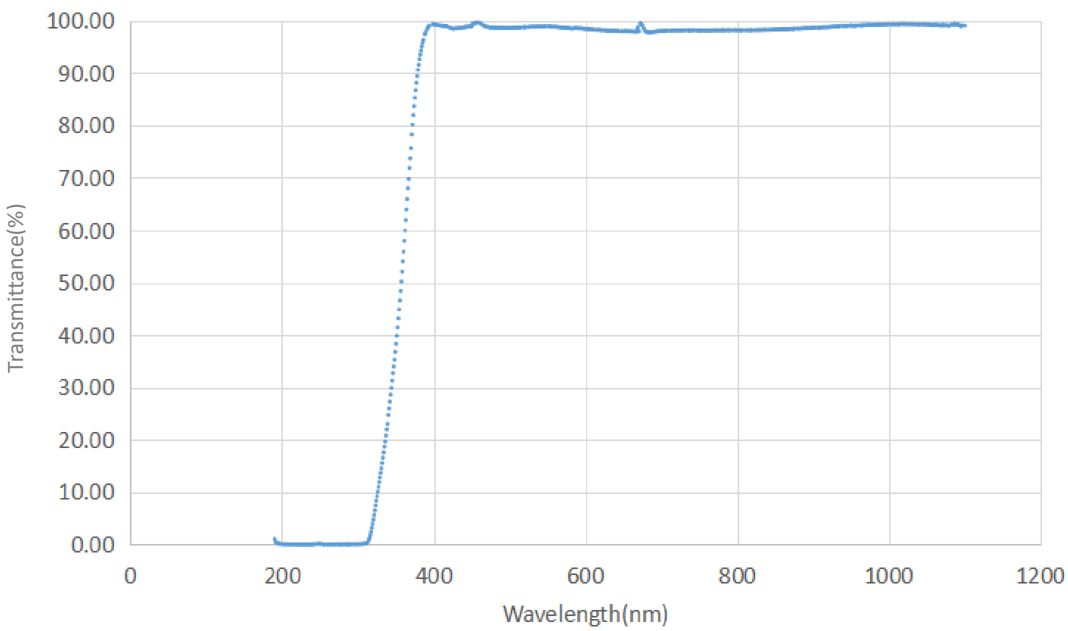


Figure 2-2 Transmission curve of a standard glass window

2.4. Camera power and signal connection

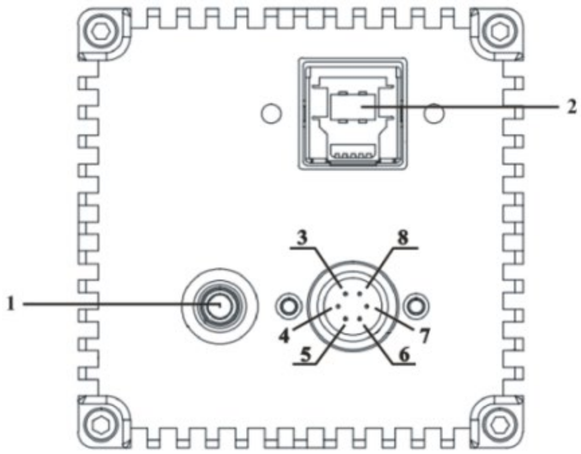


Figure 2-3 Camera interface diagram

No.	Name	Fuction
1	Indicator light	Indicate the camera status Red: Camera powered on Orange *: Normal operation
2	USB 3.0 interface	Camera data transfer
3-8	TRIG.OUT	External trigger input and output: Hirose-6-pin trigger interface, Model: HR10A-7R-6PB(73) 3: TRI_IN External trigger input 4: TRI_GND TRI ground 5, 8: NC 6: TRI_OUT0 Exposure start signal, corresponding to software Port2 7: TRI_OUT1 Readout end signal, corresponding to software Port1 The above trigger output signal types support custom settings by the customer.

*** 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 Dhyana 401D camera features a compact design that is well-suited for integration into instrument systems, achieving efficient coordination between hardware and software. With a readout noise as low as 2 electrons, it ensures image signal-to-noise and accuracy. The pixel size is perfectly matched with high numerical aperture microscope objectives, making it an ideal choice for both scientific research and industrial inspection. Whether for scientific research, medical diagnostics, or precision manufacturing, it provides users with high-quality image acquisition and imaging experience.

3.2. Structure and Operation of sCMOS

Scientific grade complimentary metal-oxide semiconductor (sCMOS) cameras are specialized cameras used for scientific research and high-performance imaging. They combine the advantages of CMOS and Charge coupled device (CCD) technologies, featuring high speed, low noise, and high sensitivity, and are widely used in scientific research, biomedical imaging, optical microscopy, and other fields.

The structure of an sCMOS camera sensor typically includes the following components:

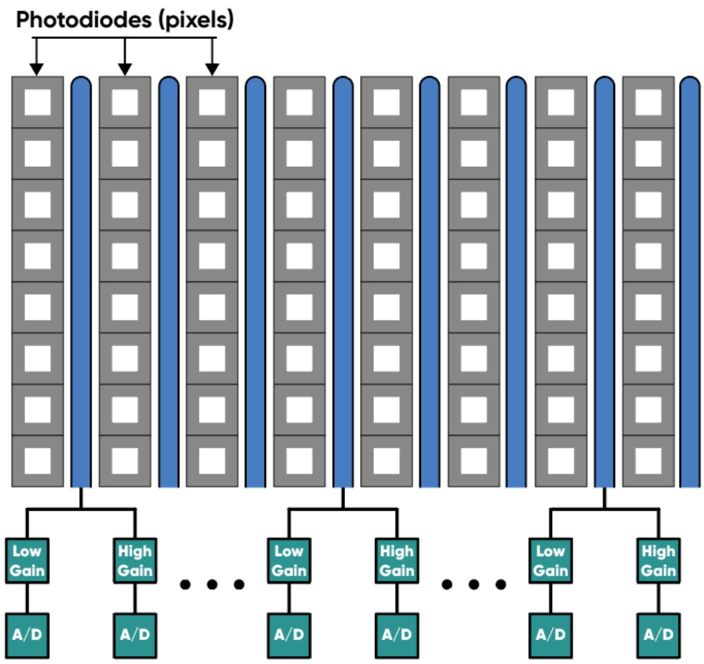


Figure 3-1 sCMOS camera sensor structure

1) Light-sensitive sensor array: sCMOS cameras use sCMOS sensor arrays (also known as image

sensors) to capture light signals. These sensors consist of many photosensitive units that convert light into charge signals.

2) Gain amplifier: Each photosensitive unit in an sCMOS camera is equipped with an independent gain amplifier to amplify the charge signal and convert it into a voltage signal.

3) Analog-to-digital converter (ADC): The amplified analog signal is digitized through an analog-to-digital converter (ADC) inside the camera, converting it into a digital signal for further processing and storage.

sCMOS cameras typically also include an image processing unit for performing image enhancement, correction, and other image processing algorithms. The digitized image undergoes these processes to obtain higher-quality images.

The operation process of an sCMOS camera is as follows:

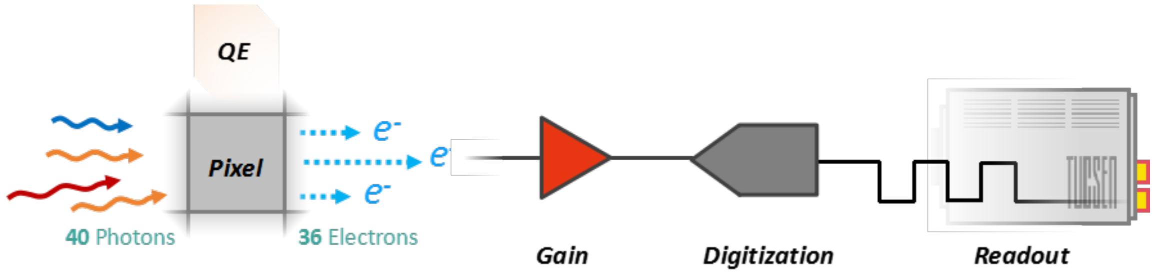


Figure 3-2 sCMOS operation process

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 401D camera uses a rolling shutter readout mode. In this mode, the camera reads out rows sequentially, with consistent exposure time for each row, but different starting exposure time point for different rows. The difference in exposure time points between adjacent rows is also known as the line time (T_{line}).

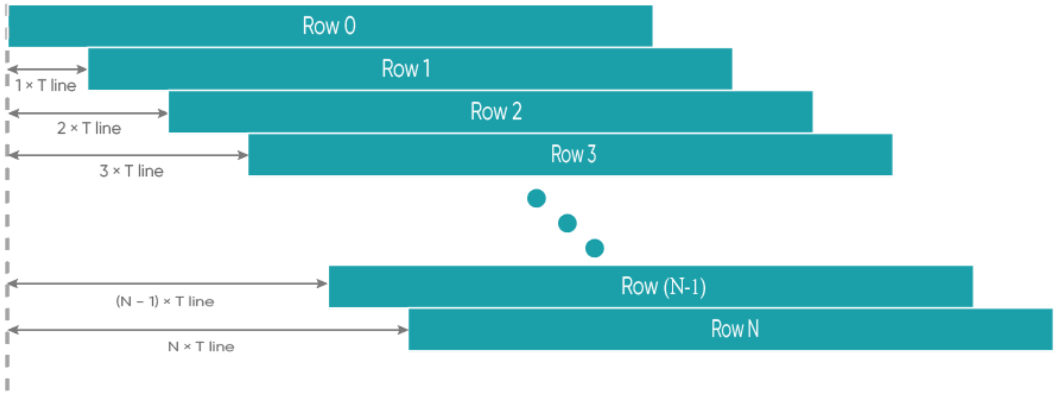


Figure 3-3 Rolling shutter diagram

In rolling shutter mode, if the camera is not synchronized with external light sources or if flickering light sources are present, it may result in striped images. This effect is especially noticeable with short exposure times(Please refer to the FAQs for solutions).

3.4. Readout Noise

Noise describes the uncertainty of a signal. Noise introduced by the circuitry during readout is called readout noise. This noise dominates at low signal levels and can limit applications in low-light imaging. In CCDs, since all pixels share the same readout circuitry, the standard deviation (σ) of each pixel is relatively uniform, allowing for a single value to represent overall readout noise. In sCMOS cameras, each pixel has its own readout circuit, resulting in a distribution of readout noise across all pixels, often represented by median and root mean square (RMS) values. The median reflects the central value of pixel standard deviations, while RMS indicates overall noise levels, typically higher than the median. Accurate measurement of readout noise is usually achieved by capturing multiple dark field images under no light and the shortest exposure conditions, then calculating the temporal standard deviation for each pixel.

