

A collection of various industrial cameras from the Aries 6510 and Aries 6506 series is displayed on a teal background. The cameras vary in size and shape, including some with large lenses and others that are more compact. Some have the TUCSEN logo visible on their housings.

Aries 6510 & Aries 6506 Product User Manual

Camera Technology Focused on
Scientific Imaging and Challenging Inspection

Tucsen Photonics →

Version Number: V 1.0.1

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Release Notes

Version	Date	Modifications
V1.0.0	Sep 2025	Crate document
V1.0.1	Nov 2025	1. Refined window specifications 2. Updated manual cover image 3. Added certification

1. Introduction

1.1. Disclaimer

To protect the legitimate rights and interests of users, please carefully read our accompanying instructions, disclaimers, and safety instructions before using our company's products. This camera user manual document contains basic information about the camera, installation instructions, product features, and maintenance, aiming to make it more convenient for users to use the TUCSEN's camera. This document is only disclosed for the above purposes. Please make sure to follow the instructions and safety instructions when operating this product.

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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 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.
- 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 a 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

2.1.1. Aries 6510

Standard Items	Specification	Quantity	Image
Camera	Aries 6510	1	
Power adapter	12V/8.5A, R7B connector, 1-meter DC cable	1	
Power adapter power cord	Cable length: 1.8m; Chinese national standard flat pin plug power cord; AC power cable; Rated current: 10A; Rated voltage: AC250V	1	
Ethernet cable	CAT7 10Gbps Shielded Ethernet Cable, Length: 3m; Brand: Ugreen	2	
Dual-Port 10Gbps Network Adapter	Model: MV-GT1002; Dimensions: 181×126.3×21.4 mm; Brand: Hikvision (compatible with LR-Link)	1	
USB flash drive	TUCSEN 4GB	1	
Trigger cable	HIROSE-BNC Trigger Cable; 6-core trigger cable with BNC coaxial interface; Total length: L=1.5m	1	
Adapter Ring	Outer Diameter × Thickness: Ø77 × 43.8mm; AL7075; T-Interface	1	
Dust Cap	Outer Diameter × Height: Ø49×5.7mm (M42×1); Black	1	
Adapter Ring	F-Mount Adapter	1	
Hex Key	L-Shape; Long Arm: 51.5mm; Short Arm: 17.5mm	1	

2.1.2. Aries 6506

Standard Items	Specification	Quantity	Image
----------------	---------------	----------	-------

Camera	Aries 6506	1	
Power adapter	12V/8.5A, R7B connector, 1-meter DC cable	1	
Power adapter power cord	Cable length: 1.8m; Chinese national standard flat pin plug power cord; AC power cable; Rated current: 10A; Rated voltage: AC250V	1	
Ethernet cable	CAT7 10Gbps Shielded Ethernet Cable, Length: 3m; Brand: Ugreen	2	
Dual-Port 10Gbps Network Adapter	Model: MV-GT1002; Dimensions: 181×126.3×21.4 mm; Brand: Hikvision (compatible with LR-Link)	1	
USB flash drive	TUCSEN 4GB	1	
Trigger cable	HIROSE-BNC Trigger Cable; 6-core trigger cable with BNC coaxial interface; Total length: L=1.5m	1	

2.2. Quantum Efficiency Curve

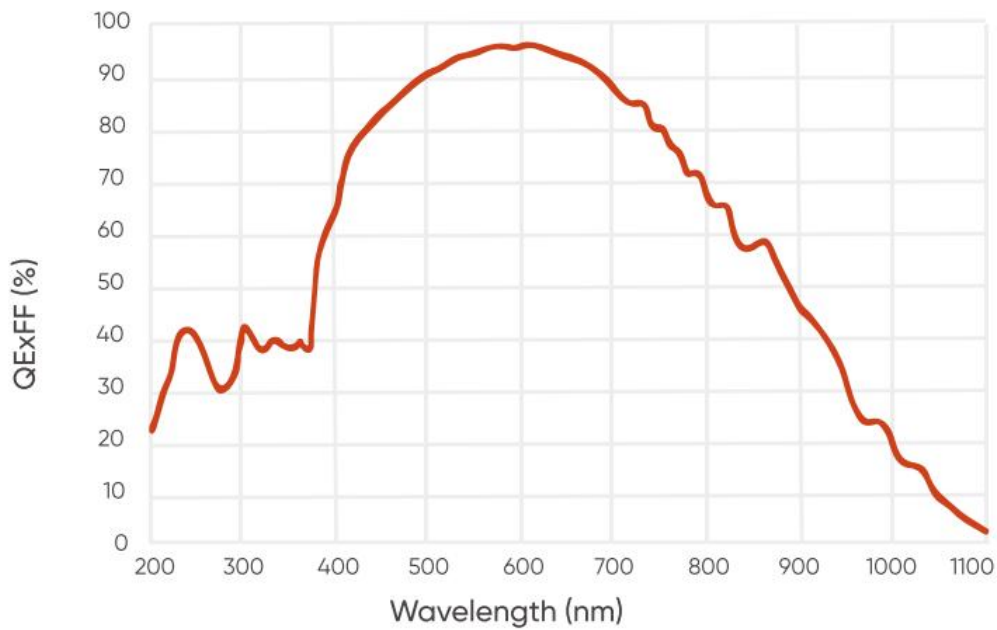


Figure 2-1 Quantum efficiency curve of Aries 6510 6506

2.3. Window Curve

2.3.1. Standard Window

The transmittance curve for default window glass for Aries 6510 and Aries 6506 shown in Figure 2-2.

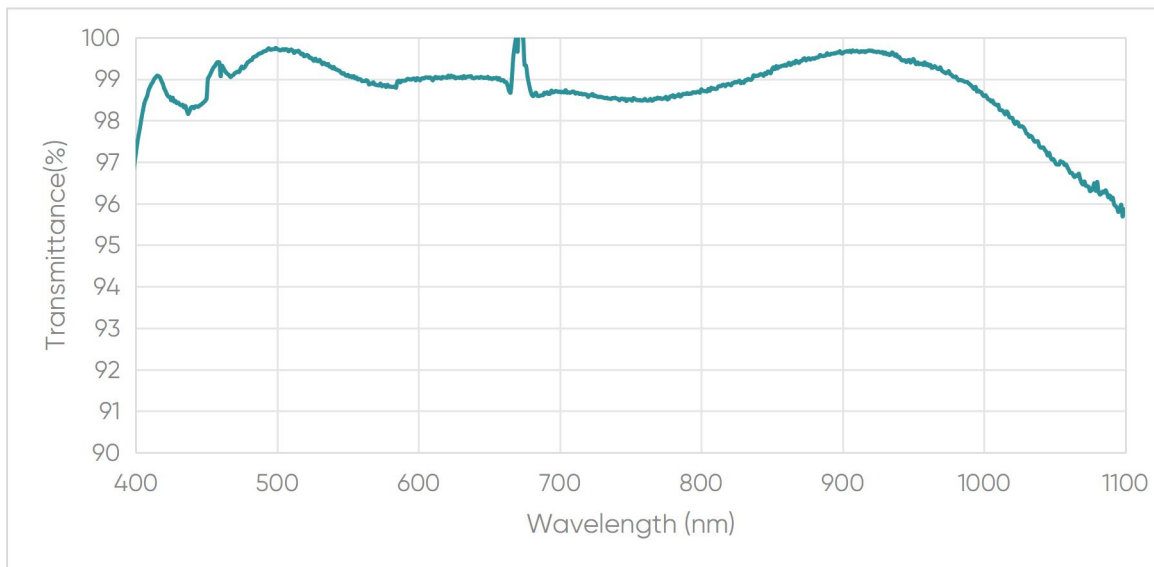


Figure 2-2

2.3.2. Optional Window

The Aries 6510 and Aries 6506 can be equipped with an optional fused silica window, and its

transmittance curve is shown in Figure 2-3.

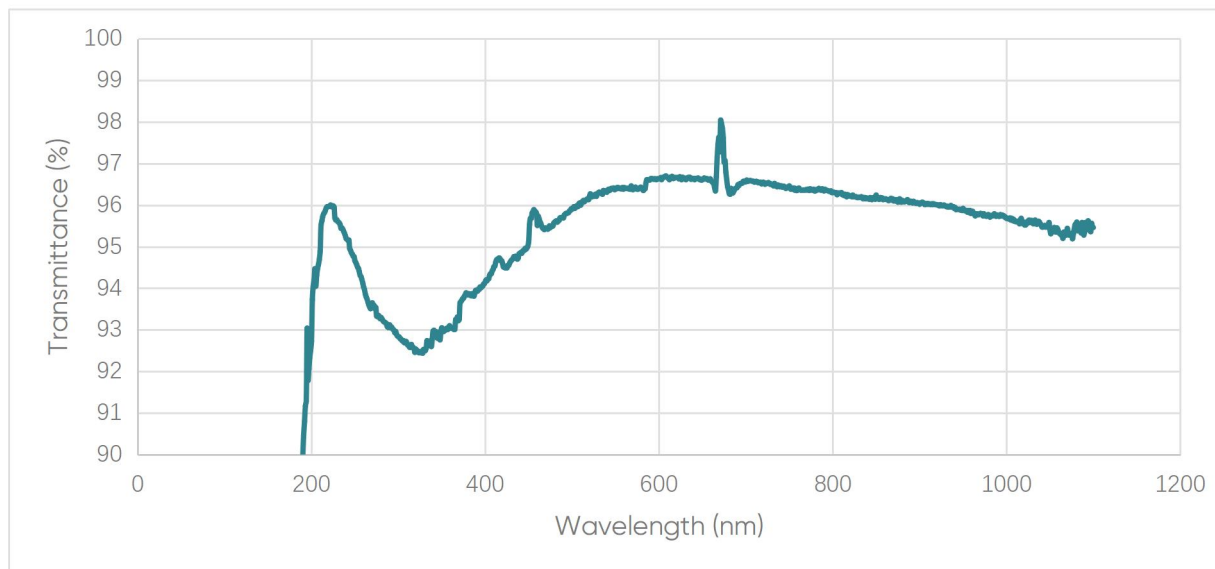


Figure 2-3 Transmission curve of a quartz window

2.4. Camera Power and Signal Connection

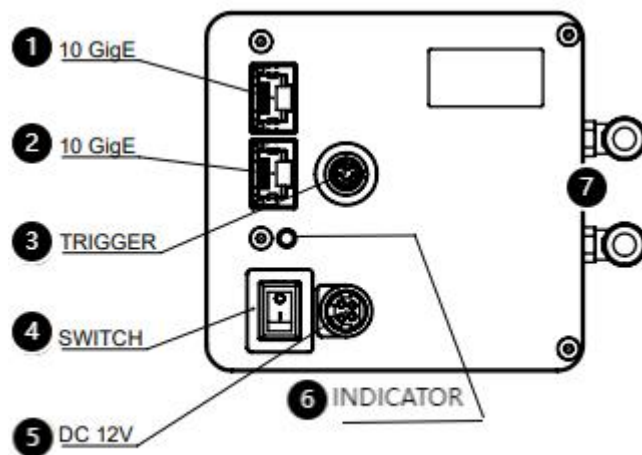


Figure 2-4

No	Name	Functions
①	10 GigE	Camera data transfer
②	10 GigE	Camera data transfer
③	Trigger	Camera Trigger Interface for trigger input/output functions. Pin definitions refer to Section 2.4.1.
④	Switch	Control camera power, Pin definitions refer to Section 2.4.2
⑤	DC 12V	Power interface

⑥	Indicator	Indicate the camera status Red: Camera powered on Amber: Normal operation
⑦	Water cooling pipe joint	Water cooling

Note:

When the camera is connected and powered on for the first time, the indicator light shows red. After drivers are detected or correctly installed, the indicator turns amber, indicating the camera is ready for operation via software.

If the software is launched while the indicator is red, a "No camera" message will appear. In this case, close the software and wait patiently until the indicator changes to amber.

2.4.1. Trigger Interface Pin Definitions

The trigger interface model for Aries 6510 and Aries 6506 cameras is HR10A-7R-6PB(73). The pin layout is shown in Figure 2-5, and the functional definitions are detailed in Table 2-1: Trigger Interface Pin Definitions.

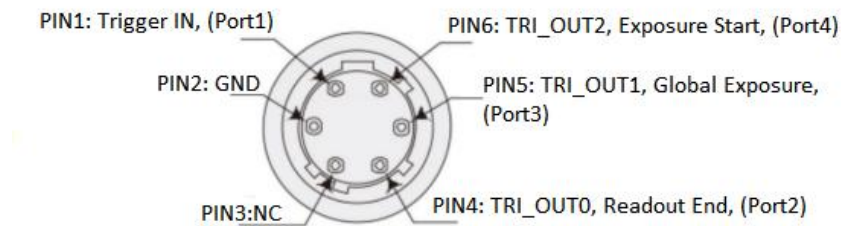


Figure 2-5

Table 2-1 Trigger Interface Pin Definitions

Pins	Signal	I/O	Descriptions
1	TRI_IN	Single-Ended Input	3.3V Level (VOL < 0.6V, VOH > 2.2V)
2	GND	Signal Ground	Signal Ground
3	NC	NC	NC
4	TRI_OUT1	Single-Ended output	3.3V Level (VOL<0.4V, VOH>2.4V)
5	TRI_OUT2	Single-Ended output	3.3V Level (VOL<0.4V, VOH>2.4V)
6	TRI_OUT3	Single-Ended output	3.3V Level (VOL<0.4V, VOH>2.4V)

2.4.2. Power Interface Pin Definitions



Figure 2-6 Power Interface Diagram

pins	Signal	I/O	Descriptions
1	GND	GND	Power Ground
2	VCC	12V	Power Positive (DC+), Input Voltage Range: 11V~13V
3	GND	GND	Power Ground
4	VCC	12V	Power Positive (DC+), Input Voltage Range: 11V~13V

3. Features and Functions

3.1. Camera Introduction

The Aries 6506/6510 cameras achieve an ideal combination of high sensitivity, wide field of view, and high-speed imaging performance. Building on (but not limited to) the inherent advantages of the sCMOS sensor, Tucsen's purpose-driven design for scientific applications—featuring versatile imaging modes, streamlined data interfaces, and a compact modular architecture—enables these systems to meet the most demanding scientific imaging requirements.