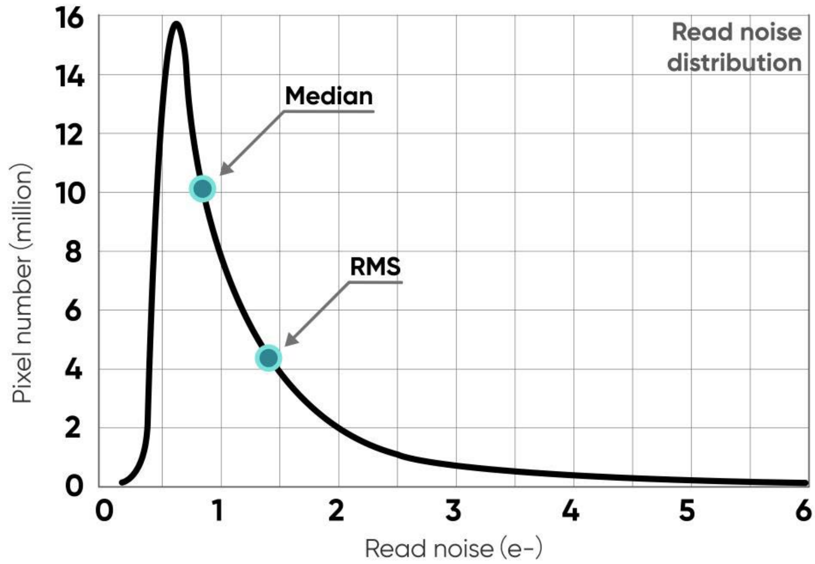


Figure 3-4 Readout noise distribution of an typical sCMOS camera

3.5. Defective Pixel Correction (DPC)

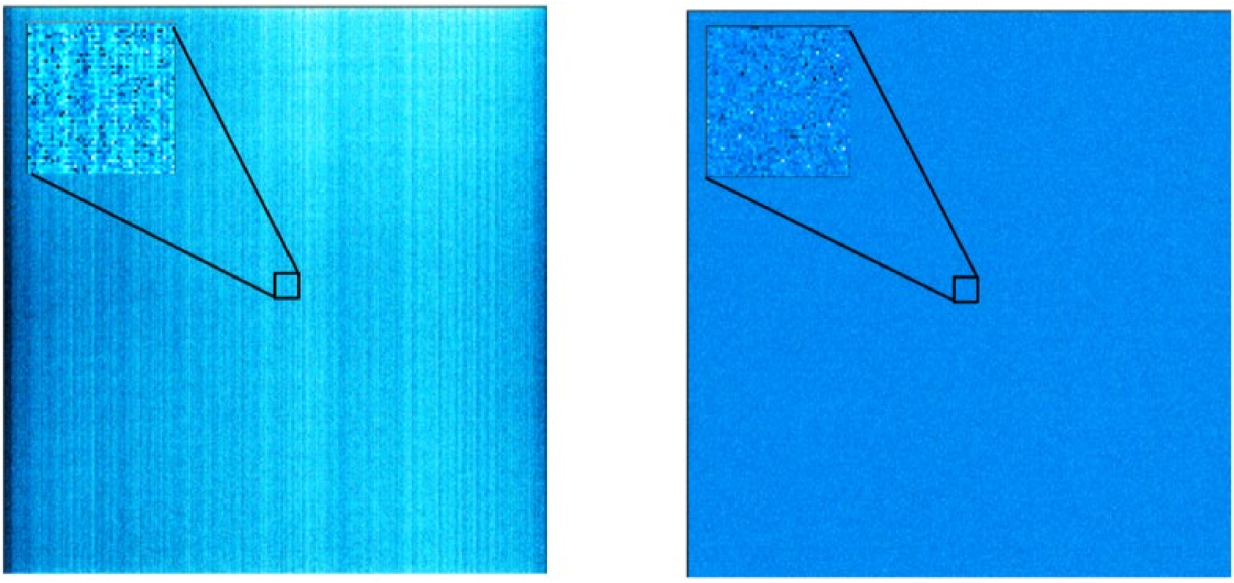
There are always a few abnormal values on the sCMOS camera chip. Through the camera's Defective Pixel Correction (DPC) function, these abnormal points can be corrected, removing defective pixels from the image. However, this may cause flickering pixels in some single-molecule imaging applications. It is not recommended to use the DPC function for these applications or to use only the weakest correction level.

The Dhyana 401D 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.

3.6. Dark Signal Non-Uniformity (DSNU)

When the camera captures images in complete darkness, ideally, all pixel grayscale values should be close to zero and equal. However, in reality, when the camera captures images in darkness, subtle differences in the performance of each pixel in the sensor will cause some variations in the pixel grayscale values outputted from the camera.

In practical applications, when there are no photons incident on the camera, the obtained image usually does not show a grayscale value of 0 (DN). This is because manufacturers typically set a offset value, such as 100 grayscale values, to account for the influence of noise on measurements based on this baseline in the absence of light. However, without careful calibration and correction, this fixed offset may also vary between different pixels. This variation is called "fixed pattern noise" and can be measured by DSNU (Dark Signal Non-Uniformity). It represents the standard deviation of pixel bias, measured in charge units.



Before correction After correction

Figure 3-5 DSNU correction comparison before(left) and after(right)

For many low-light imaging cameras, the Dark Signal Non-Uniformity (DSNU) is usually low. This means that in applications with moderate to high light levels (where each pixel typically captures hundreds or thousands of photons), the impact of DSNU can be considered negligible. Moreover, even in low-light applications, if the DSNU is lower than the camera's readout noise, this fixed-pattern noise is unlikely to significantly affect image quality.

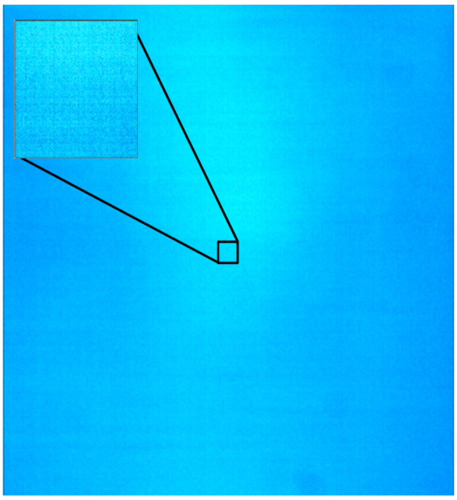
3.7. Photo Response Non-Uniformity (PRNU)

When a camera captures uniformly illuminated light targets under bright light conditions, ideally, all pixel grayscale values should be close to the maximum grayscale value and equal. However, in reality, there are subtle differences in the performance of camera pixels, causing changes in pixel grayscale values outputted from the camera due to variations in lenses or illumination.

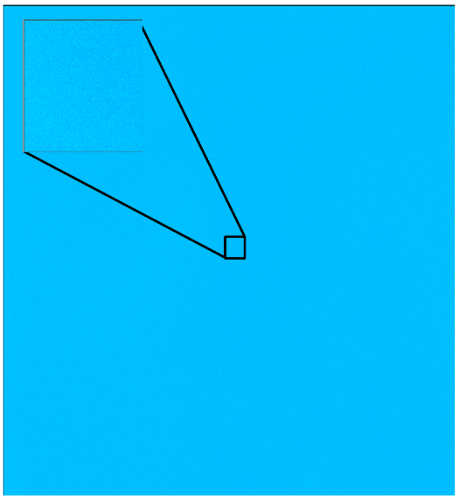
When the camera detects light signals, the number of photoelectrons captured by each pixel during the exposure process is measured and transmitted as digital grayscale values (DN) to the computer. The conversion from electrons to DN follows a certain proportion, called the system gain (K) or conversion gain, plus a fixed offset (usually 100 DN). These values are determined by both the analog-to-digital converters and amplifiers used for conversion. sCMOS cameras use parallel transmission, with one or more analog-to-digital converters per column of the camera and one amplifier per pixel, resulting in slight variations in pixel gain and offset.

In dark field or low-light conditions, bias variations can be measured by the DSNU mentioned in

Section 3.5. In bright environments, however, the effect of gain must also be considered. The differences caused by gain and bias variations are measured by the Photo Response Non-Uniformity (PRNU), which is the ratio of detected electrons to displayed DN (digital number). Since the intensity values produced depend on the signal size, PRNU is expressed as a percentage.



Before correction 1.6%



After correction 0.3%

Figure 3-6 PRNU correction comparison before(left) and after(right)

The calibrated PRNU value is negligible compared to readout noise and other noise sources for low-light and medium-intensity imaging (with signals of 1000 e- or less). Similarly, at high light levels, the variation in PRNU is not significant compared to other noise sources in the image, such as shot noise. However, for high-precision imaging applications at high light levels—especially those using frame averaging or frame summing—a PRNU value of less than 1% is necessary.

3.8. Gain Mode

The 401D camera offers three operating modes: High Dynamic Range (HDR), High Gain (HG), and Low Gain (LG). Each mode differs in terms of synthesis principles, line time, gain values, and readout noise. Selecting the appropriate mode based on the actual scene is essential to achieve high-quality imaging results.

Table 3-1 Typical gain mode parameter table*

Mode	HDR	HG	LG
System gain (DN/e-)	1.5	2.15	0.08
Full-Well Capacity (e-)	40000	1700	43000
Readout noise(e-)	2.2(Median) 2.7(RMS)	2.0(Median) 2.8(RMS)	21(Median) 22(RMS)

***Note:**

The values in this table are typical and may vary between different cameras. Please refer to the factory photoelectric report for specific details.

3.8.1. High Dynamic Range

High Dynamic Range (HDR) mode synthesizes images with different analog gains but the same exposure time. It includes Low Gain (LG) mode with high full well capacity and high noise suitable for imaging strong signals, and High Gain (HG) mode with low full well capacity and low readout noise suitable for imaging weaker signals. Combining high and low gain images through algorithms generates an HDR image. This mode is suitable for applications with large variations in signal strength.

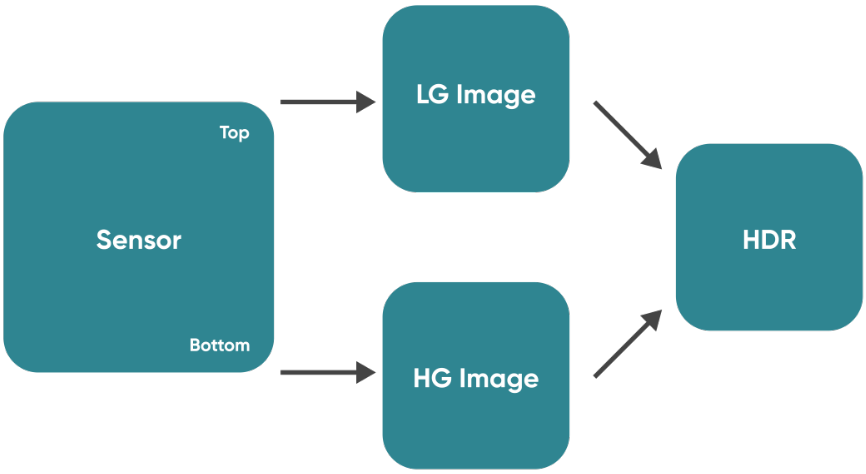


Figure 3-7 Schematic diagram of HDR mode

3.8.2. High Gain

The High Gain (HG) mode has lower readout noise and is suitable for imaging scenarios with weaker signals.

3.8.3. Low Gain

The Low Gain (LG) mode has a higher full well capacity, making it suitable for imaging scenarios with strong signals.

3.9. Region of Interest Readout

In imaging applications, ROI (Region of Interest) is a defined sub-region within the camera sensor's resolution range that is of particular interest. Once the ROI is selected, only the image data within this sub-region is read out. For rolling shutter cameras, reducing the number of rows can increase the camera's readout rate. The software allows for preset sub-regions and also supports user-defined settings. The row window size must be a multiple of 4, and the column window size must be a multiple of 8.

The typical measured frame rates (fps) for different ROI regions of the Dhyana 401D camera under USB 3.0 are shown in the table below:

Table 3-2 Typical ROI area measured frame rate (fps) table for Dhyana 400BSI V3 camera under USB 3.0

Column (Pixel)	Row (Pixel)	HDR 16bit (fps)	HG/LG 12bit (fps)	HDR/HG/LG 8bit (fps)
2048	2048	40	45	45
2048	1024	80	91	91
2048	512	160	182	182
2048	256	320	362	362
2048	128	641	720	720
2048	64	1284	1418	1418
2048	32	2603	2753	2753
2048	16	5050	5201	5201
2048	8	9100	9363	9363

Note:

1) *The minimum supported ROI for Dhyana 401D on Mosaic V3 is 48 (columns) × 8 (rows).*

2) *Frame rates are affected by computer system configuration, and it is recommended to use a computer with an i5 processor or above and a 64-bit system.*

3) *For high-speed image acquisition, it is recommended to uncheck automatic levels and turn off the Image Adjustment module.*

4) The frame rates in the above table are the measured maximum values under the shortest exposure time.

3.10. Binning Readout

Binning is a readout mode that recombines camera pixels, which can improve sensitivity but may also reduce resolution. For example, 2 x 2 binning combines every 4 pixels (2 rows 2 columns) into one "large pixel", and the camera outputs one pixel intensity value.

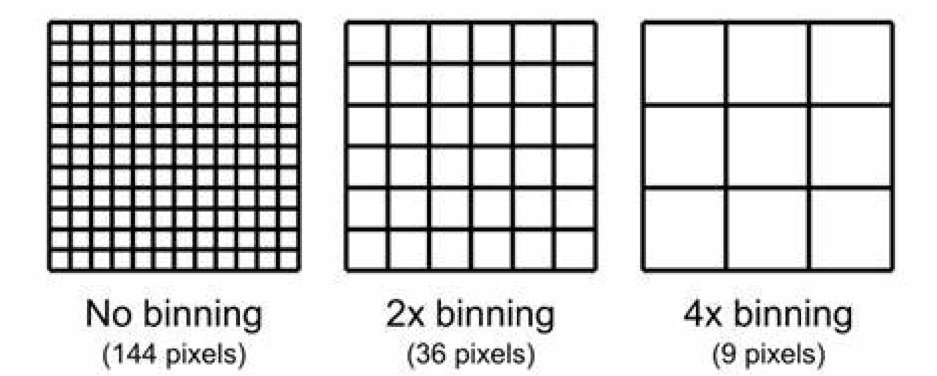


Figure 3-8 Schematic diagram of Binning

Binning can be performed by the camera's FPGA or by the camera operating software. Combining signals in this way can improve the signal-to-noise ratio, enabling the detection of weaker signals, improving image quality, or shortening exposure times. However, the effective pixel size of the camera also increases, which may reduce the camera's resolution of target details.

Binning data processing can be divided into Sum Binning and Average Binning. In 2 x 2 Binning, for example, Sum Binning adds the grayscale values of four pixels, while Average Binning adds the grayscale values of four pixels and then divides by 4 to obtain the average grayscale value.

The software Binning seclection on Mosaic V3 is shown below:

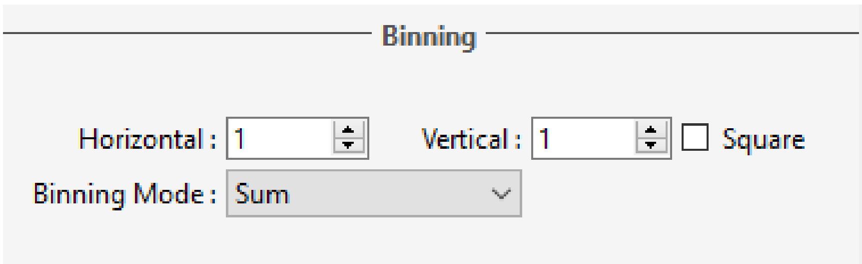


Figure 3-9

The FPGA Binning seclection on Mosaic V3 is shown below:

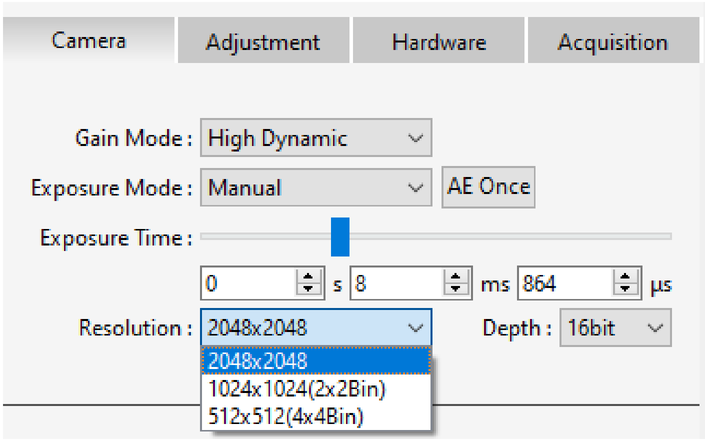


Figure 3-10

3.11. Timestamp

The camera accurately reads the start time of each frame with a time precision of 1 µs. In Mosaic V3 software, images are saved in .sen format, and timestamp information is displayed in the image information, supporting the export of image information to .csv format files.

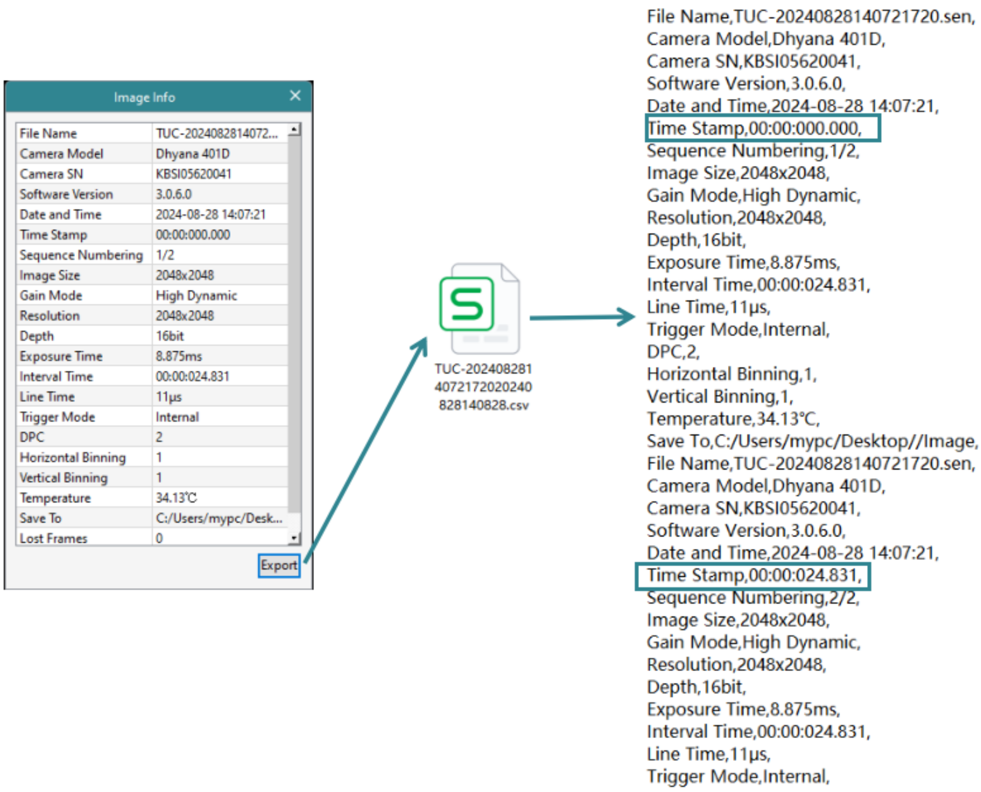


Figure 3-11 Timestamp export schematic

Note:

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

3.12. Frame Rate Calculation

The camera's frame rate is influenced by the readout time and exposure time. Theoretical frame rates are calculated based on Tables 3-4 and 3-5.

The line time and theoretical minimum full-frame readout times for each mode of the Dhyana 401D are shown in the table below:

Table 3-3 Calculation of readout time

Gain mode	Line time（T_{line}）	Readout Time（$T_{readout}$）
High Dynamic Range HighGain LowGain	10.68μs	(2048+2)×10. 68μs=21.894ms

Typical frame rate calculation for USB 3.0:

Where Hn: The number of rows selected horizontally; Vn: The number of rows selected vertically; T_{line}: Line time; T_{exp}: The set exposure time; Y_{U3}: 40 fps(Maximum frame rate at full frame in USB3.0)

Table 3-4 Frame rate calculation for 12-bit and 8-bit bit depth

Gain mode	Line time T_{line}	Calculation formula	Horizontal (Hn)	Vertiacal (Vn)	Frame rate (fps)
HG/LG(12Bit） HDR/HG/LG(8bit)	10.68μs	1/((Vn+2)*T_{line})	2048	2048	45.68
				1024	91.26
				512	182.17
				256	362.92
				128	720.28
				64	1418.7

Table 3-5 Frame rate calculation for HDR 16-bit bit depth

Gain mode	Line time T_{line}	Calculation formula	Horizontal (Hn)	Vertiacal (Vn)	frame rate (fps)
HDR（16Bit）	10.68μs	1/(Vn/2048/Y_{U3}）	2048	2048	40
				1024	80
				512	160
				256	320
				128	640
				64	1280

Note:

1) Frame rate is affected by actual transmission bandwidth and computer system configuration. To prevent frame drops, additional interval time in terms of line periods is added during actual transmission, resulting in increased readout time. This may cause the calculated frame rate to be higher than the actual frame rate;

2) The frame rate values in the table are calculated for the minimum exposure time. In HDR/HG/LG modes, when $T_{exp} > (T_{readout} - 2*T_{line})$, *the frame rate=* $1/(T_{exp} + 2*T_{line})$ *(s).*

3.13. Frame Rate Adjustment

Each frame image readout has a fixed blanking time, and frame rate adjustment is achieved by changing the blanking time (T blanking) to control the frame rate.

For example, if the exposure time < readout time, considering a frame rate of 60 fps, setting the frame rate to 45 fps adds 3.1 ms of blanking time during image output.

Similarly, if the exposure time > readout time, considering an exposure time of 100 ms, setting the frame rate to 5 fps adds 100 ms of blanking time during image output.

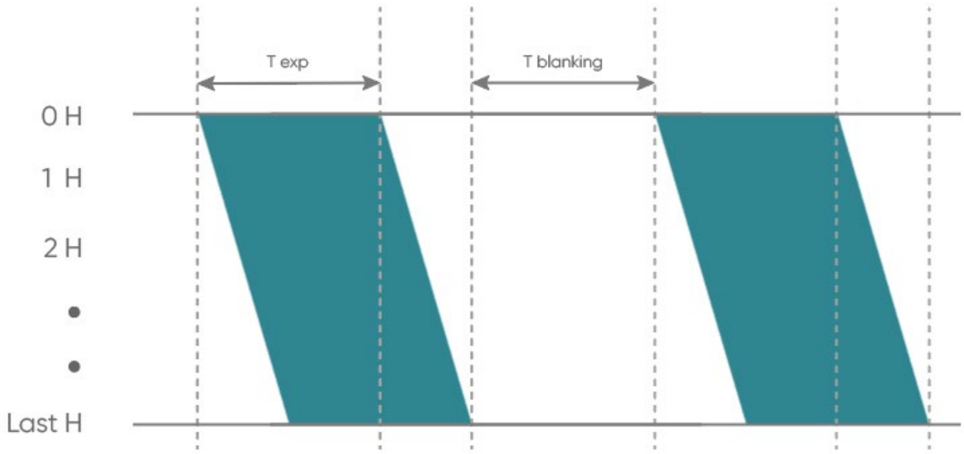


Figure 3-12 Frame rate adjustment timing diagram

3.14. 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) in (DN/e-). Q(λ) corresponds to the quantum efficiency at the wavelength. Offset is the camera's baseline value, measured in DN (digital numbers)..