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:

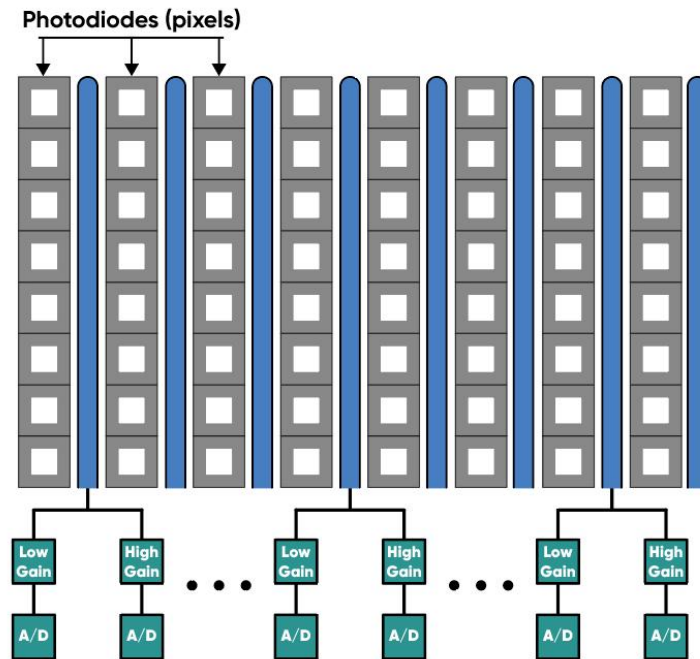


Figure 3-1 sCMOS camera sensor structure

- 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:

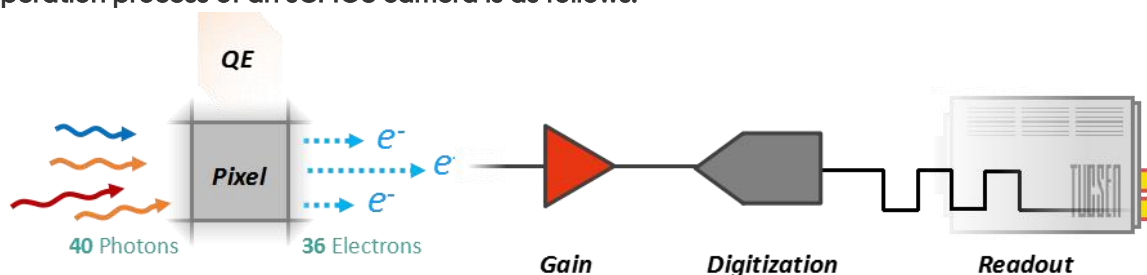


Figure 3-2 sCMOS operation process

- 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 Aries 6510 and 6506 support both rolling shutter and global reset readout.

In rolling 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}).

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).

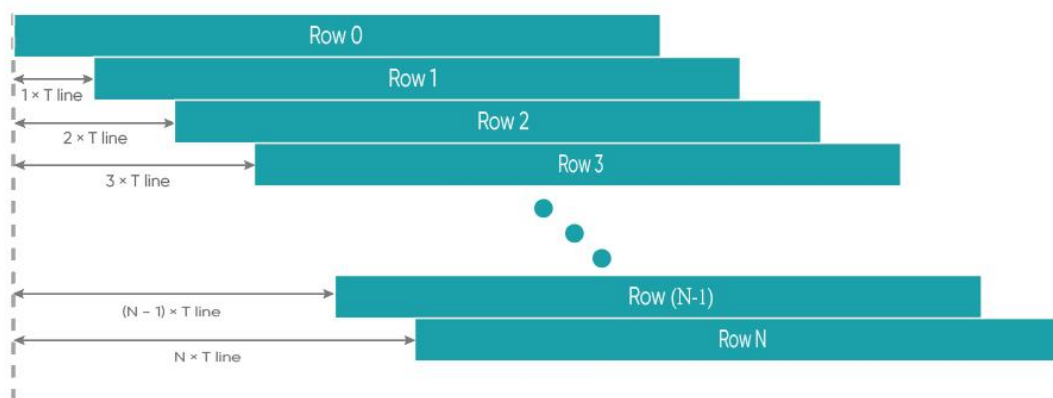


Figure 3-3 Rolling shutter diagram

In Global Reset readout mode, rolling shutter cameras can achieve imaging effects equivalent to global shutter. The Global Reset function first clears and resets the entire pixel array of the sensor, then exposes all rows at the same time. After exposure, data is read out row by row, causing each row to have

slightly longer exposure time than the previous one. For best results, the light source should be shut off right after the first row finishes exposure. This prevents uneven brightness in the image. This mode works well for applications that require precise timing, making it great for capturing fast-changing subjects.

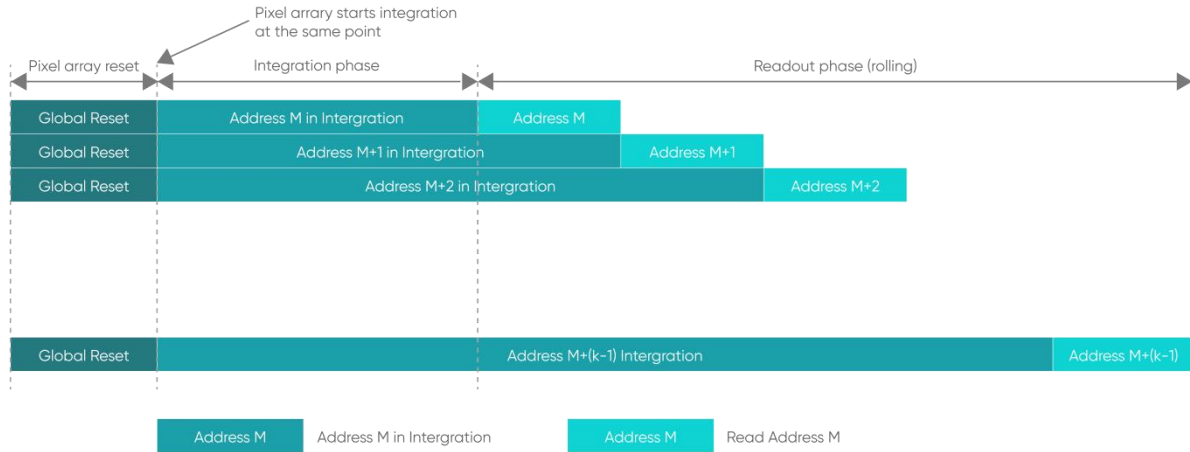


Figure 3-4

3.4. Front-Illuminated and Back-Illuminated sCMOS Technology

Cameras based upon sCMOS 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.

The Aries 6510 and Aries 6506 adopt a back-illuminated chip, achieving a peak QE of around 95%.

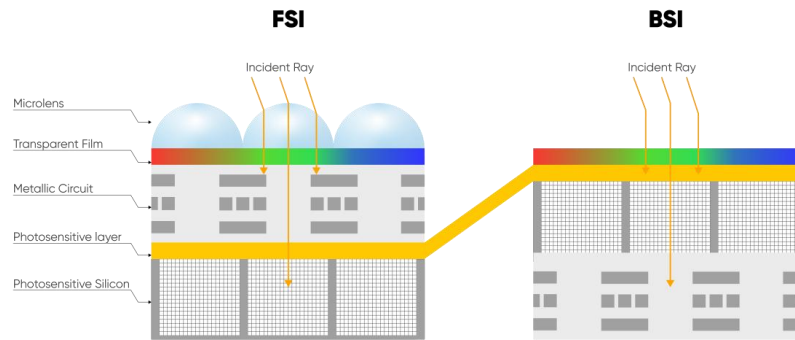


Figure 3-5 Front-Illuminated and Back-Illuminated diagram

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 sCMOS corresponds to a different readout circuit, forming a distribution curve, shown in Figure 3-5. To illustrate the characteristics of this curve, sCMOS 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 sCMOS camera chip—having less impact on the median than on the RMS—median values are generally lower than RMS values.

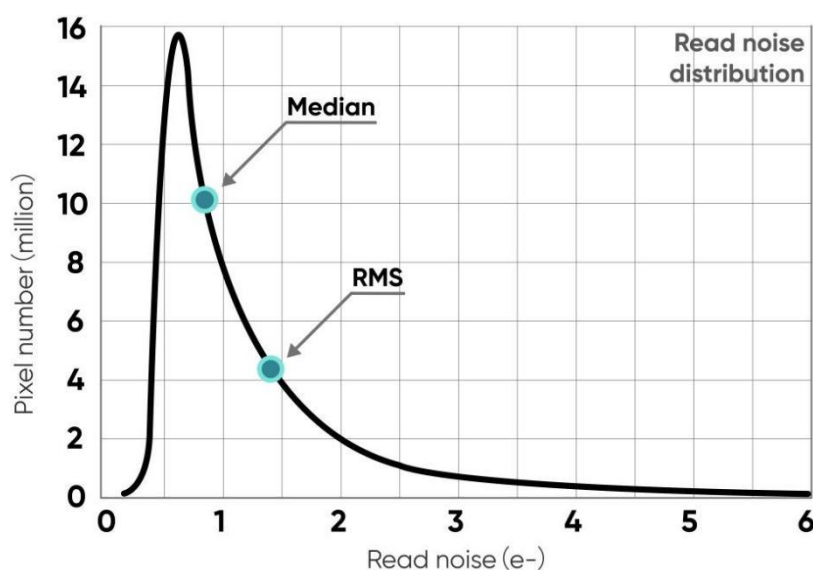


Figure 3-6 Readout noise distribution of an typical sCMOS camera

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 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 Aries 6510 and Aries 6506 adopt dynamic and static 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. 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.

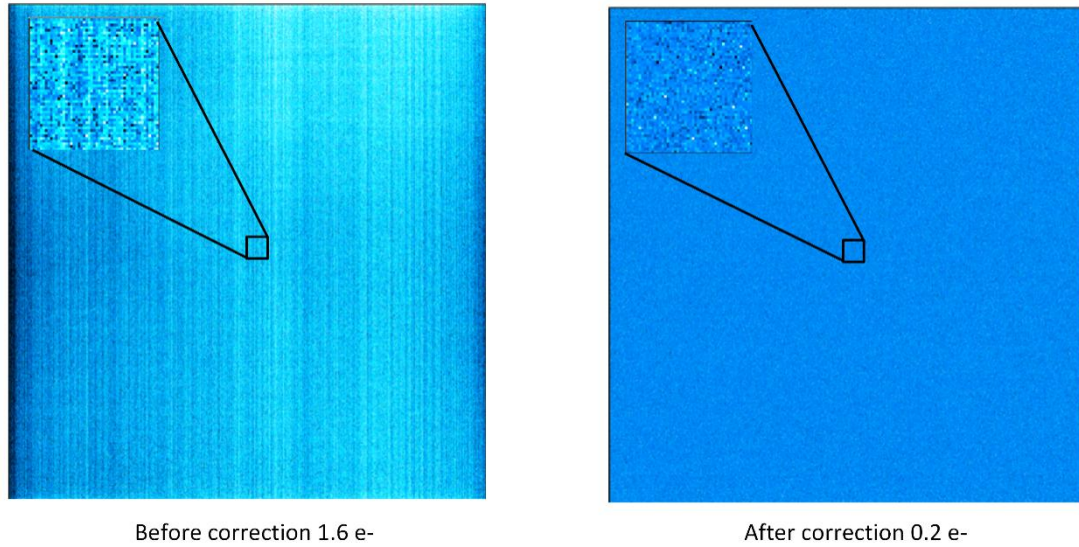


Figure 3-7 DSNU correction comparison before(left) and after(right)

For many low-light imaging cameras, DSNU is typically less than $0.5 e^-$. This means that in medium or high light level applications (where each pixel can typically capture hundreds or thousands of photons), the influence of this noise can be completely negligible. Moreover, even for low-light applications, if DSNU is lower than the camera's readout noise (typically $1-3 e^-$), this fixed pattern noise is unlikely to affect image quality.

3.8. 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.

Under dark field or low light conditions, differences in offset can be measured by DSNU as mentioned in Section 3.7. In bright environments, the influence of gain also needs to be considered. Differences in gain and offset changes are measured by Photo Response Non-Uniformity (PRNU), which is the ratio of detected electrons to displayed DN. Given that the intensity values produced will vary depending on the

signal size, PRNU is expressed as a percentage.

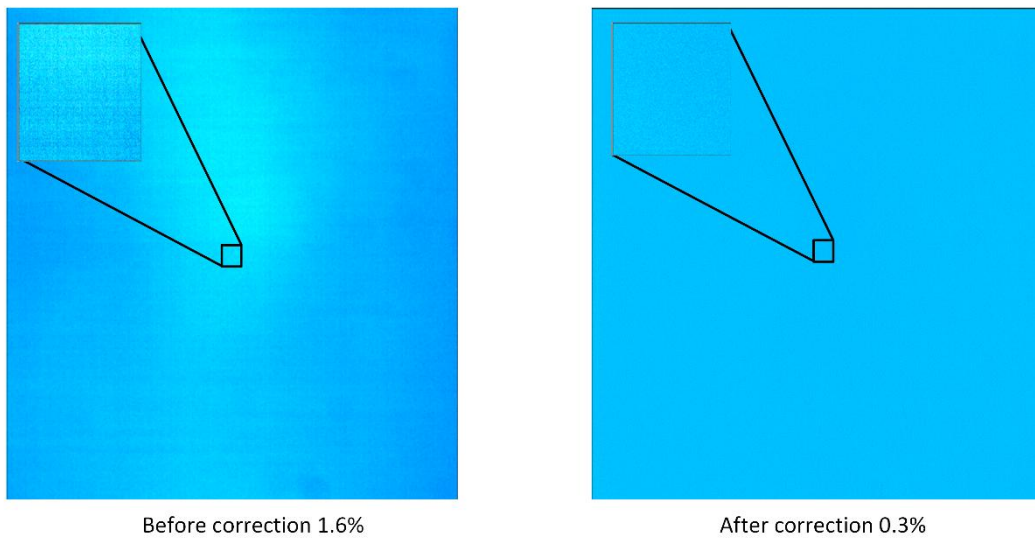


Figure 3-8 PRNU correction comparison before(left) and after(right)

Typical PRNU values are < 1%. For all low-light and medium-intensity light source imaging (signals of 1000 e⁻ or less), this variation is negligible compared to readout noise and other sources of noise. Similarly, when imaging at high light levels, this variation is not significant compared to other noise sources in the image (such as photon shot noise). However, in high light level imaging applications requiring very high measurement accuracy, especially those using frame averaging or frame summation, PRNU values < 1% are highly necessary.

3.9. Gain Mode

The Aries 6510 and Aries 6506 have three gain modes: High Dynamic Range(HDR) 、 Speed 、 Sensitivity. Each mode has differences in synthesis principles, line times, gain values, and readout noise. Selecting the appropriate mode based on the actual scenario is essential to obtain high-quality imaging results.

Table 3-1 Typical gain mode parameter table*

	HDR(16-BIT)	Speed (11-bit)			Sensitivity (12-bit)	
	HDR	High Gain	Mid Gain	Low Gain	Standard	Low Noise
System gain (DN/e ⁻)	4.6	1.57	0.40	0.095	2.35	5.00
Full-Well Capacity (e ⁻)	13700	1240	4700	21000	1660	730
Readout noise(e ⁻)	1.8	1.8	3.7	10.0	1.3	0.66

*Note:

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

3.9.1. 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.

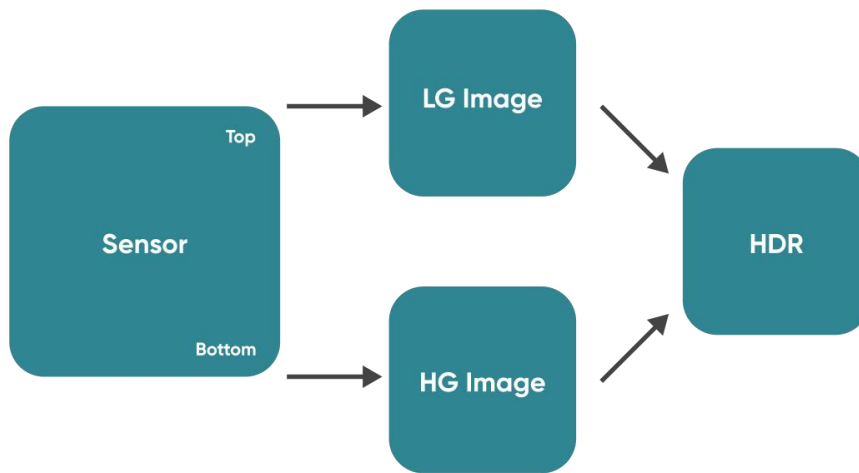


Figure 3-9 Schematic diagram of HDR mode

3.9.2. Speed

In Speed Mode, the image data output is 11-bit, with three gain options: Low Gain, Mid Gain, and High Gain. Taking High Gain as an example, the working principle of Speed Mode is illustrated in the figure below. The sensor simultaneously reads out data from both the top and bottom readout chains, outputting odd and even rows in parallel to increase frame rate. This mode is typically suited for dynamic observation scenarios that require higher frame rates.

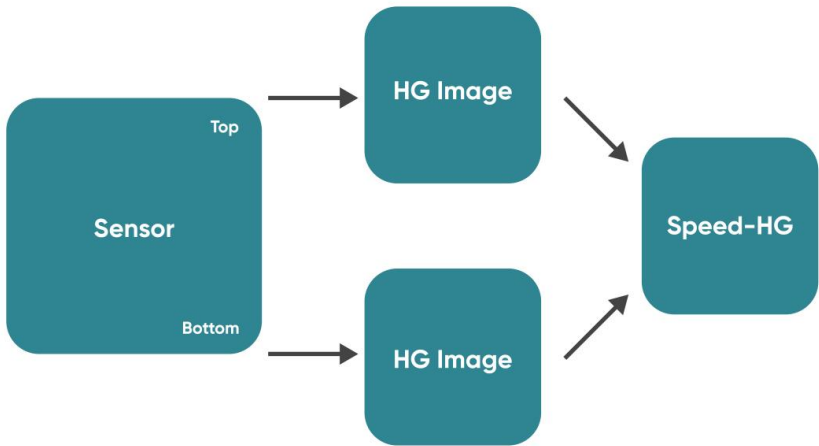


Figure 3-10 Schematic Diagram of High Gain in Speed Mode

3.9.3. Sensitivity

In Sensitivity Mode, the image data output is 12-bit, with two gain options: Standard and Low Noise. The Low Noise mode utilizes Correlated Multiple Sampling (CMS) technology, which is also referred to as CMS Mode. In practice, the system performs n samplings to reduce noise by a factor of $\sqrt{n}$. As illustrated in the figure below, each row's data is simultaneously acquired through dual top and bottom readout channels. A CMS mode image is then generated by superimposing and averaging the two datasets. This mode is typically configured with higher gain, it is suitable for weak-signal applications.



Figure 3-11 Schematic Diagram of Low Noise Mode in Sensitivity Mode

3.10. Region of Interest 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.

Typical ROI frame rates for different interfaces of the camera can be found in Table 3-2, Table 3-3:

Table 3-2

Rows	Columns	Rolling				GlobalReset		
		Dynamic	Speed	Sensitivity		Dynamic	Speed	Sensitivity
		HDR/ HG/ LG	HG/ MG/ LG	Standard	Low Noise	HDR/ HG/ LG	HG/ MG/ LG	Standard
3200	3200	83.00	150.10	87.94	5.17	82.96	150.10	87.74
3200	1600	165.50	300.10	175.30	10.31	165.17	300.10	174.30
3200	800	329.01	600.40	348.30	20.47	327.40	599.40	344.31
3200	400	650.35	1200.80	686.31	40.35	643.36	1197.80	671.33
3200	200	1269.73	2404.60*	133.67	78.37	1242.76	2348.65	1278.72
3200	128	1932.07	3756.24*	2018.98	118.76	1872.13*	3579.42*	1898.10*
3200	100	24255.57*	4764.24*	2525.47*	148.41	2330.67*	4406.59*	2337.66*
3200	6	16670.33*	25632.37*	15714.29*	925.07*	13013.99*	19704.31*	10482.52*
2720	2720	97.61	176.47	103.48	6.08	97.51	176.29	103.07
2720	1360	194.61	352.94	205.97	12.1	194.03	352.94	204.59
2720	680	386.23	707.29	408.18	24.04	383.85	706.29	403.19
2720	340	762.24*	1419.58*	804.20*	47.24	752.25	1413.58	782.44
2720	6	16670.33*	25632.37*	15714.29*	925.07*	13013.99*	19704.31*	10482.52*
2400	2400	110.67	200.00	117.19	6.89	110.45	199.80	116.77
2400	1200	220.34	400.20	906.09	13.71	219.34	399.80	231.54
2400	600	437.13	800.40	461.54	27.16	433.70	799.20	455.09
2400	300	860.21	1606.39	907.19*	53.29	847.15	1601.40	880.12
2400	150	166.33	3214.79*	1745.25*	102.59	1621.38	3118.88*	1653.35
2400	6	16670.33*	25632.37*	15714.29*	925.07*	13013.99*	19704.31*	10482.52*
8	6	16670.33*	29632.37*	15714.29*	925.07*	13013.99*	19704.31*	10482.52*

Table 3-3

Rows	Columns	Dynamic		Speed	Sensitivity	
		HDR	HG/ LG	HG/MG/LG	Standard	Low Noise
3200	3200	60.34	80.36	80.44	80.36	5.17
2720	2720	83.50	97.64	111.33	103.48	6.08
2400	2400	107.25	110.67	143.00	117.18	6.89

Note:

- 1) The minimum supported ROI for Aries 6510 & Aries 6506 is 48 (columns) × 8 (rows).
- 2) Frame rates are affected by computer system configuration, and it is recommended to use a computer with Intel Core i7-14700 or above processors and 64-bit operating systems.
- 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. For hardware trigger mode, frame rates are detailed in Section 3.13

3.11. 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.

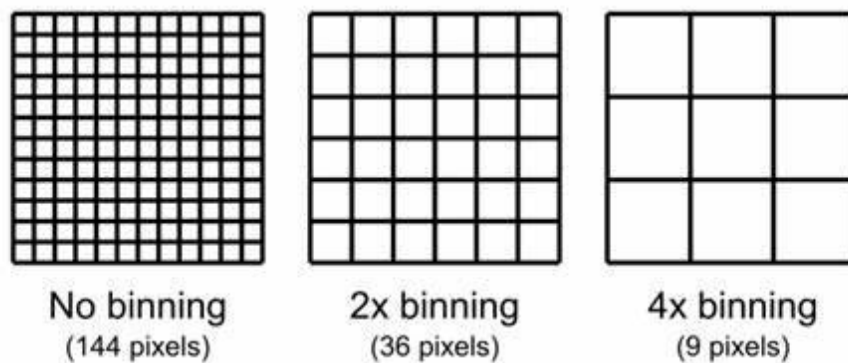


Figure 3-12 Schematic diagram of Binning

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.

3.12. Timestamp

The camera accurately reads the start time of each frame with a time precision of 1 μ s.

Note:

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

3.13. Frame Rate Calculation

The camera's frame rate is affected by the readout time and the exposure time. The theoretical frame rates can be calculated using the formulas provided in Table 3-5 and Table 3-6.

The line time and theoretical full-width minimum readout time for each mode of the Aries 6510 & Aries 6506 are shown in the following table.

Dynamic Mode Readout Time: $T_{\text{readout}}(\text{Rolling}) = T_{\text{line}} * (V_n + 10)$

Others Readout Time: $T_{\text{readout}}(\text{Rolling}) = T_{\text{line}} * (V_n / 2 + 6)$

Table 3-4

Mode		Tline	Treadout (Rolling)
Dynamic	HDR	3.75us	12037.5us
Speed	High Gain	3.75us	6022.5us
	Mid Gain	3.75us	6022.5us
	Low Gain	3.75us	6022.5us
Sensitivity	Standard	7.075us	11362.45us
	Low Noise	120.275us	193161.65us

Typical frame rate calculations(Rolling)

H_n : Number of selected rows in the horizontal direction;

V_n : Number of selected lines in the vertical direction;

T_{line} : Line period;

T_{exp} : Set exposure time;

Table 3-5 Rolling Frame Rate Calculation (FreeRunning & Trigger Mode)

Modes	T _{line}	Formula	Horizontal (H _n)	Vertical (V _n)	Frame Rate(fps)
Dynamic	3.75us	83*3200/Vn	3200	3200	83
				2720	97.64
		1000000/(Tline*(Vn+10))		2400	110.65
				1600	165.63
				800	329.21
				400	650.40

				128	1932.36
				6	16666.66
Speed	3.75us	150*3200/Vn	3200	3200	150
				2720	176.47
				2400	200
				1600	300
				800	600
				400	1200
				128	3750
		1000000/(Tline*(Vn/2+6))		6	29629.62
Sensitivity -Standard	7.075us	88*3200/Vn	3200	3200	88
		1000000/(Tline*(Vn/2+6))		2720	103.47
				2400	117.19
				1600	175.36
				800	348.13
				400	686.12
				128	2019.18
				6	15704.75
Sensitivity -LowNoise	120.275us	1000000/(Tline*(Vn/2+6))	3200	3200	5.18
				2720	6.09
				2400	6.9
				1600	10.33
				800	20.51
				400	40.42
				128	118.97
				6	925.34

Typical frame rate calculations(Global Reset)

H_n : Number of selected rows in the horizontal direction;

V_n : Number of selected lines in the vertical direction;

T_{line} : Line period;

T_{exp} : Set exposure time;

Minimum Exposure Time Calculation for 3-Line Readout on hardware trigger mode

Table 3-6 Global Reset Frame Rate Calculation (FreeRunning & Hardware Trigger Mode)

Modes	T _{line}	Formula	Horizontal (H _n)	Vertical(V _n)	Frame Rate(fps)	
Dynamic	3.75us	$1000000 / (T_{exp} + ((Height+8)+3) * T_{line} + ExpOffset)$	3200	3200	82.95	
				2720	97.51	
				2400	110.44	
				1600	165.17	
				800	327.4	
				400	643.35	
				128	1871.43	
				6	13012.36	
Speed	3.75us	$150 * 3200 / V_n$	3200	3200	150	
				2720	176.47	
				2400	200	
				1600	300	
				800	600	
				400	1200	
		$1000000 / (T_{exp} + ((Height+8) / 2 + 3) * T_{line} + ExpOffset)$		128	3577.49	
		6		19694.73		
Sensitivity-Standard	7.075us	$1000000 / (T_{exp} + ((Height+8) / 2 + 3) * T_{line} + ExpOffset)$	3200	3200	87.76	
				2720	103.13	
				2400	116.76	
				1600	174.39	
				800	344.32	
				400	671.48	
				128	1897.39	
				6	10475.31	

Note:

The frame rate values in the above table are calculated at the minimum exposure time. For other scenarios, please contact Technical Support to obtain the frame rate calculator;

Actual frame rates are subject to interface bandwidth and computer system configuration. To prevent data loss, additional line-period-based intervals are added during transmission, resulting in increased readout time. Thus, calculated frame rates may exceed actual achievable rates.

3.14. Frame Rate Adjustment

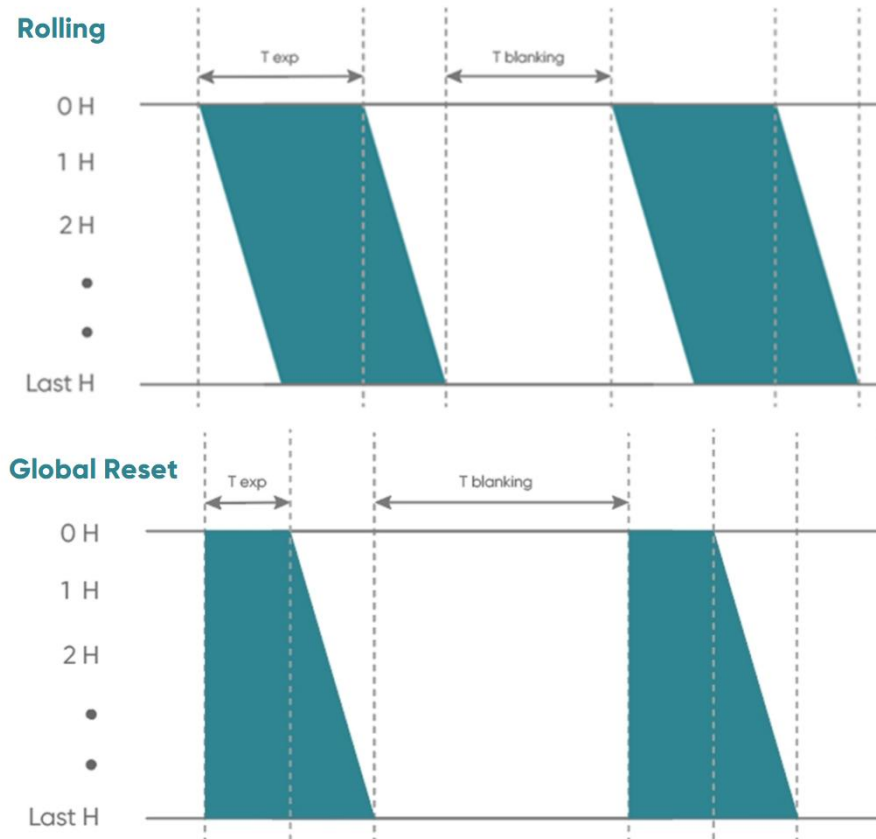


Figure 3-13 Frame rate adjustment timing diagram

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 40 fps adds 8.33 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.

3.15. 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-). $Q(\lambda)$ corresponds to the quantum efficiency at the wavelength. Offset is the camera's background value in DN.

3.16. Acquisition Mode

3.16.1. FreeRunning

FreeRunning 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.

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.

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.

3.16.2. 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.