3.15. Acquisition Mode

3.15.1. 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 the Mosaic V3 software and drivers, the hardware trigger mode defaults to "internal" (live mode), the user can click Preview/Stop to control the opening and closing of the camera live mode, and click Capture to obtain the image.

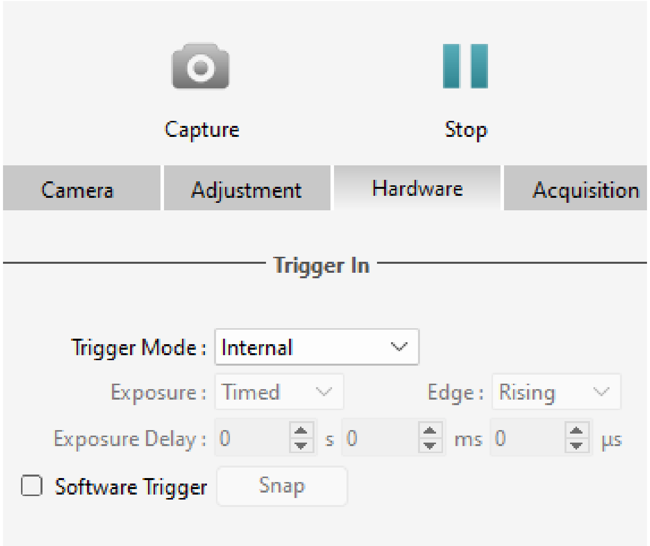


Figure 3-13

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

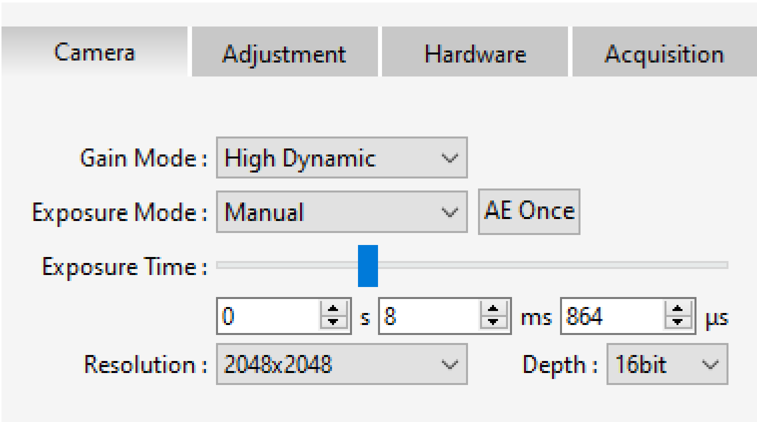


Figure 3-14

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.

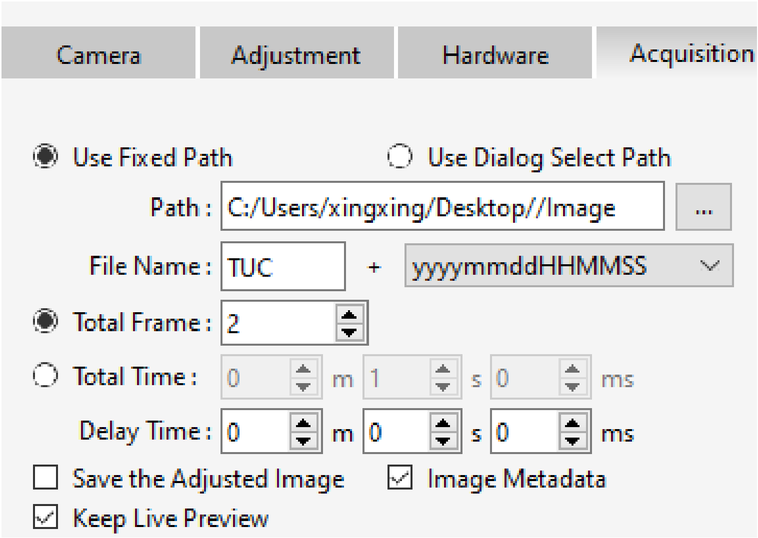


Figure 3-15

3.15.2. 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.

To use the software trigger mode in Mosaic V3, check the software trigger, click Capture to enter the waiting trigger state, and then click the **Snap** to execute the image capture command, and only output one image at a time.

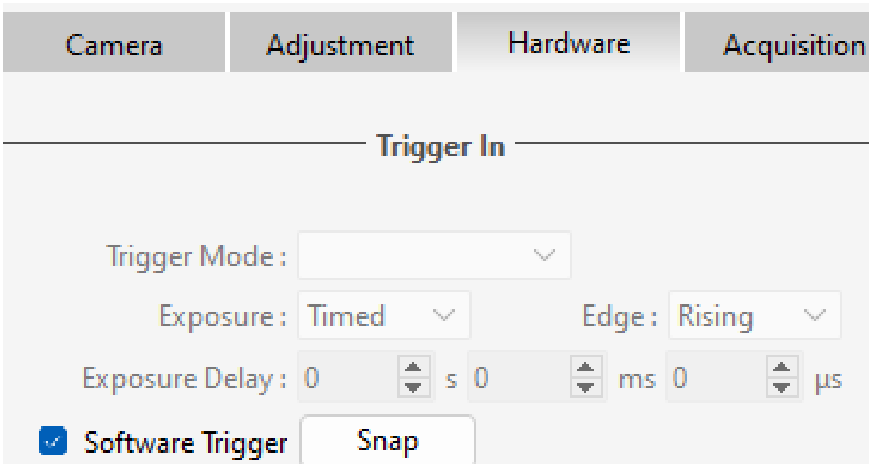


Figure 3-16

3.15.3. Hardware Trigger Mode

Hardware trigger mode waits for an external level trigger signal command to capture an image.

It includes two modes: Standard Overlap, Standard Non-Overlap.

The Mosaic V3 software provides configurations such as mode, frames/signal, exposure, edge, exposure delay, etc., to control the number of triggered images captured continuously according to the set quantity.

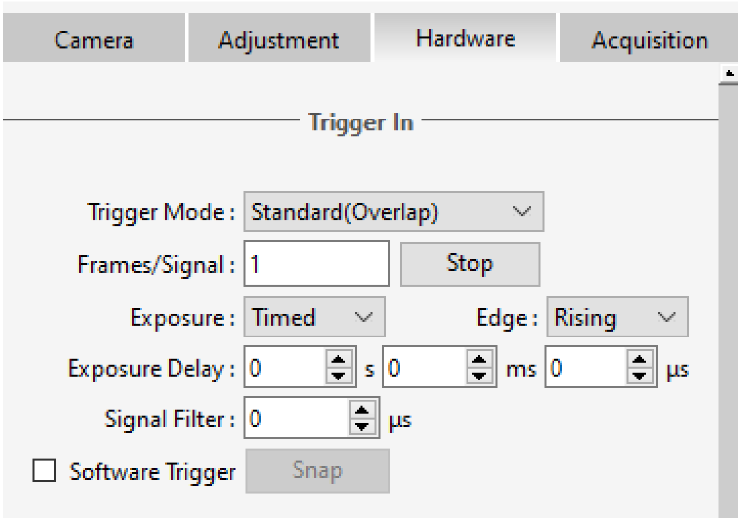


Figure 3-17

3.15.3.1. Hardware Trigger input circuit

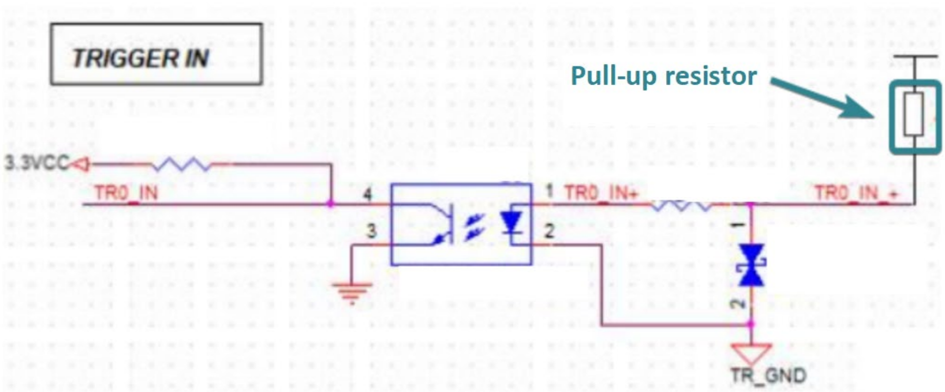


Figure 3-18 Hardware trigger input circuit

Note:

1) The external trigger circuit of the Dhyana 401D uses an optocoupler isolation circuit and requires an external pull-up resistor to enable the trigger function, as shown in the diagram: 3.3V voltage and 1kΩ resistor;

2) The trigger signal supports both square wave and sine wave signals.

3.15.3.2. Trigger Filtering

To suppress interference in the external trigger signal, external trigger filtering supports high and low-level filtering. This function filters out spikes in the level signal. The filtering time range can be set to [0, 1000000] µs, with the default being 0.

The following figure takes the filtering time set to 1 ms as an example:

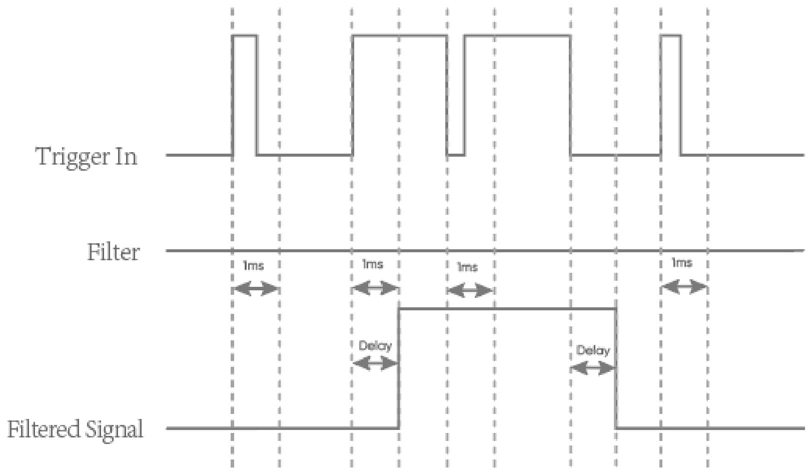


Figure 3-19 Trigger Filter function schematic

Note:

After the camera receives a valid trigger signal, the filter signal will lag behind the last edge of the jitter time period, with the lag time = the set filter time.