3.16.3. Hardware Trigger Mode

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

3.16.3.1. Hardware Trigger input circuit

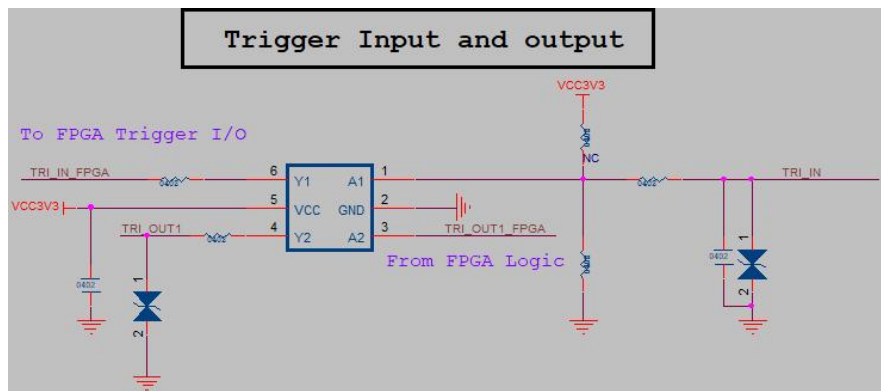


Figure 3-14

Note:

The valid external trigger signal recognized by the imager must be a level signal of 3.3 to 5 V.

Exceeding the maximum voltage limit may cause permanent damage;

The pulse width of the recognized level signal must be greater than 1 μ s.

3.16.3.2. Trigger Delay and Jitter

The trigger delay and jitter for the HDR, High Sensitivity, and High Speed modes are 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 $T_{delay}=T_{iso} + T_{logic}$, 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.

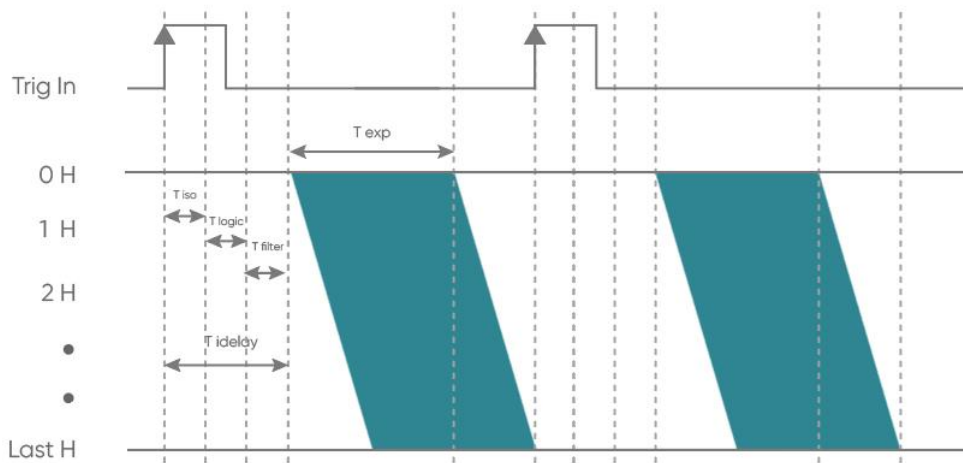


Figure 3-15 Schematic of trigger delay under Rolling

The delay and jitter in Global Reset mode is 600 ns, and if the trigger trigger filter function is enabled, a trigger filter delay time T_{filter} will be added on top of this. the timing diagram is as follows:

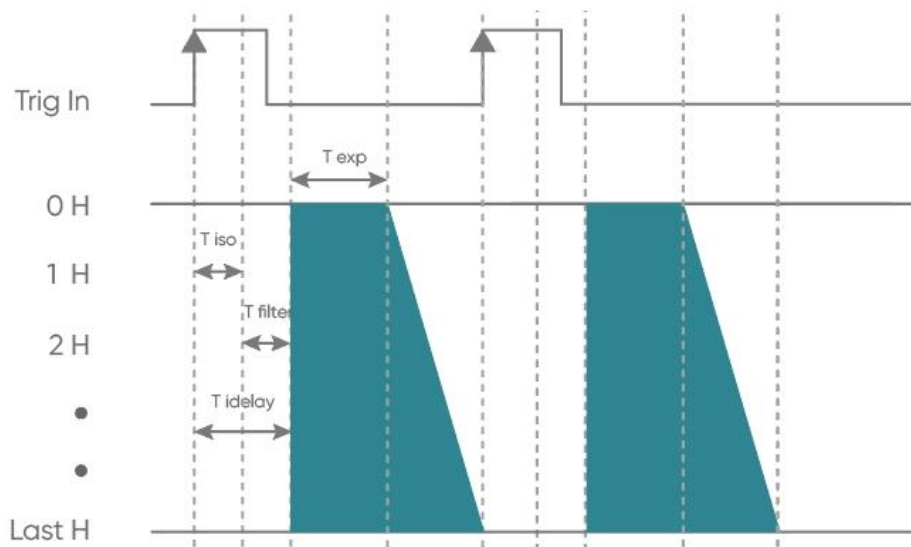


Figure 3-16 Schematic of trigger delay under Global Reset mode

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}

3.16.3.3. Standard Trigger Mode

Standard Trigger Mode: In this mode, when the camera is in FreeRunning, it responds to external trigger signals only when the trigger frequency is lower than the currently configured maximum frame rate.

Both of these modes support both level and edge triggering.

In Standard 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.

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.

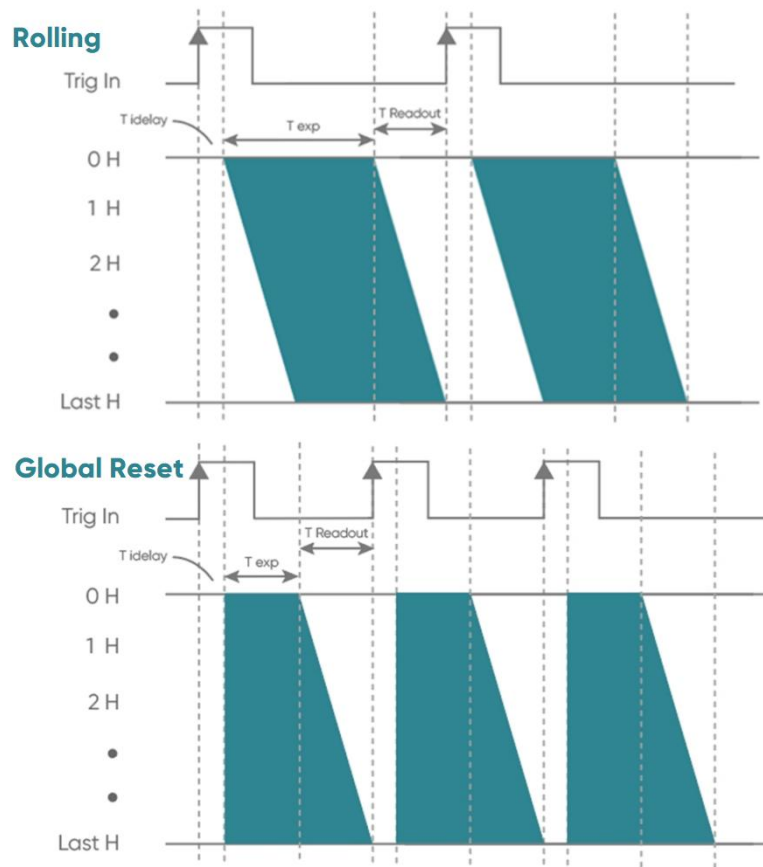


Figure 3-17

3.16.4. Rolling Shutter Control Mode

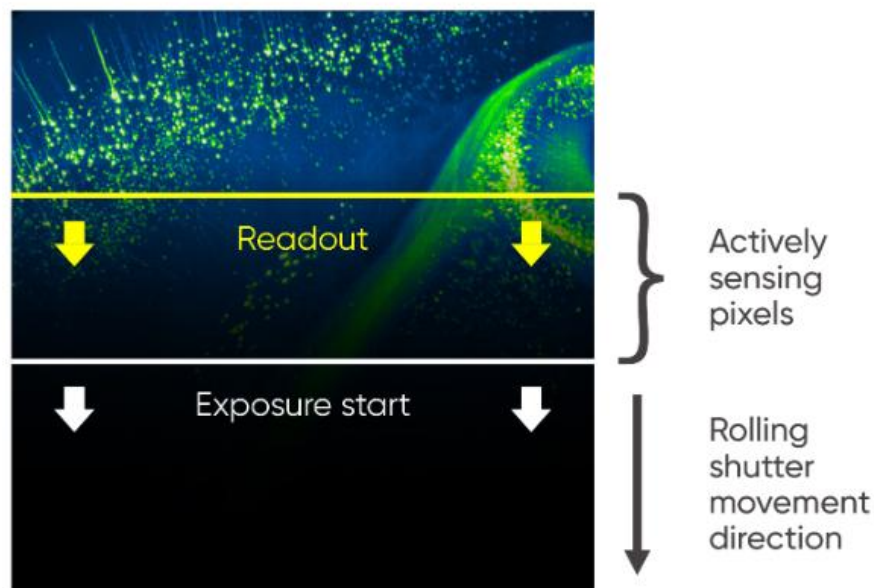


Figure 3-18 Schematic diagram of Rolling Shutter Control

Rolling shutter control is supported in Aries 6510 and Aries 6506. This mode utilizes the characteristic of rolling shutter readout, allowing seamless synchronization with the movement of LightSheet imaging

systems. This mode significantly improves the signal-to-noise ratio of images by repeatedly exposing samples from top to bottom or bottom to top, line by line. It is mainly used in life sciences, especially in applications such as neural development microscopy.

The implementation of the rolling scan control mode requires firmware to operate the SENSOR imaging chip: adding a delay to the reset signal and the readout signal to control the time at which the exposure starts for each line after the first line, and to control the synchronization of the active exposure area and external illumination within a more flexible line time frame, thus enabling efficient and fast imaging.

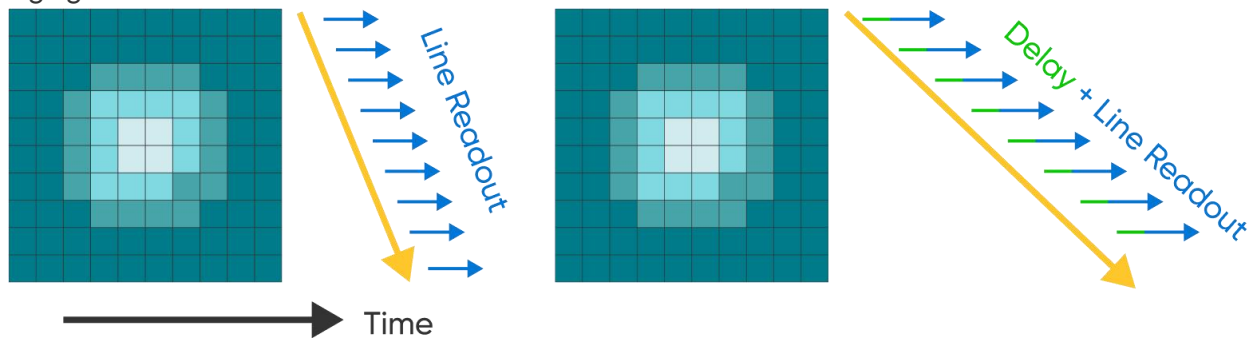


Figure 3-19 Schematic diagram of Rolling Shutter Control

LightSheet user can define the "line time delay" or "Slit Height" to enable the LightSheet system flexibly scanned simultaneously, and the scanning direction can be set from top to bottom or bottom to top to meet different application needs.

There are three options for the direction of the rolling shutter:

Down: The downward scanning direction is the default scanning direction for sCMOS cameras. The rolling shutter starts at the top of the sensor and scans down to the bottom of the last line. Each subsequent frame acquisition starts with the first line at the top.

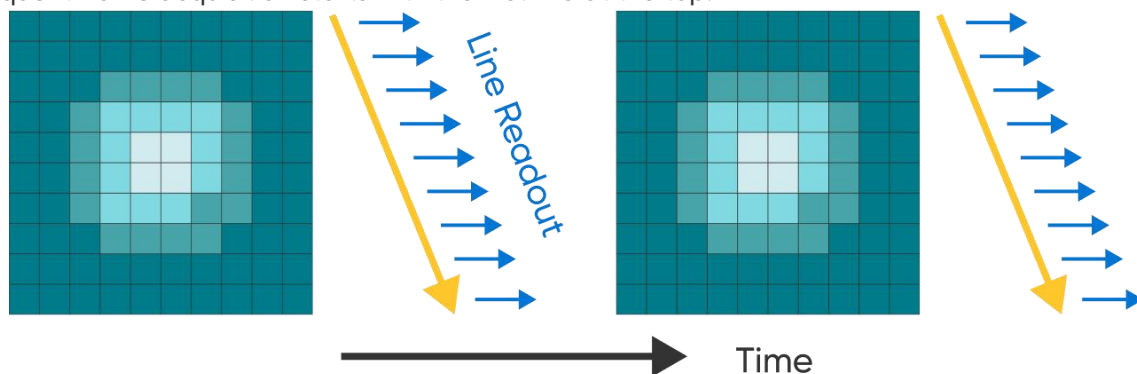


Figure 3-20 Schematic diagram of Down scanning

Up: Upward scanning mode, the rolling shutter scans upwards from the bottom line to the top first line. Each subsequent frame acquisition starts with the bottom line. The image orientation acquired in this mode is not reversed and is consistent with the image in scan down mode.

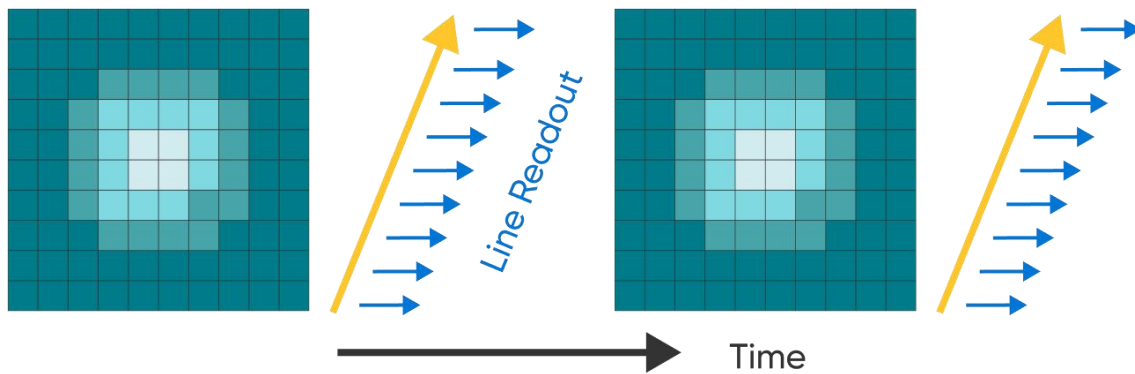


Figure 3-21 Schematic diagram of Up scanning

Down-up cycle: When scanning up and down, the rolling shutter starts at the top of the first row and goes down to the bottom of the last line. For the next frame, the rolling shutter will start at the bottom row and sweep up to the top first row, and so on. The image acquired in this mode is oriented in the same direction as the downward scan direction.

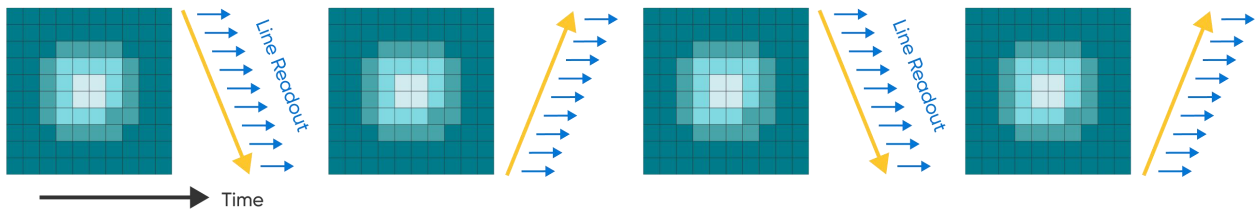


Figure 3-22 Schematic diagram of Down-up cycle scanning

3.17.Trigger Output

3.17.1. Hardware Trigger output circuit

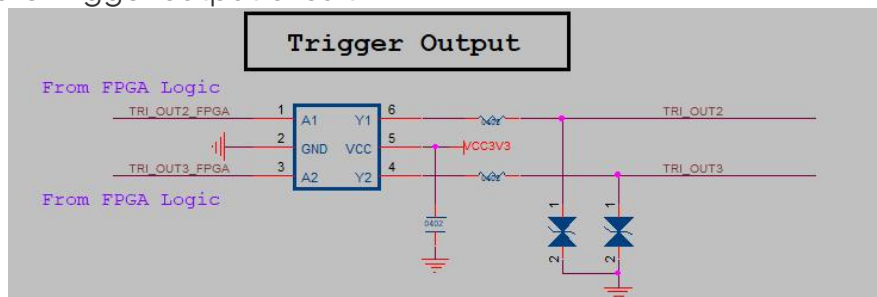


Figure 3-23 Trigger Output Circuit

3.17.2. 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.

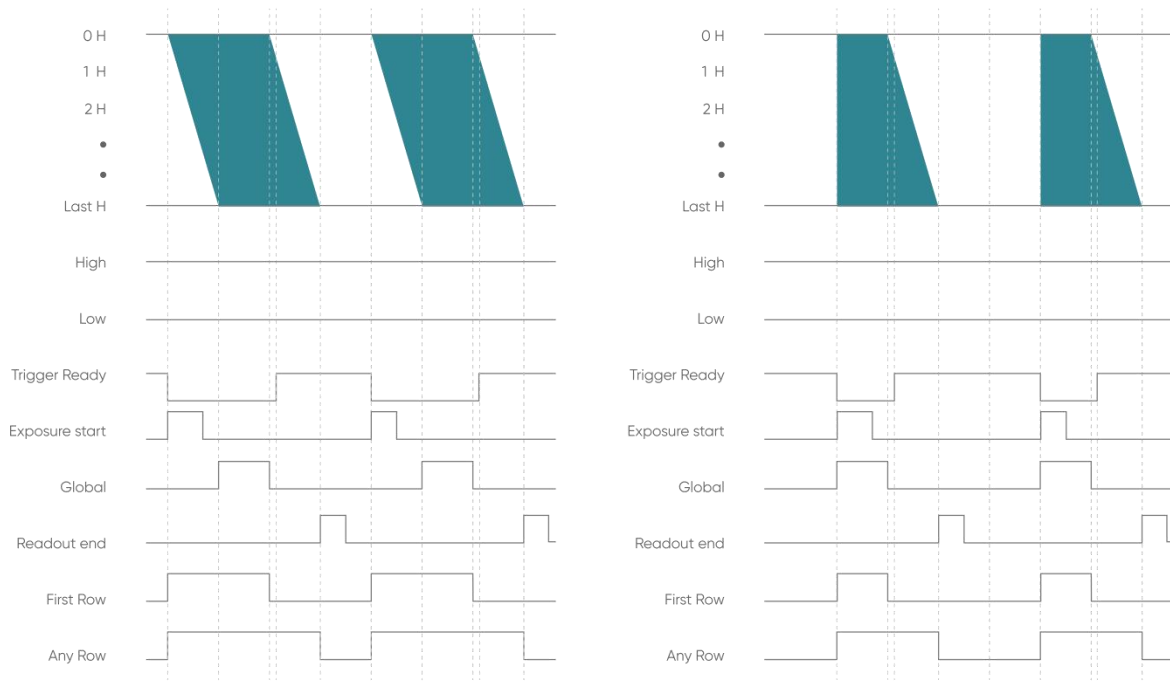


Figure 3-24

- **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 TRIG.OUT3 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 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), the default pulse width is 5ms, which is customizable. And the output is in the TRIG.OUT2 interface by default.
- **FirstRow:** The trigger signal from the camera is high only when the first row of a frame is being exposed. The length of the signal is equal to the exposure time for the first row. Exposure time is equal to the time that is set in the software application.
- **AnyRow:** The signal remains active from the beginning of the first row's exposure until the end of the last row's exposure

3.18. Cooling

Camera cooling effectively reduces "dark current noise" and the impact of hot pixels. The camera adopts semiconductor cooling using the Peltier effect, where an N-type and P-type material form a

thermocouple. When a DC current is passed through the thermocouple, heating and cooling phenomena occur at the junctions due to the direction of the DC current. The cooling module is placed close to the chip to lower the chip's temperature and reduce dark current, while the hot end is connected to a metal heat sink to dissipate heat efficiently.

Both air cooling and water cooling are commonly used cooling methods. In air cooling, a fan exchanges excess heat with the surrounding air via airflow, while in water cooling, a liquid circulation system transfers excess heat. The Aries 6510 supports both air cooling and water cooling modes, allowing users to choose the appropriate cooling method based on the actual usage environment. In air cooling mode, the inlet and outlet vents are indicated as shown in the figure.



Figure 3-25 Schematic diagram of air inlet and outlet

Air cooling can achieve cooling effects of $\sim 25^{\circ}\text{C}$ below ambient temperature, while water cooling can achieve cooling effects of $\sim 30^{\circ}\text{C}$ below ambient temperature. The camera fan speed can be controlled variably, generally supporting High, Medium, and Low speed options. The higher the fan speed, the better the heat dissipation performance, while lower speeds result in lower vibration transmission. For complete low-vibration performance, the fan of the Aries 6510 and the Aries 6506 can be completely turned off in the software, and a water cooling port is provided (refer to section 4.3 for installing water cooling).

4. Installation

4.1. Recommended computer configurations

Camera Interface	Dual-Port 10Gbps Network Adapter
------------------	----------------------------------

CPU	Intel Core i7-14700
OS	Windows 10 Pro 64-bit (DirectX 12)
RAM	128 GB or higher (DDR4 3200 MHz)
PCIe	PCIe4.0*4
Motherboard	ASUS PRIME B760-PLUS (Intel B760 Chipset)
Primary Storage	Samsung SSD 990 PRO 2TB (2 TB / Solid State Drive)

4.2. Camera installation

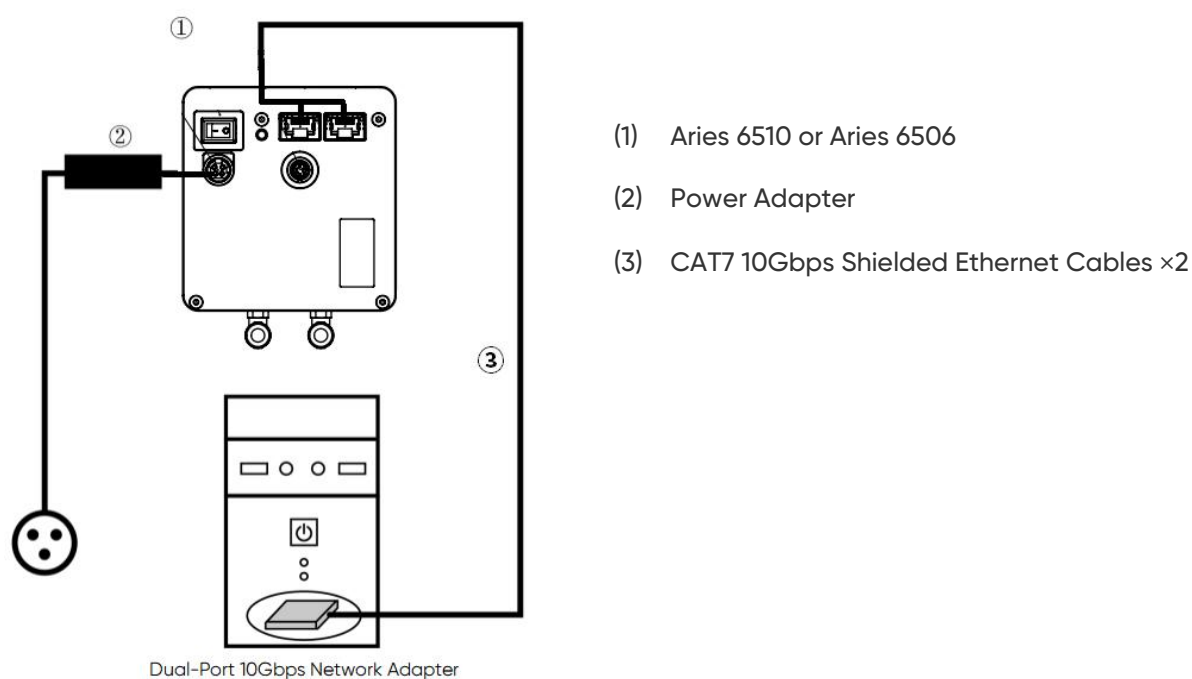


Figure 4-1

Connect one end of the Ethernet Cable to the PC, connect the other end to the sCMOS camera, then plug in the power cord, turn on the power switch, and you will see the indicator light lit up in red.

Note:

- 1) To prevent the camera from overheating, do not cover the camera with cloth or any other material, nor block the camera's ventilation openings in any way.
- 2) If operating the camera in an enclosed environment, ensure there is at least a 10 cm gap between the camera's air intake and exhaust vents for safe operation and optimal cooling performance. If the camera is placed on a desk or platform, make sure the camera's vents are not facing downwards.
- 3) Before connecting and disconnecting cables, please turn off the power to the camera and surrounding devices.

4.3. Water cooling pipe installation

4.3.1. Connect the water cooling pipe

Operation steps:

- 1) Place the camera on a stable workbench;
- 2) Connect the water cooling pipe to the water pipe joint on the camera and make sure it is inserted in place, as shown in Figure 4-2 below;



Figure 4-2

- 3) Insert the water pipe into the water nozzle of the cooling water circulation machine and lock it with a clamp;
- 4) The cooling water circulating machine water pipe is connected to the camera water pipe through an adapter valve.

4.3.2. Software Fan Status

- 1) After installing the water cooling pipe, it is necessary to switch the cooling mode on the software. The default cooling method for the camera is air cooling, which can be switched to water cooling by adjusting the fan gear;

PeripheralControl	
DeviceTemperatureTarget	0
DeviceWarningTemperature	90.0
DeviceFanEnable	☒ True
DeviceFanSpeed	Medium ▾
DeviceLedEnable	Low
MultiROIControl	Medium
	High

Figure 4-3

- 2) If you choose to turn off the fan, please ensure that the water cooling system is functioning properly before proceeding with this operation.

4.3.3. Disconnect the Water Cooling Pipe

- 1) Disconnect the power supply to the camera and all other equipment, including the recirculating water chiller;
- 2) Following the instructions for the recirculating water chiller, unplug the water hose from the chiller and drain the water from the chiller;
- 3) Press the adapter valve sleeve and remove the water hose from the recirculating water chiller to drain the internal water;
- 4) Press the water connector and remove the camera's water hose from the hose connector. First, position the side with the water valve facing sideways (**not upwards**). When removing the hose, ensure the water valve is facing downwards. Use an absorbent towel or paper towel to protect the area to ensure no water leaks into the camera.



Figure 4-4 Removing water-cooled pipes

Note:

- 1) Selection of cooling water: Deionized water is recommended;
- 2) Water temperature: Generally, a water temperature of 20°C is recommended. Inappropriate environmental conditions can cause condensation on the water valves and hoses, posing a risk of equipment damage. To ensure proper operation, the water temperature should not be below the dew point. Refer to the dew point table in the appendix for the dew point;
- 3) Pressure: The maximum water pressure entering the camera should not exceed 2 bar;
- 4) Recirculating water chiller: Use the chiller and cooling water correctly according to the chiller's

instructions;

- 5) Properly install the water-cooling pipeline to ensure no leakage at the connections on both the camera and chiller ends;
- 6) Before operating the camera, ensure the correct installation of the recirculating water chiller and the camera's water valves, and that the water flow rate reaches 1L/min;
- 7) After operation, turn off the power to the camera and chiller, and drain the water from both the chiller and the camera.

Warning:

- 1) Do not turn off the recirculating water chiller during camera operation, as this may cause the chip to run at a high temperature continuously, leading to damage;
- 2) During camera operation, the water cooling and fan can be operated simultaneously, but cannot be disabled at the same time. At least one cooling method must be running to prevent the chip from running at high temperatures and being damaged.

4.4. Network Adapter Installation

Turn off the computer and open the cover of the computer host, as shown in Figure 4-6. Install the network adapter into a compatible PCIe 4.0×4 or higher slot, ensuring proper alignment and secure connection, secure it with screws, and then restart the computer. Connect the interface between the camera and the network adapter through a ethernet cable.