3.15.3.3. Trigger Delay and Jitter

As shown below, When the external trigger signal arrives, there is a nanosecond-level delay T_{iso}. through the hardware circuitry. After the delay through the hardware circuitry, the level signal input to the camera's internal undergoes conversion, resulting in some jitter T_{logic}, ranging from 0-1 minimum exposure unit T_{line}. Therefore, the total delay time from external trigger input to exposure start is T_{idelay}=T_{iso} + T_{logic}, within the range of one line time. If the Trigger Filter function is used, a Trigger Filter Delay Time T_{filter} is added to this.

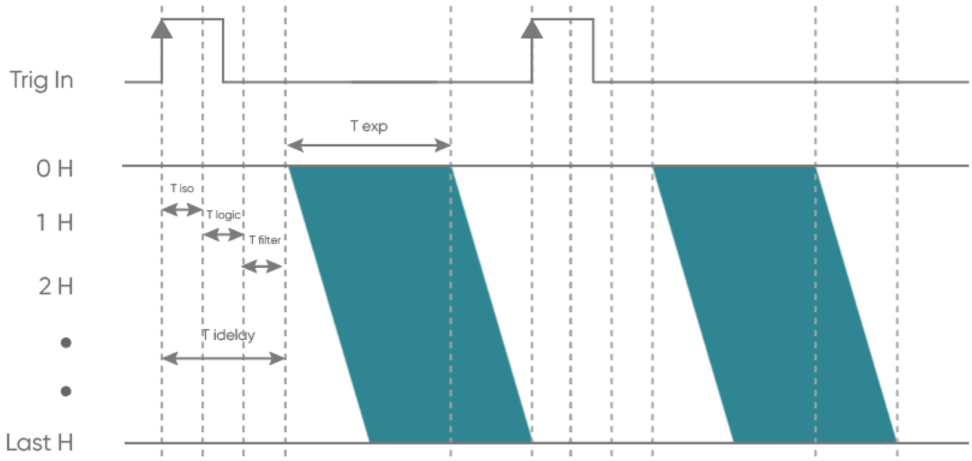


Figure 3-20 Trigger Delay Diagram

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

3.15.3.4. Standard Trigger Mode

Standard trigger mode is divided into Standard (Overlap) trigger mode and Standard (Non-Overlap) trigger mode.

Standard (Overlap) Trigger Mode: In this mode, when the camera is in live mode, it responds to the trigger signal immediately after the first row of exposure ends.

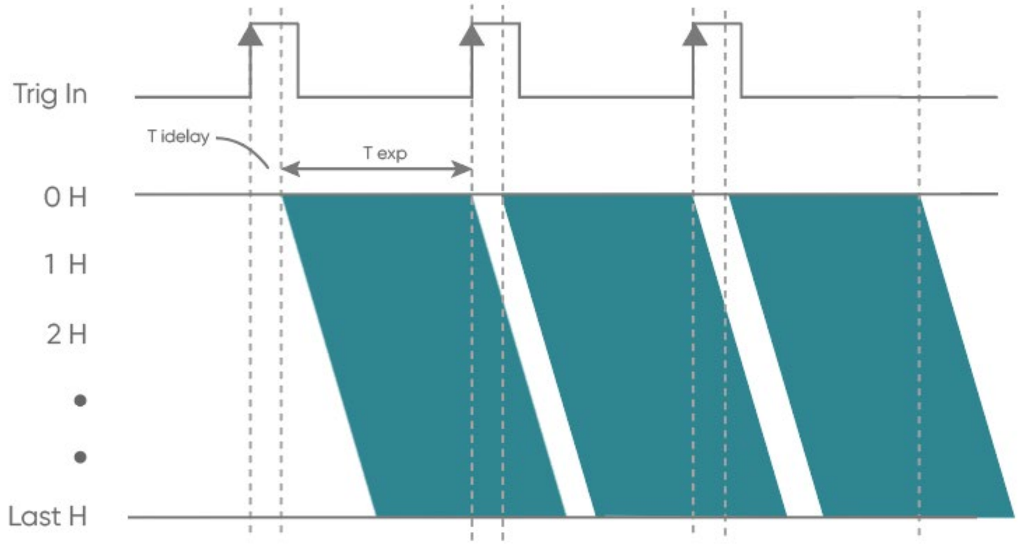


Figure 3-21 Standard (Overlap) Trigger timing

Standard (Non-Overlap) Trigger Mode: In this mode, when the camera is in live mode, it responds to the external trigger signal only after the readout ends.

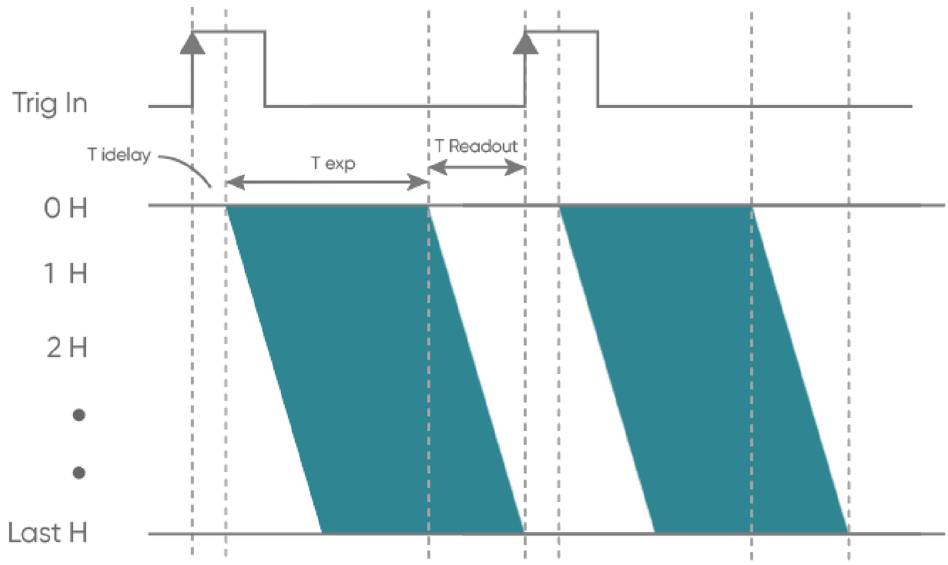


Figure 3-22 Standard (Non-Overlap) Trigger timing

Both of these modes support both level and edge triggering. In Standard (Non-Overlap) Trigger Mode, for example, in level trigger mode（i.e., the exposure type is selected as Width in the software）, exposure start and end are controlled by the duration of the trigger signal's high or low level. Level trigger mode is not continuous shooting; it is commonly used to capture stationary or slowly moving objects.

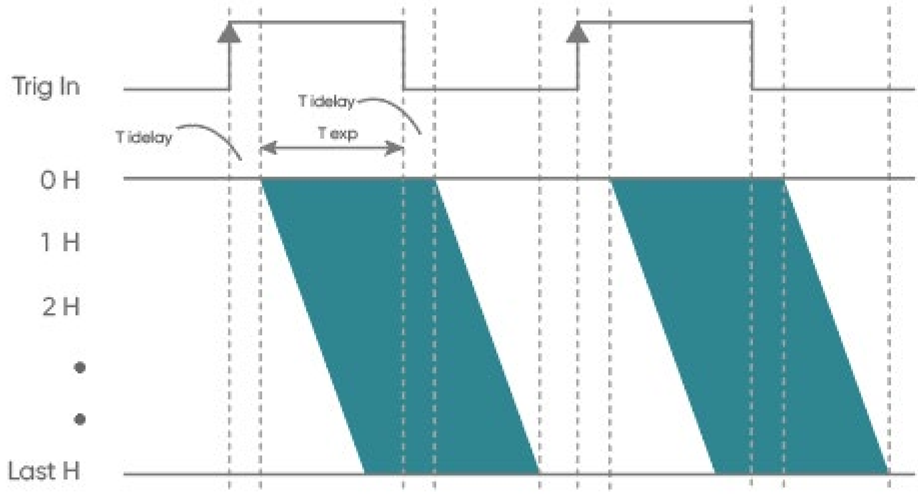


Figure 3-23 Non-Overlap Level Trigger timing diagram

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

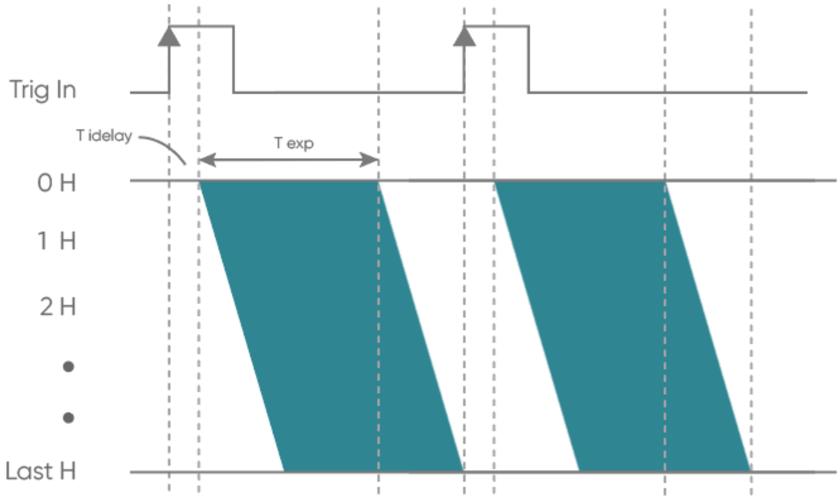


Figure 3-24 Edge Trigger timing diagram

401D camera supports single-trigger multi-frame acquisition function, you can modify the number of triggering out of the picture by setting the frame/signal in the standard triggering mode (refer to Figure 3-17), for example, by setting the number of 2, the triggering timing diagram is as follows:

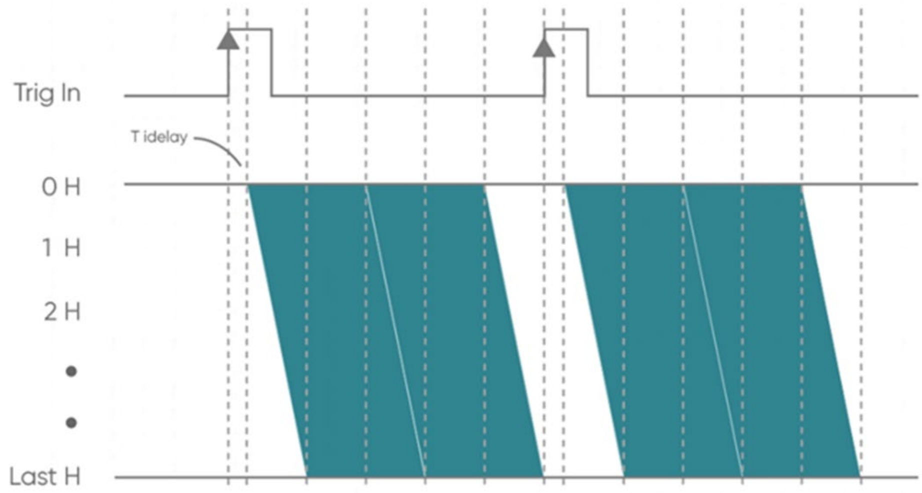


Figure 3-25 Single-trigger multi-frame acquisition timing diagram

3.16. Trigger Output

3.16.1. Hardware Trigger output circuit

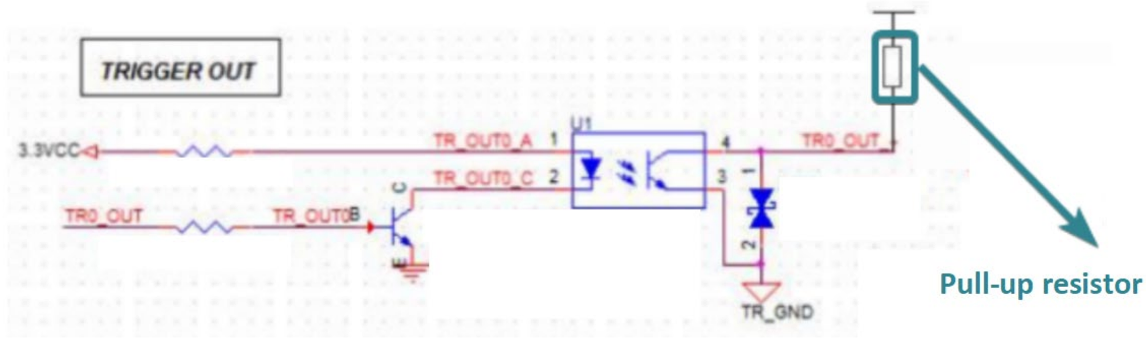


Figure 3-26

3.16.2. Trigger Output Timing Diagram

The camera has three external trigger output interfaces, each independently capable of outputting six timing signals. Each output signal can be independently configured on the three output ports and can simultaneously output to different devices.