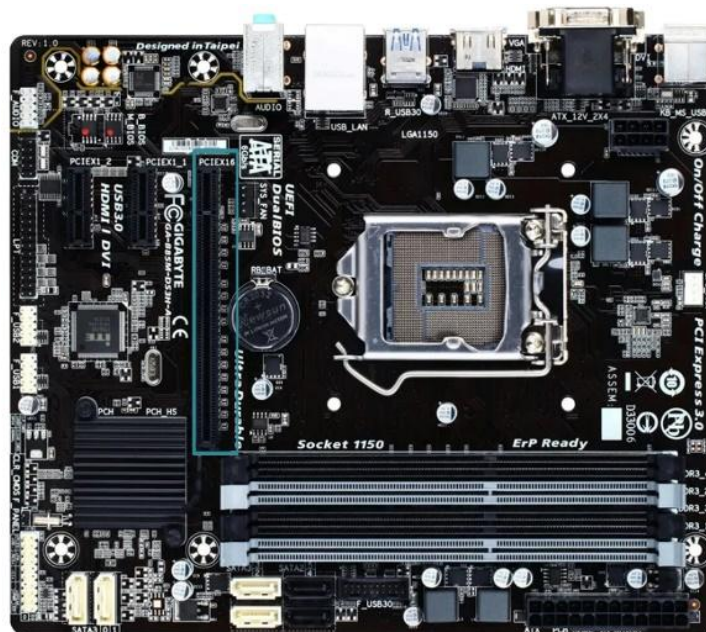


Figure 4-5 Computer motherboard diagram

Table 4-1 Maximum transfer rate corresponding to different PCIe slots

PCIe	X1	X4	X8	X16
1.0	250MB/s	1GB/s	2GB/s	4GB/s
2.0	500MB/s	2GB/s	4GB/s	8GB/s
3.0	985MB/s	3.9GB/s	7.8GB/s	15.7GB/s
4.0	1969MB/s	7.8GB/s	15.7GB/s	31.5GB/s

Note:

- 1) When installing and disassembling the Network Adapter, be sure to operate with power off;

4.5. Network Adapter Driver Installation

4.5.1. Hikvision Network Adapter Environment Configuration

- 1) Install or remove the network adapter only when the computer is powered off. After installing the adapter, proceed with driver installation as follows:
- 2) Double-click the MVS_STD_4.4.0_240913.exe program file, check the box to agree to the terms, and click **Start Setup**.

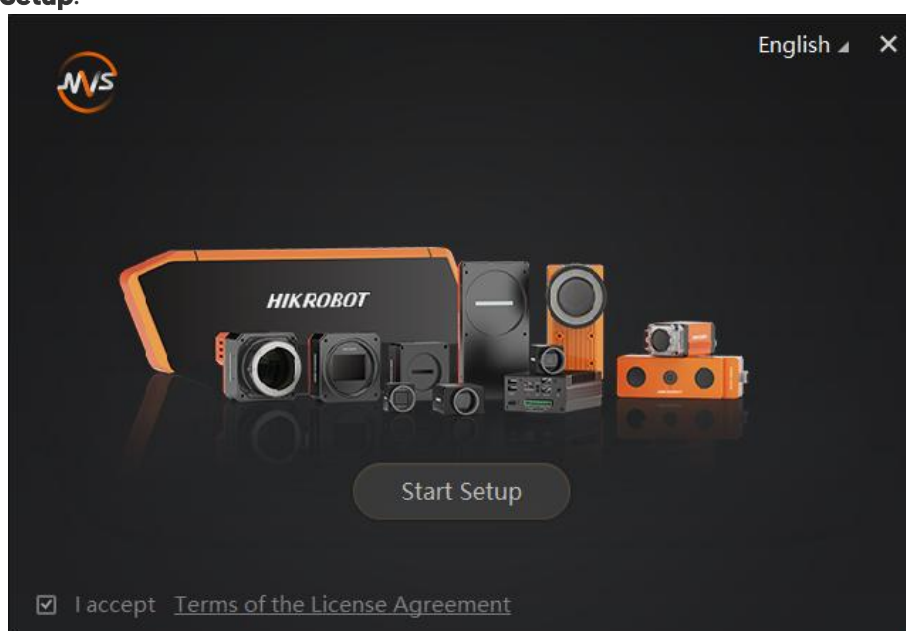


Figure 4-6

- 3) Select the installation path, drivers, and other components, then click **Next**.

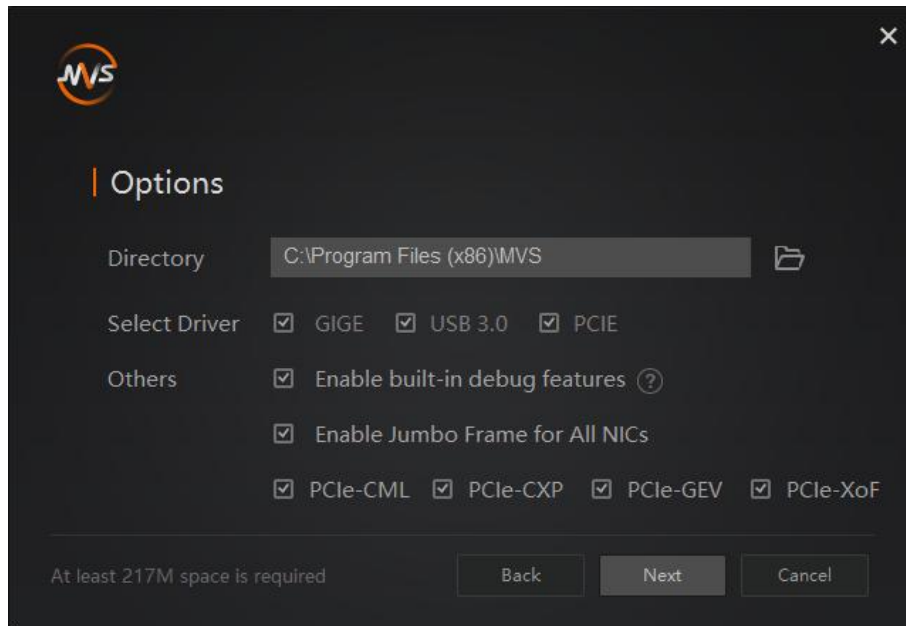


Figure 4-7

- 4) Wait for the installation to complete. Verify that the device is recognized as **MVFG PCIe Devices** in Device Manager, then restart the computer.



Figure 4-8

4.5.2. LR-Link Network Adapter Environment Configuration

Install or remove the network adapter only when the computer is powered off. After installing the adapter, proceed with driver installation

4.5.2.1. Driver Installation

- 1) Double-click the driver to install, check the box for **I accept the terms in the License Agreement** , and click **Install**.



Figure 4-9

- 2) During installation, a progress bar is displayed. Wait for the process to complete, click Finish, and the driver will be successfully installed.

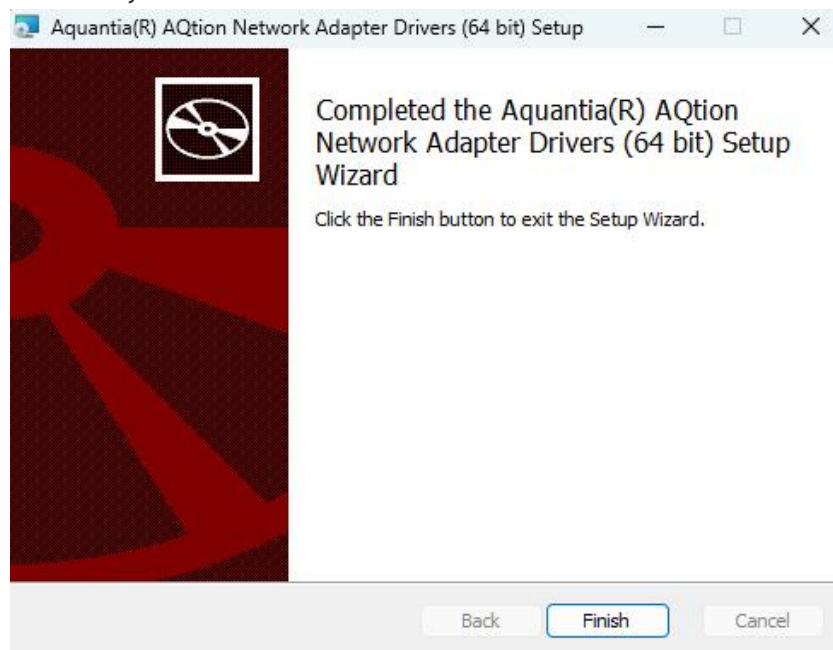


Figure 4-10

Note:

- 1) On some computers, the network adapter may not be recognized in Device Manager after driver installation. If this occurs, uninstall the driver and then scan for hardware changes;
- 2) If the card remains undetected, reinstall the ASUS network card driver and rescan for hardware changes.

4.5.2.2. Network Adapter Configuration

- 1) Configure **Jumbo Frames** for the network adapter. Open **Device Manager**, navigate to **Network adapters** and select the target adapter **Marvell AQtion 10Gbit Network Adapter**;

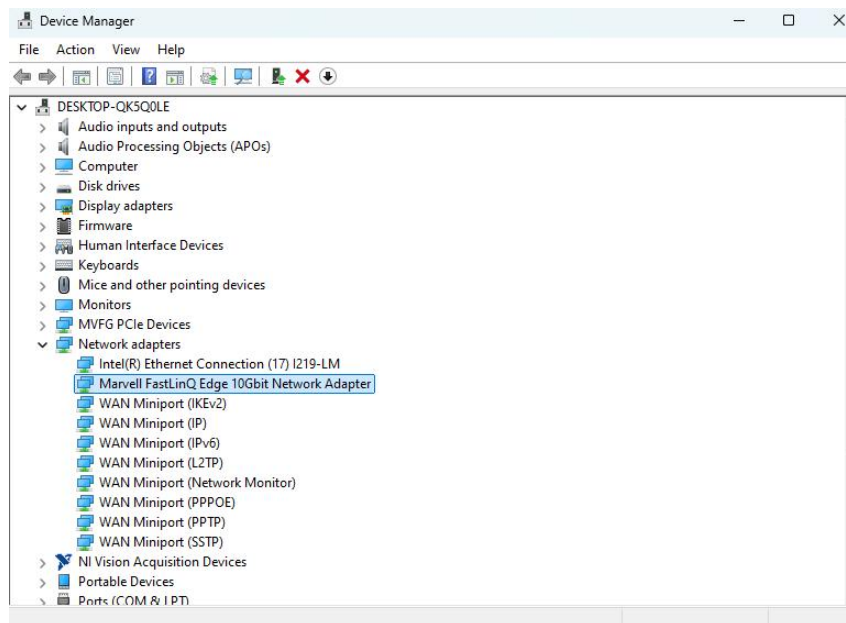


Figure 4-11

- 2) Right-click on the **Properties**:

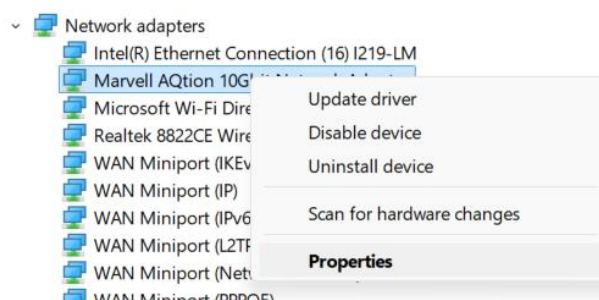


Figure 4-12

- 3) Select the **Advance** page in the properties page:
- 4) Find the **Jumbo Packet** in the advanced tab and select it. Set the value on the right to maximum and click OK. (Jumbo packets are sometimes called Jumbo frames or large packets) :

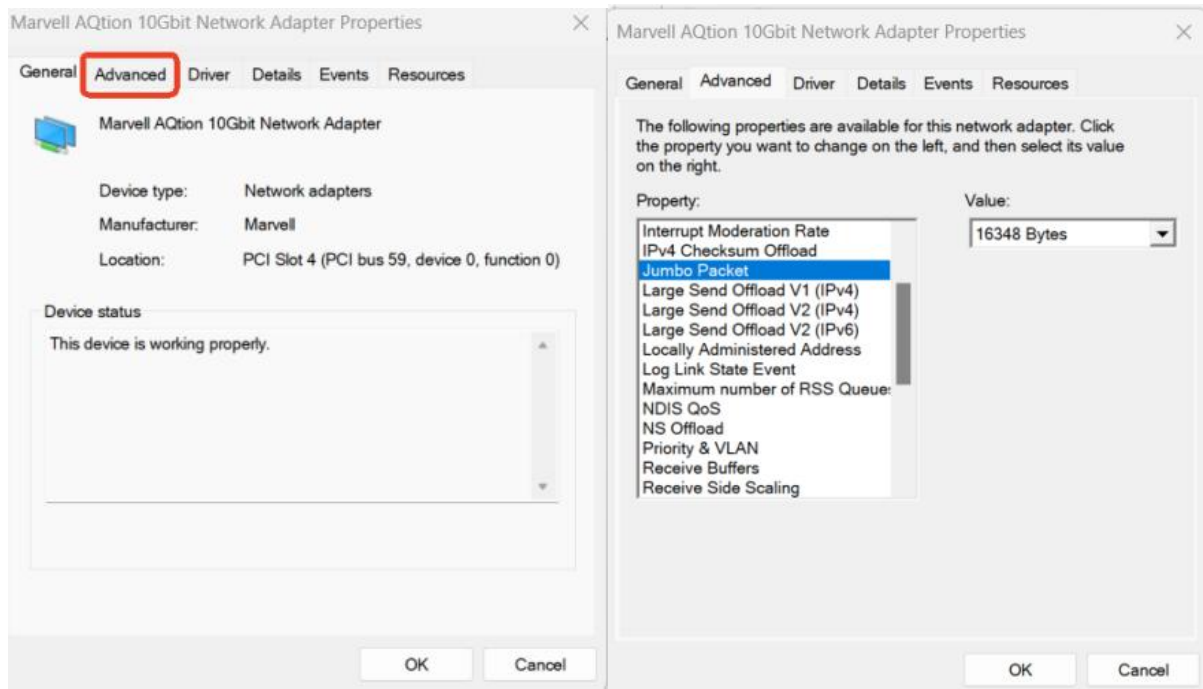


Figure 4-13

- 5) If the camera doesn't have an image or the image doesn't display properly, look at the receive buffer and turn it up to full, interrupt throttling to extreme. If the camera captures normally this step can be ignored:

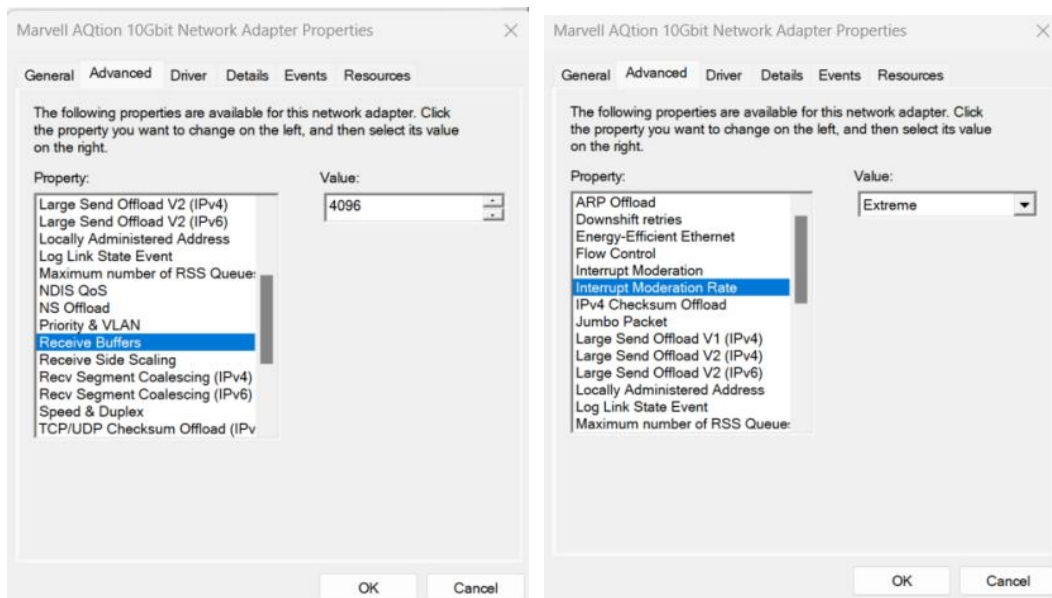


Figure 4-15

- 6) Deselect all options in the Resources section;
- 7) The network adapter supports dual network ports. Select the other **Marvell AQtion 10Gbit Network Adapter** and repeat steps 2) and 6)

4.6. Computer Environment Setup

4.6.1. FilterDriver Installation

- 1) Double-click the **InstallFilterDriver.bat**;

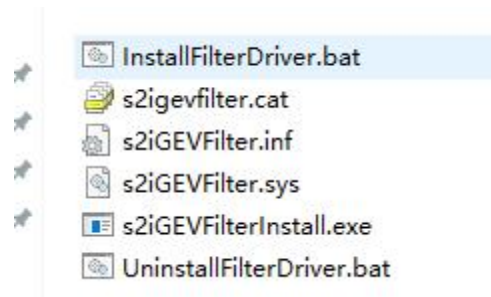


Figure 4-12

- 2) Click **OK** to continue the installation;

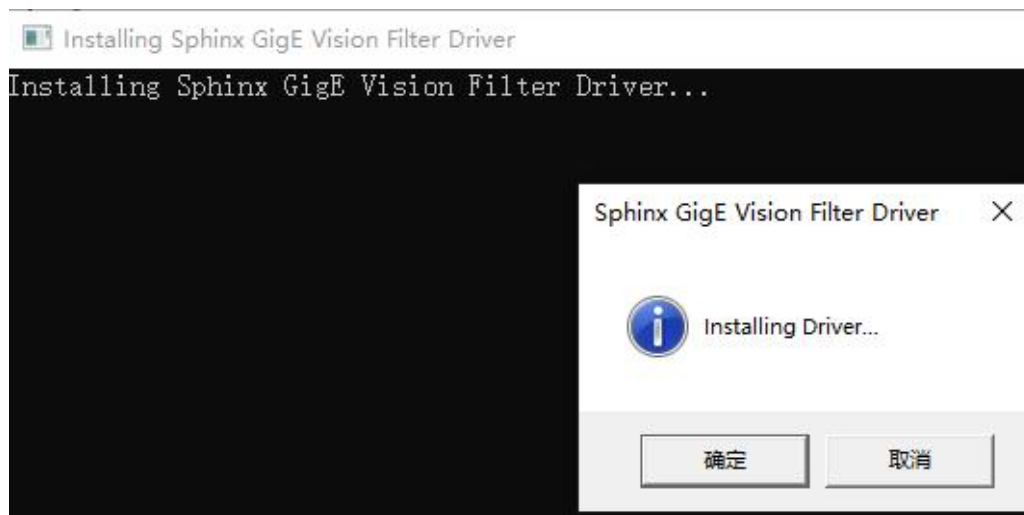


Figure 4-13

- 3) When the message **End with any key** appears, press any key or simply close the pop-up window to complete the installation.

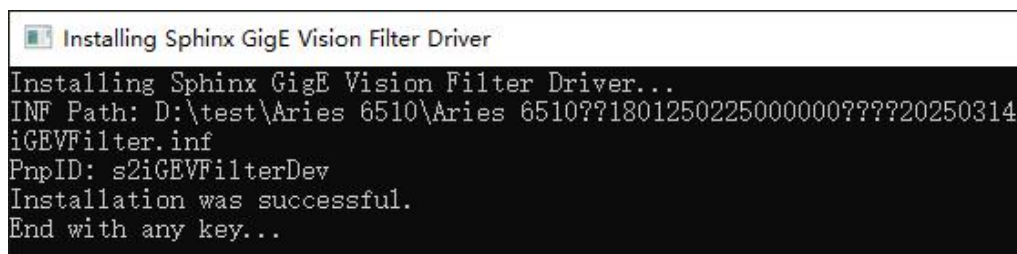


Figure 4-14

Note:

After completing the installation, you **must restart the computer** for the drivers to take effect.

4.6.2. Computer's IP configuration

Most computers have their IP addresses set to automatic (DHCP) by default. To ensure proper camera operation, verify the configuration as follows:

- 1) Open **Control Panel** → **Network and Sharing Center** → Click **Ethernet** → **Change adapter settings**;



Figure 4-15

- 2) Click on **Ethernet**, then right-click and select **Properties** (If no additional network cards are installed, the computer typically has only one Ethernet adapter).

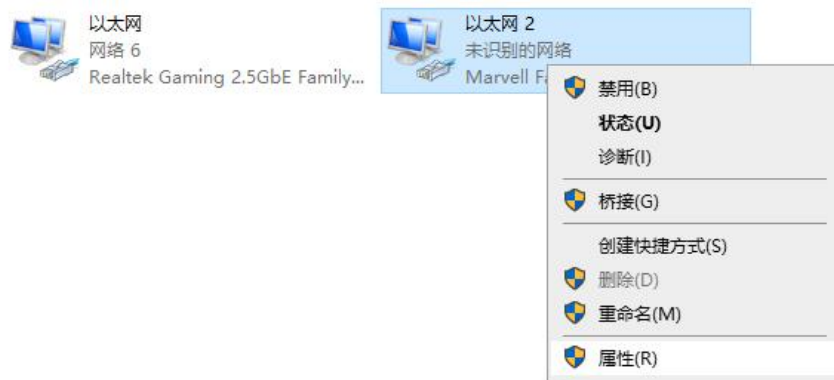


Figure 4-16

- 3) Select **Internet Protocol Version 4 (TCP/IPv4)** and click **Properties**;
- 4) Check both **Obtain an IP address automatically** and **Obtain DNS server address automatically**, then click **OK**.

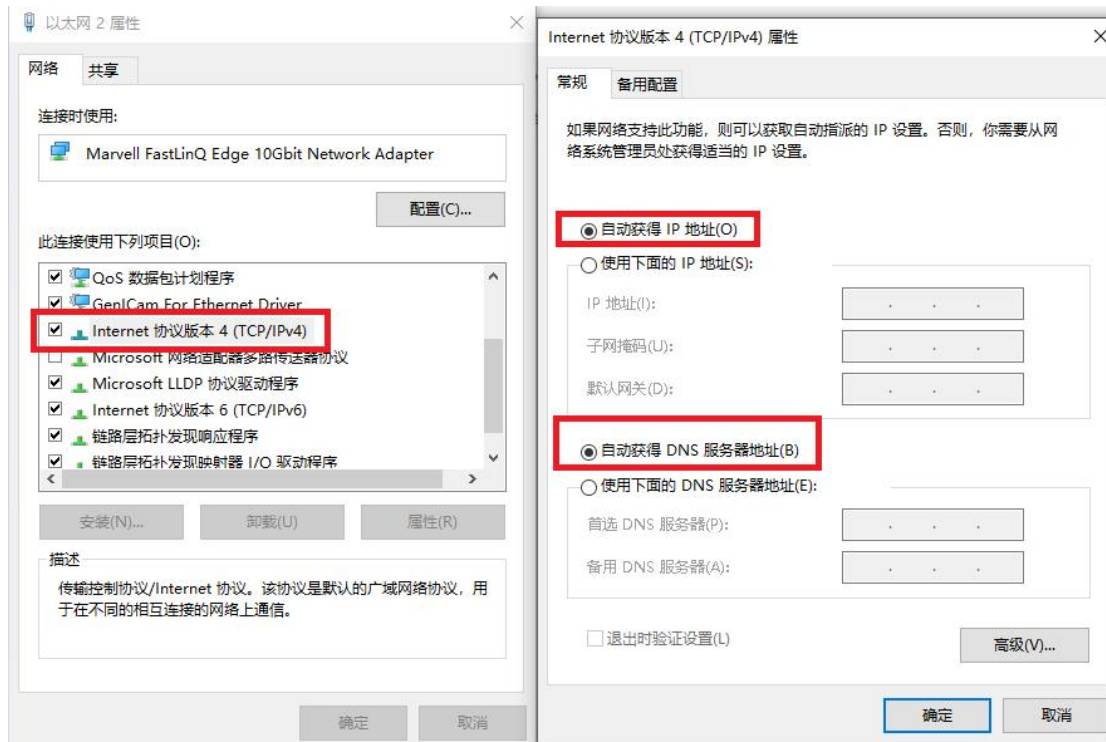


Figure 4-17

4.7. SamplePro Software Installation

Open the provided USB drive and double-click to run the SamplePro application;

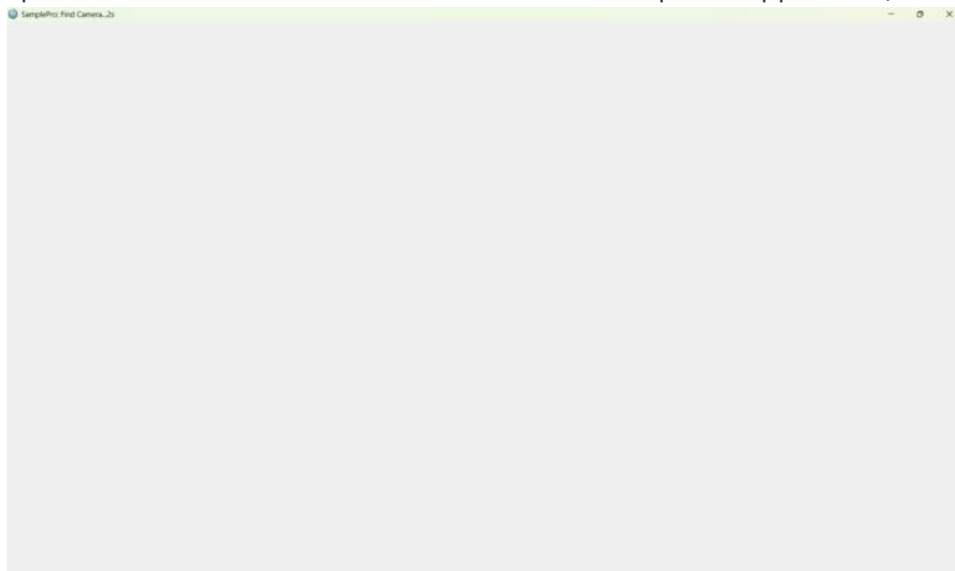


Figure 4-18

After a few seconds, the camera connection will be established. Launch the software setting menu and click the **Live** button to initiate real-time preview. The current mode's frame rate will be displayed.

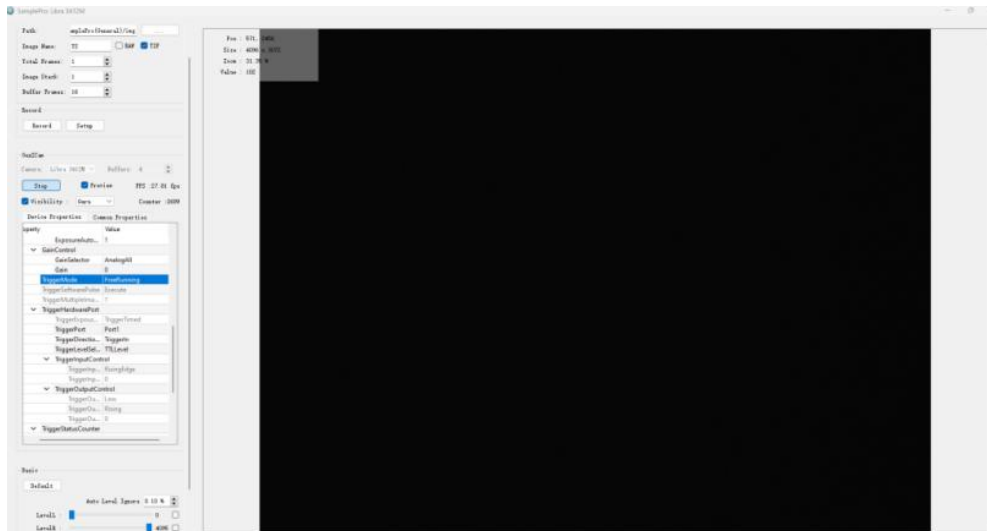


Figure 4-19

Note:

- 1) If the screen appears as a solid white image without preview, check the network adapter configuration.
- 2) If the software repeatedly fails to detect the camera or displays file corruption warnings, please contact our Technical Support team.

5. SamplePro Operating Instructions

5.1. Launch Interface

Double-click SamplePro to start the software. The launch interface is shown in Figure 5-1. Wait for the loading process to complete.

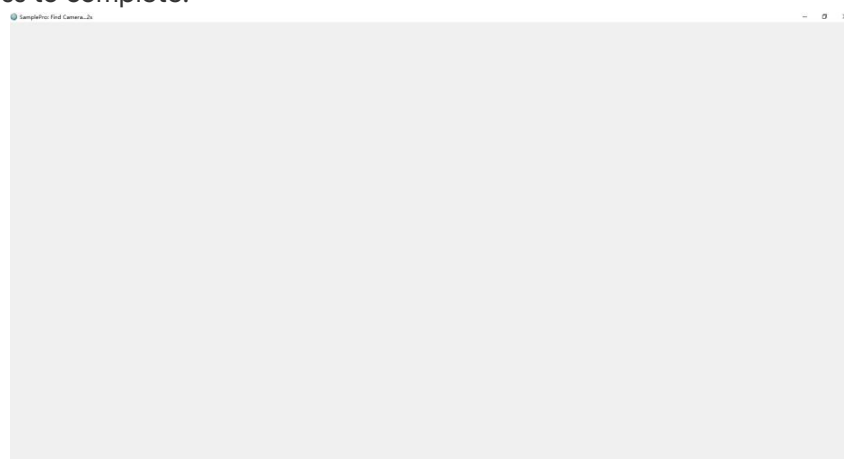


Figure 5-1

Note:

- 1) During the first launch, right-click and select "Run as Administrator". For subsequent use, double-click normally to start the software.

5.2. Window Composition

The main interface of SamplePro software consists of five sections: "Preview Window", "Control Panel", "Image Capture", "Device Parameters", and "Basic", as shown in Figure 5-2.