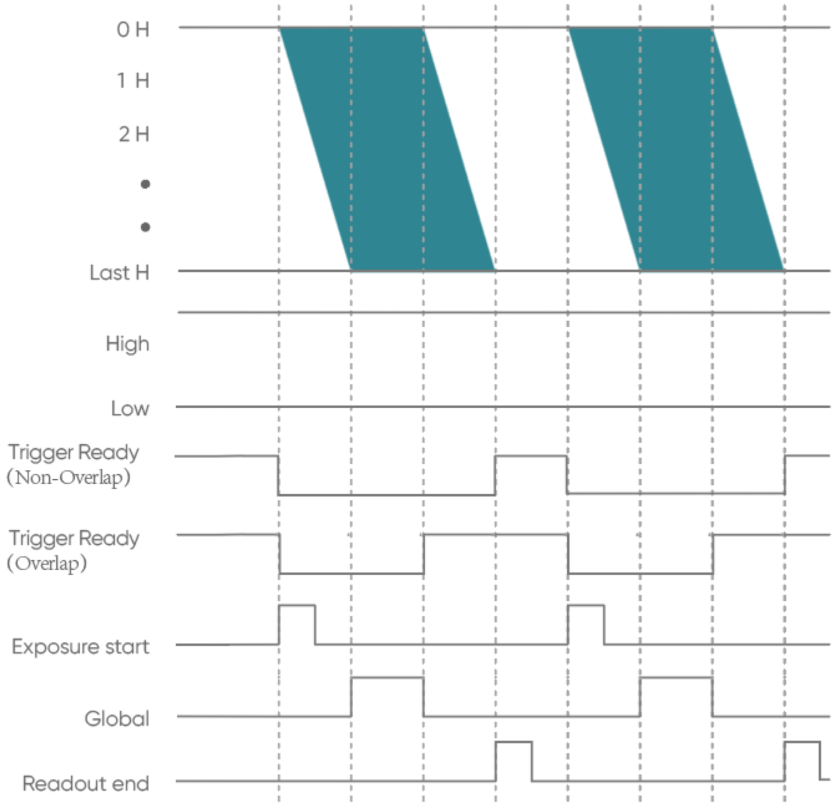


Figure 3-27 Trigger output timing diagram

- **High**: always output high level.
- **Low**: always output low level.
- **Trigger Ready**: when the camera is in the open-current state and can respond instantly to external triggers, the trigger ready output is high level.
- **Exposure Start**: output starting from the first line of exposure, the default pulse width is 5ms, which is customizable. And the output is in the Port2（TRIG.OUT0）interface by default.
- **Readout End**: output starting from the last line of exposure end, the default pulse width is 5ms, which is customizable. And the output is in the Port1（TRIG.OUT1）interface by default.
- **Global**: output from the beginning of the last line of exposure to the end of the first line of exposure end (valid when the exposure time is larger than the readout time).

4. Installation

4.1. Recommended computer configurations

Camera Interface	USB3.0
CPU	I5 and above performance, with a main frequency of 2.6GHz and above
Operating system	Windows 10/11 64 bit PC
Memory	8GB and above

4.2. Camera installation

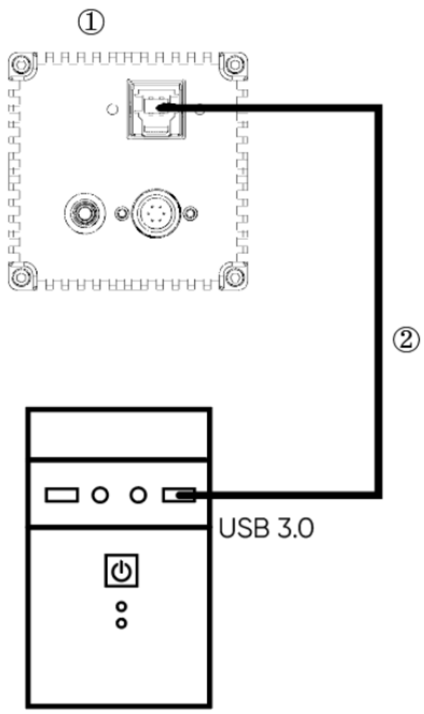


Figure 4-1 Dhyana 401D camera connection diagram

① Dhyana 401D camera

② USB 3.0 data cable

Connect one end of the USB 3.0 data cable to the PC, ensuring that the USB is plugged into the USB 3.0 port on the back of the host. Connect the other end to the sCMOS camera, secure the screws, and you should see the indicator light up, showing red.

Note:

The depth of the C-mount is 7 mm. Over-tightening the base may scratch the glass surface.

4.3. Driver installation and uninstallation

This section will introduce the installation of camera USB driver installation and uninstallation.

4.3.1. 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;

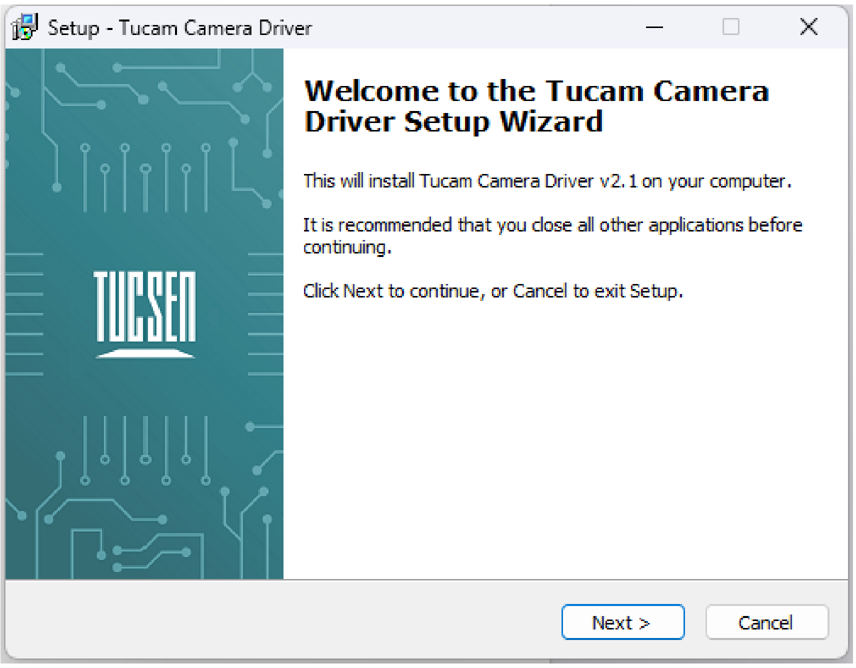


Figure 4-2

(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;

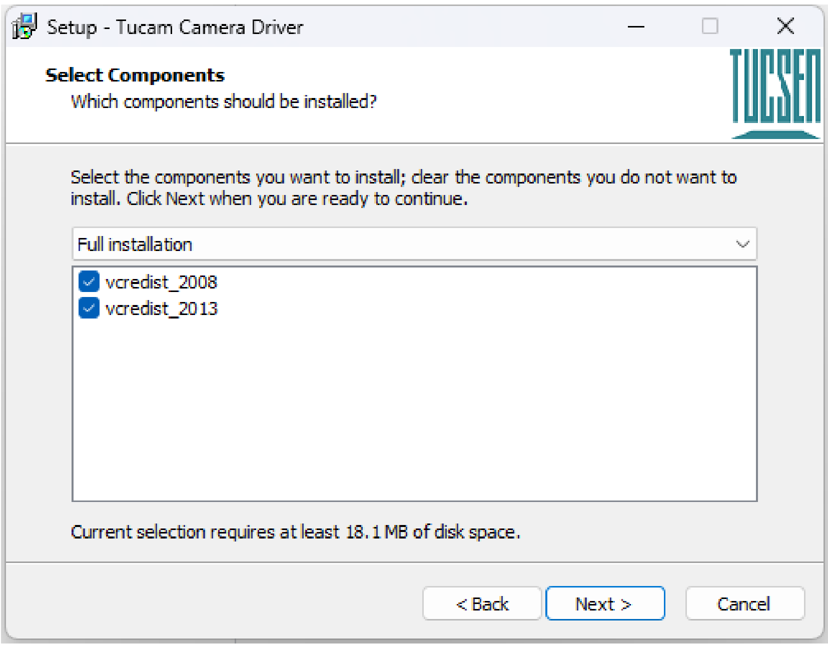


Figure 4-3

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

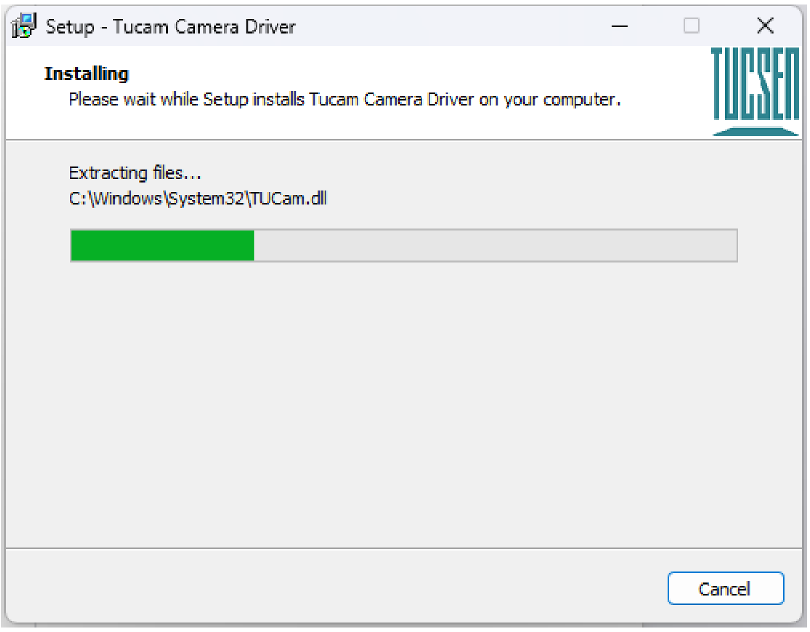


Figure 4-4

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

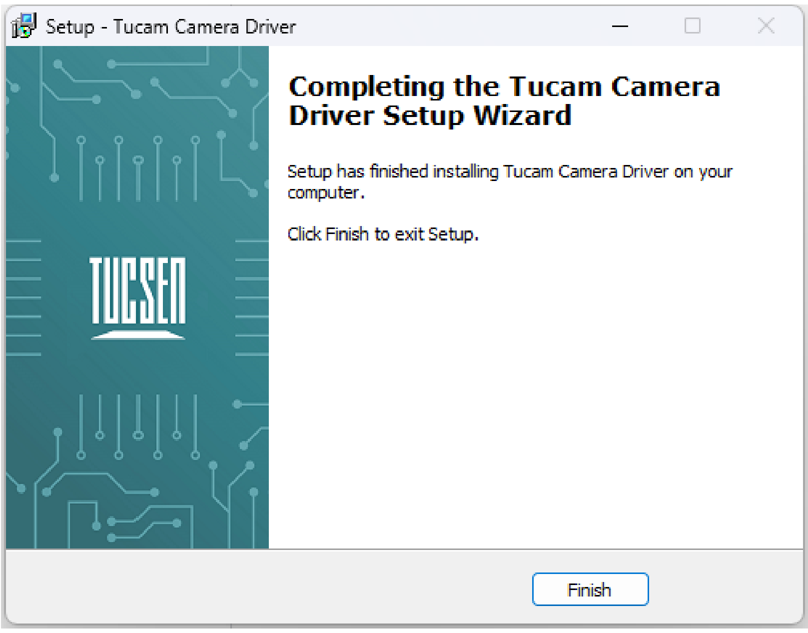


Figure 4-5

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

4.4. Software installation and uninstallation

4.4.1. 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 your needs;

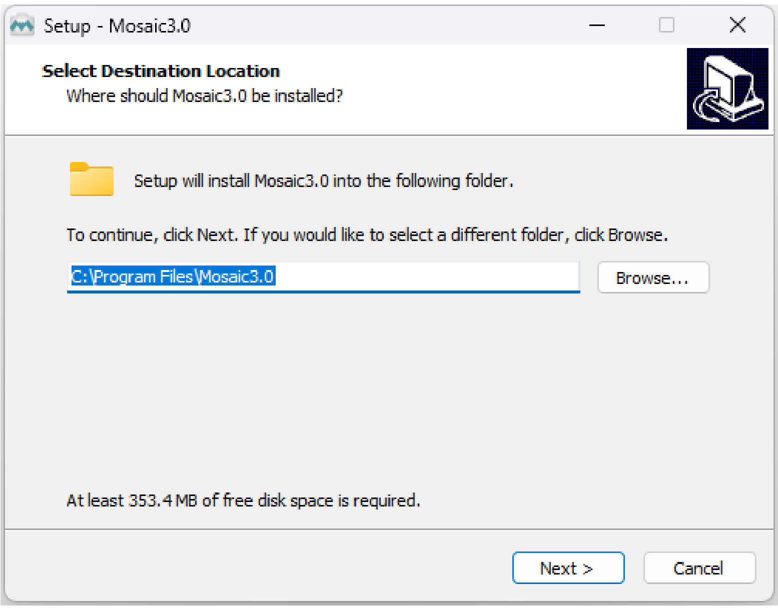


Figure 4-7

(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;

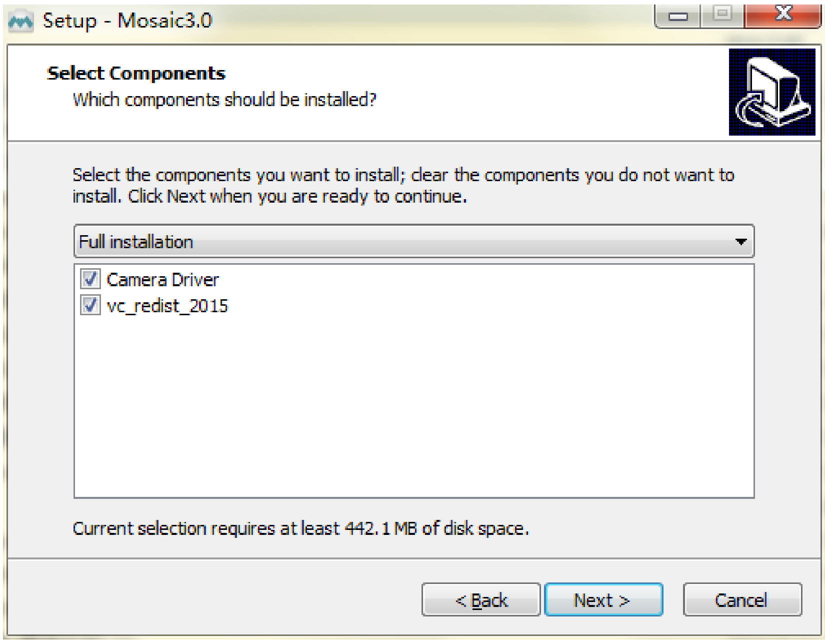


Figure 4-8

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

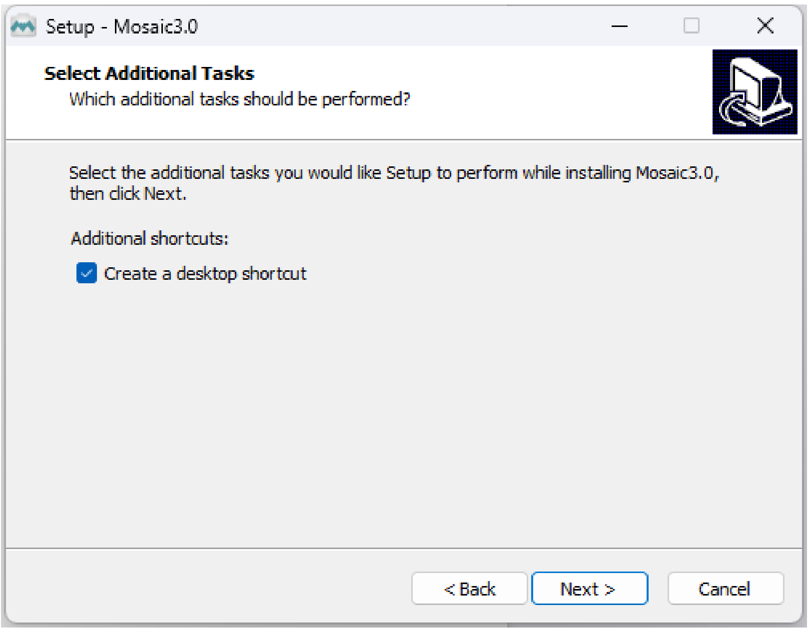


Figure 4-9

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

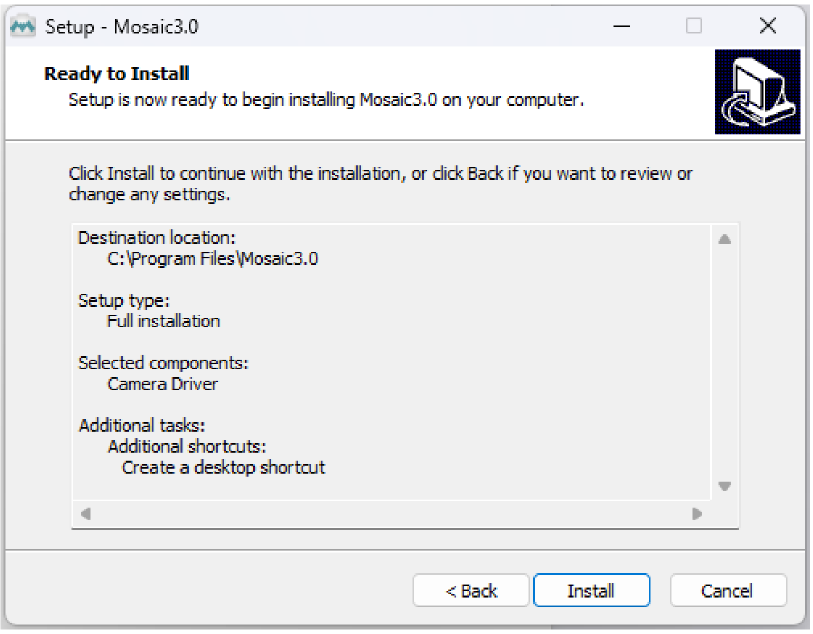


Figure 4-10

(6) Waiting for installation to complete;

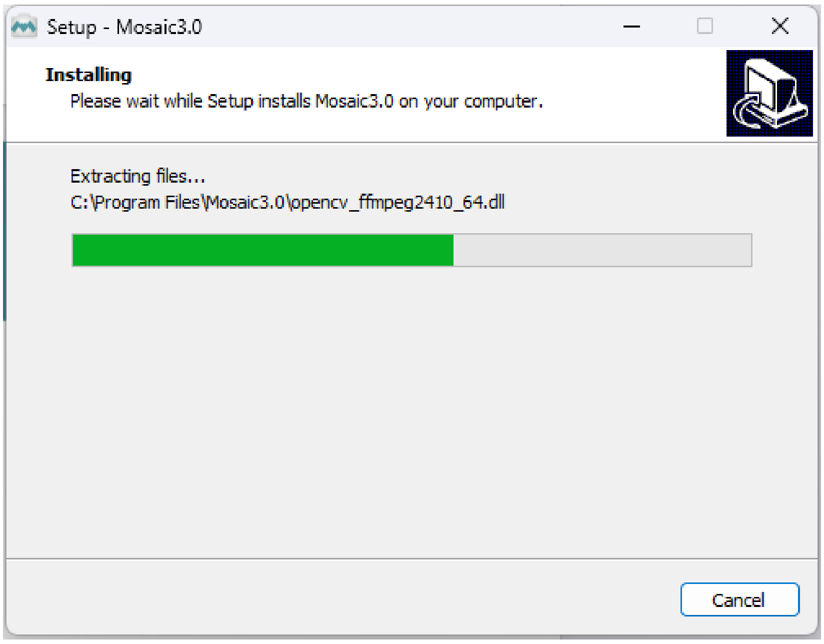


Figure 4-11

4.4.2. 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;

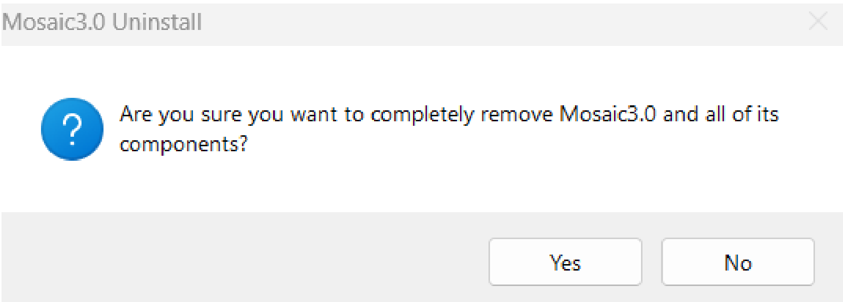


Figure 4-12 Uninstalling through installation package

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

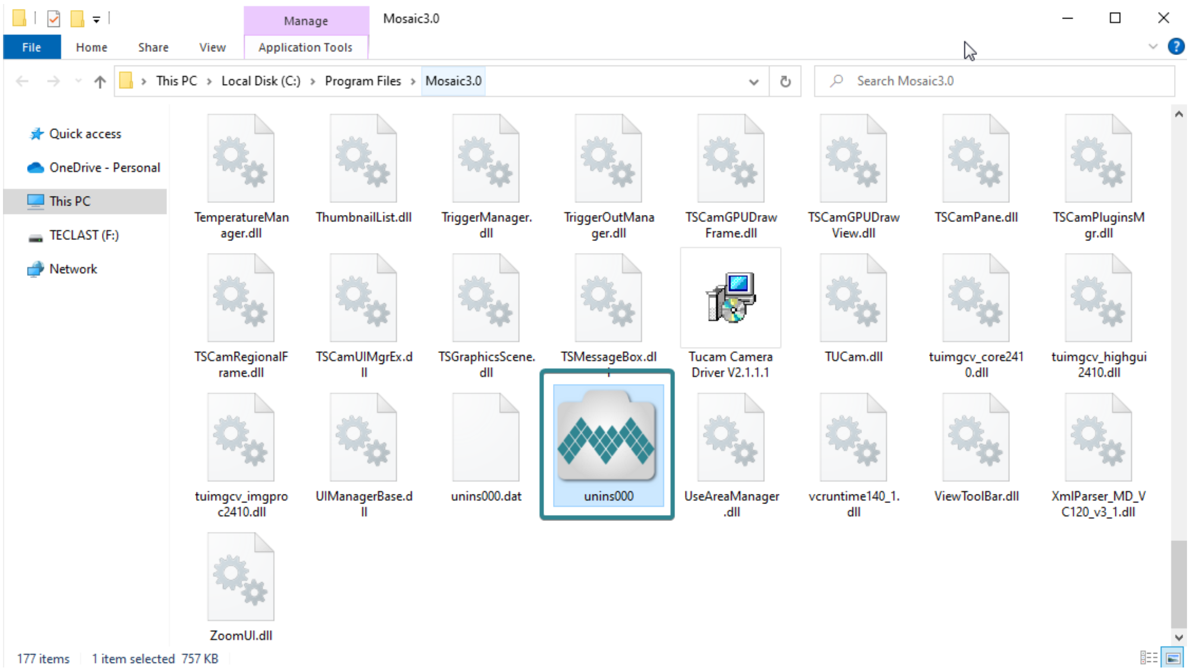


Figure 4-13

(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

Regularly check the product's condition and do not use damaged equipment.

5.2. Basic usage

(1) Avoid opening the lens dust cover in dusty environments;

(2) When opening the lens dust cover and installing the lens, keep the camera mouth facing downwards to prevent dust from falling on the surface of the windows;

(3) When not in use for a long time, please keep the dust cover installed.

5.3. 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 by following 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) Confirm that the camera is powered on and turned on normally;

2) Confirm that the camera is connected to the computer normally;

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 frame rate cannot reach the nominal level

1) Confirm whether the exposure time affects the frame rate by setting the minimum exposure time to check the frame rate.

2) The frame rate in the table is the measured frame rate under ideal bandwidth conditions. The actual frame rate in practical use will be affected by data transmission, which is related to the type of data interface used and the length of the transmission cable.

3) Verify that you are using the correct data transmission interface. USB requires a USB 3.0 interface; if a non-USB 3.0 interface is used, the frame rate may not reach the nominal frame rate.

4) Even if you are using a USB 3.0 interface, using a HUB, extension, or other adapters can also prevent achieving 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 unsynchronised external light source. 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, switching 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) Log in to the official website, click on the [Technical Support] module, and get answers to common questions.

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 professionals for technical support:

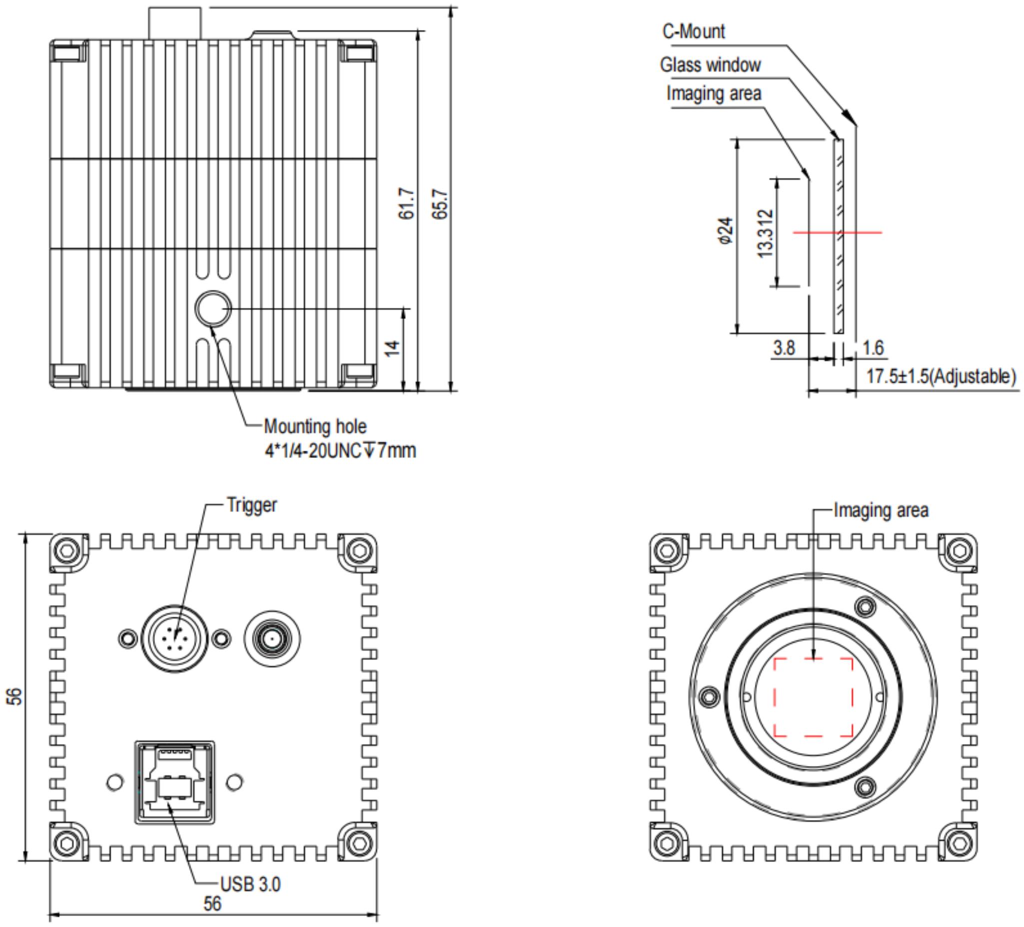
- TEL: +86-591-28055080-818
- Email: service@tucsen.com
- Visiting the official website to leave a message: http://www.tucsen.com

4) Please prepare the following information in advance:

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

Appendix 1 : Dimensions

Unit: mm, Diameter: ø.



Appendix 2 : Specifications

Camera

Model	Dhyana 401D
Sensor Type	FSI sCMOS
Sensor Model	Gpixel GSENSE2020
Peak QE	72% @ 595nm
Color / Mono	Mono
Array Diagonal	18.8 mm
Effective Area	13.3 mm x 13.3 mm
Resolution	2048 (H) x 2048 (V)
Pixel Size	6.5 µm x 6.5 µm
Full-Well Capacity	Typ. : 43 ke-
Dynamic Range	Typ. : 85 dB
Frame Rate	40 fps @ 16bit 45 fps @ 8bit&12bit
Readout Noise	2.1 e- (Median)
Shutter Type	Rolling
Exposure Time	10 µs ~ 10 s
Binning	2 x 2, 4 x 4
ROI	Support
Timestamp Accuracy	1 µs
Trigger Mode	Hardware , Software
Output Trigger Signals	Exposure start, Global, Readout end, High level, Low level , Trigger ready
Trigger Interface	Hirose-6-pin
Data Interface	USB 3.0
Bit Depth	8 bit, 12 bit, 16 bit

Optical Interface	C-mount
Power	USB3.0
Power Consumption	<4W
Dimensions	56 mm x 56 mm x 61.7 mm
Weight	305 g
Software	Mosaic V3, SamplePro, LabVIEW, MATLAB, Micro-Manager2.0
SDK	C, C++, C#, Python
Operating System	Windows, Linux
Operating Environment	Temperature 0~40℃, Humidity 10~85%

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 calling third-party software (LabVIEW, Matlab, Micro-Manager2.0, etc.), please click on the link to download the configuration: Tucsen camera software download - Tucsen

Appendix 4 : Third party certification

FQII

Certificate of Compliance

Certificate No.: FQII-DZ-21001

Certificate Holder: FUZHOU TUCSEN PHOTONICS CO.,LTD

Address: 5# building, Wanwushe Smart Industrial Park , No.2 Yangqi Branch Rd, Gaishan Town, Cangshan Area, Fuzhou, Fujian, PRC

Product Description: Scientific Camera

Model Reference: Dhyana 401D , Dhyana 201D

Brand Name: TUCSEN

Report No.: (2021) DZ10022

Standard/Directive:

EC Electromagnetic Compatibility Directive 2014/30/EU
EN 55032: 2015 , EN 61000-3-2: 2014 ,
EN 61000-3-3: 2013 , EN 55035: 2017

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.

CE

Authorized Signatory
Date of Issue: Mar. 26 , 2021

FUJIAN INSPECTION AND RESEARCHINSTITUTE FOR PRODUCT QUALITY
No.:121 Shantoujiao, West Yangqiao Road, Fuzhou, Fujian, P.R.China

SGS

Verification Report No. CANEC2016482001 Date: 15 Oct 2020 Page 1 of 43

FUZHOU TUCSEN PHOTONICS CO.,LTD
5# WANWUSHE SMART INDUSTRIAL PARK , NO.2 YANGQI BRANCH RD, GAISHAN TOWN, CANGSHAN AREA, FUZHOU, FUJIAN,PRC

Sample Name :	Dhyana 401D
SGS Job No. :	21187002 - XM
Tested Basic Model No. (P.O.No) :	Dhyana 401D
Client Ref. Info. :	Dhyana 201D
Date of Sample Received :	18 Sep 2020
Verification Period :	18 Sep 2020 - 15 Oct 2020
Verification Requested :	With reference to RoHS Directive (EU) 2015/863 amending 2011/65/EU.
Verification Method :	Please refer to next page(s).
Verification Result :	Please refer to next page(s).
Verification Conclusion :	Based on the verification results of the submitted samples, the results of Lead, Mercury, Cadmium, Hexavalent chromium, Polybrominated biphenyls (PBBs), Polybrominated diphenyl ethers (PBDEs) and Phthalates such as Bis(2-ethylhexyl) phthalate (DEHP) , Butyl benzyl phthalate (BBP), Dibutyl phthalate (DBP) , and Diisobutyl phthalate (DIBP) comply with the limits as set by RoHS Directive (EU) 2015/863 amending Annex II to Directive 2011/65/EU.

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

Jenny Liao
Approved Signatory

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Member of the SGS Group (SGS SA)

Appendix 5 : Update log

Version	Date	Modified Content
V1.0.0	2024-8-14	Create this document.