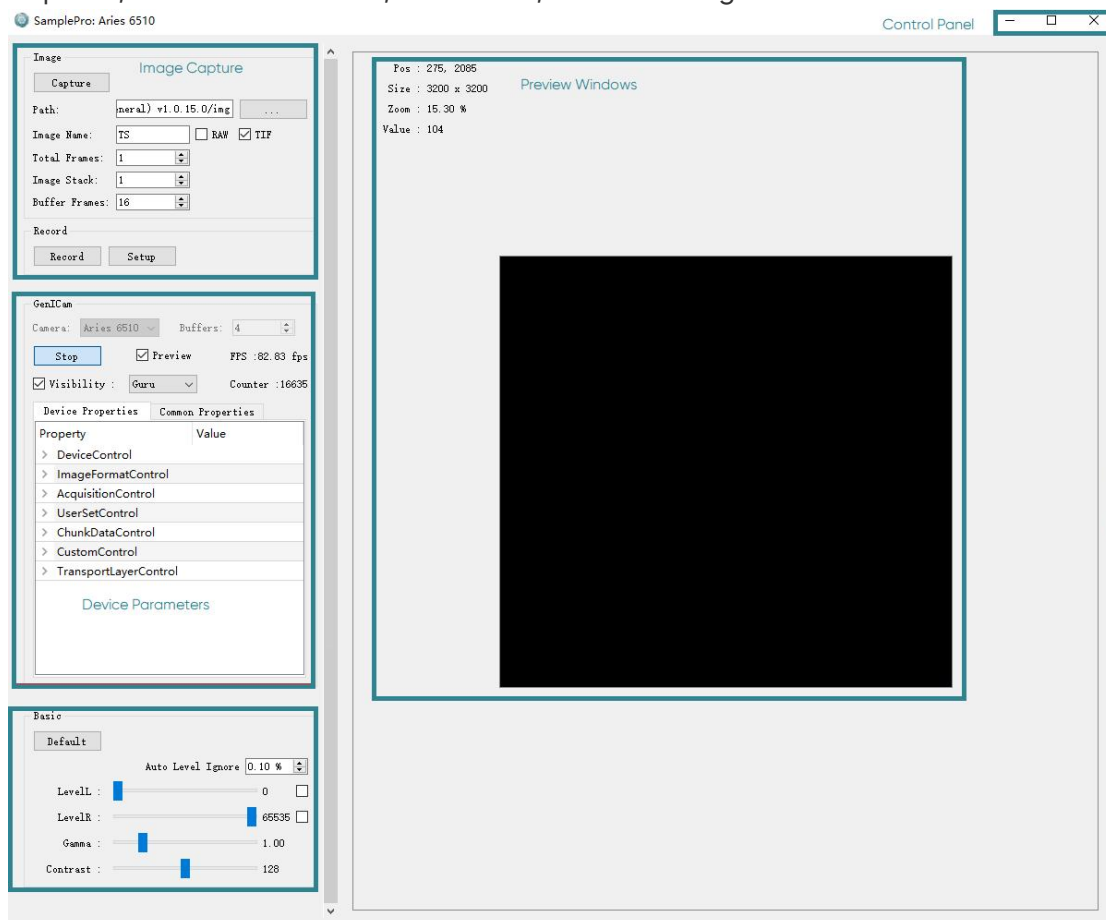


Figure 5-2

This section briefly introduces the functions of each window.

5.2.1. Preview Window

The Preview Window displays live camera in FreeRunning. It supports real-time scaling, allowing users to zoom in or out using the mouse wheel according to their needs.

The top-left corner of the window shows: Image Resolution, Zoom Ratio, Pixel Grayscale Value & Coordinates dynamically displayed based on the cursor position over the live image.

```
Pos : 744, 416  
Size : 3200 x 3200  
Zoom : 12.50 %  
Value : 106
```

Figure 5-3

5.2.2. Window Control

The functions of the window control are the common ones of minimizing, maximizing, and closing the window.

5.2.3. Image Capture

The image capture module provides basic photo and video functions for the camera. Users can choose different image formats for capturing photos and customizing video length according to their needs. The images are saved by default in the img folder under the software root directory.

5.2.4. Parameters

The main functions and parameters of the camera are all expanded under this module, and the output method of the camera is also controlled here. Users can expand and use the corresponding function modules according to their needs.

5.2.5. Image Adjustment

Users can adjust the image gamma value, contrast value, and set left and right color levels on the image adjustment interface based on the difference between the real-time preview effect and the actual sample to achieve the desired image effect.

5.3. Image Capture

This section provides a detailed introduction to the functions of the image capture module, including the steps for some functions.

As shown in Figure 5-4, the image capture module supports the basic camera functions of taking images and recording videos.

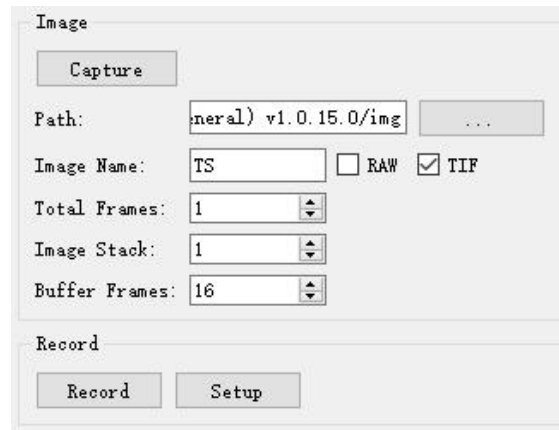


Figure 5-4

- 1) Capture: Click the button to take a single image. During continuous capture, click **Stop Capture** to manually interrupt the process.
- 2) Path: Set the default storage path for images and videos, and click  to modify.
- 3) Image Name: The default prefix for image names, which can be customized.
- 4) Image Format: Select the image file format. Supports raw sensor data (RAW) and TIFF formats. Default is TIFF (single selection only).
- 5) Total Frames: Set the number of images to capture. Default is 1 image.
- 6) Image Stack: Set the stack frame count. Default is 1 (no stacking). If set to any value other than 1, multiple captured images will be merged into a single stacked image for storage.
- 7) Buffer Frames: Default is 16. Increase this value appropriately during high-speed acquisition to prevent frame loss. Generally set equal to or higher than the frame rate.
- 8) Record: Click to manually start video recording. Click **Stop Record** during capture to manually stop.
- 9) Setup: As shown in Figure 5-5, configure video compression format and playback rate. Compression options include Full Frame (No Compression) and MPEG-4.

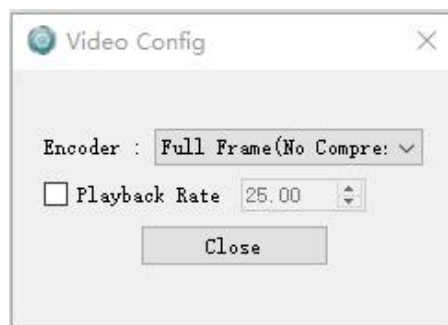


Figure 5-5

5.4. Device Parameters

This functional module includes all the settings and parameters interfaces for the camera.

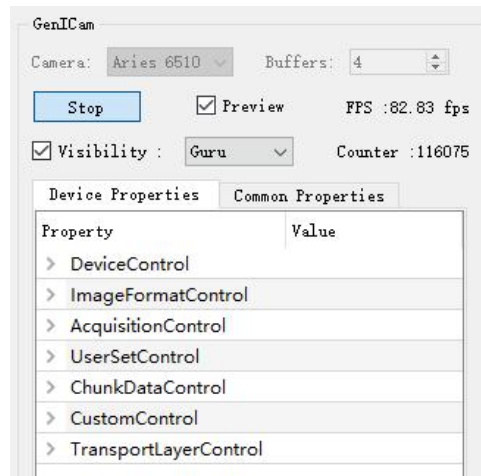


Figure 5-6

- 1) Camera: Used to switch between connected cameras when multiple cameras are connected.
- 2) Buffer: Sets the number of memory buffer frames. Increase this value when capturing large image sequences.
- 3) Stop: Halts the camera's FreeRunning, stopping real-time image display in the preview window. In external trigger mode, stops image acquisition based on trigger signals.
- 4) Live: Resumes normal camera operation from a halted live state.
- 5) Preview: When checked, the preview area refreshes images in real time. When unchecked, streaming continues but preview refresh is disabled.
- 6) FPS Displays the current frame rate.
- 7) Visibility: When checked, the Properties panel is displayed. When unchecked, the Properties panel is hidden.
- 8) Counter: Real-time count of frames received by the PC software.

5.4.1. Device Control

This module displays camera basic information (read-only), User ID editing, camera reset, and temperature monitoring. (Refer to Figure 5-7)

▼ DeviceControl	
DeviceScanType	Areascan
DeviceVendorName	Tucsen
DeviceModelName	Aries 6510
DeviceManufacturerI...	Tucsen GigE Vi...
DeviceVersion	180125022500...
DeviceSerialNumber	QBSC16025002
DeviceUserID	
DeviceReset	Execute
DeviceTemperatureS...	Sensor
DeviceTemperature	-0.06

Figure 5-7

- 1) DeviceScanType: Displays the camera scanning mode: Area scan (read-only);
- 2) DeviceVendorName: Displays device vendor;
- 3) DeviceModeName: Displays camera model;
- 4) DeviceManufactureInfo: Displays device manufacture;
- 5) DeviceVersion: Displays camera firmware version
- 6) DeviceSeriaNumber: Displays camera SN;
- 7) DeviceUserID: Supports customization;
- 8) DeviceTemperatureSelector: Temperature selector offering three options: Sensor, FPGA, and PHY;
- 9) DeviceTemperature: Displays the temperature of the type selected in the temperature selector;

5.4.2. ImageFormatControl

The camera's gain mode, image width, starting offset, binning, mirroring, bit depth, and test pattern generator modules are featured in this section, as shown in Figure 5-8.

▼ ImageFormatControl	
SensorWidth	3,200
SensorHeight	3,200
SensorShutterMode	Rolling
SensorOperationMode	Dynamic
Dynamic	HDR
Speed	HighGain
Sensitivity	Standard
WidthMax	3,200
HeightMax	3,200
Width	3,200
Height	3,200
OffsetX	0
OffsetY	0
BinningSelector	BinOff
BinningMode	Sum
ReverseX	☐ False
ReverseY	☐ False
PixelFormat	Mono16
TestPattern	Off

Figure 5-8

- 1) SensorWidth: Displays the maximum horizontal resolution (Width), the value of which is affected by BinningSelector and Resolution parameters.
- 2) SensorHeight: Displays the maximum vertical resolution (Height), the value of which is affected by BinningSelector and Resolution parameters.
- 3) SensorShutterMode: Shutter type selection, supports Rolling and GlobalReset.
- 4) SensorOperationMode: Gain mode selection, supports Dynamic, Speed, and Sensitivity.
- 5) Dynamic: Available when **SensorOperationMode** is set to Dynamic. Options include HDR, HighGain, and LowGain.
- 6) Speed: Available when **SensorOperationMode** is set to Speed. Options include HighGain, MidGain, and LowGain.
- 7) Sensitivity: Available when **SensorOperationMode** is set to Sensitivity. Options include Standard and LowNoise.
- 8) WidthMax: Displays the maximum horizontal resolution (Width), the value of which is affected by BinningSelector and Resolution parameters.
- 9) HeightMax: Displays the maximum vertical resolution (Height), the value of which is affected by BinningSelector and Resolution parameters.

- 10) Width: Sets the horizontal ROI under the current resolution. Maximum value cannot exceed WidthMax, minimum is 8, adjustable in steps of 8.
- 11) Height: Sets the vertical ROI under the current resolution. Maximum value cannot exceed HeightMax, minimum is 6, adjustable in steps of 2.
- 12) OffsetX: Sets the horizontal starting position of the ROI under the current resolution. Minimum is 0, adjustable in steps of 8.
- 13) OffsetY: Sets the vertical starting position of the ROI under the current resolution. Minimum is 0, adjustable in steps of 2.
- 14) BinningSelector: Supports BinOff, Bin2x2, and Bin4x4. Bin2x2 reduces horizontal and vertical resolution by half; Bin4x4 reduces to 1/4 of original.
- 15) BinningMode: Supports **Sum** and **Average**. When set to Sum:
- 16) Bin2x2 increases grayscale value by 4 times
- 17) Bin4x4 increases grayscale value by 16 times
- 18) ReverseX: Horizontal mirroring. Enabled when checked.
- 19) ReverseY: Vertical mirroring. Enabled when checked.
- 20) PixelFormat: Image pixel data format (read-only). Corresponds to the OperationMode setting.
- 21) TestPattern: Selects the camera's output image mode. Options include: Off (real-time data), Horizontal Grayscale Gradient, Vertical Grayscale Gradient, Diagonal Grayscale Gradient, Moving Diagonal Grayscale Gradient.

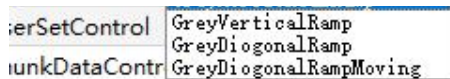
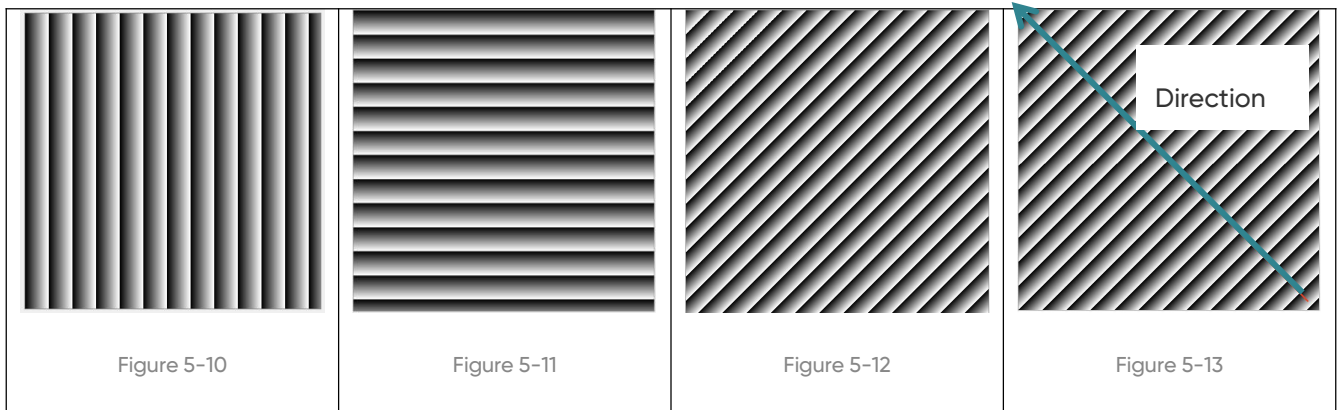


Figure 5-9

- Horizontal Grayscale Gradient: As shown in Figure 5-10, the preview displays a static grayscale gradient pattern along the horizontal direction.
- Vertical Grayscale Gradient: As shown in Figure 5-11, the preview displays a static grayscale gradient pattern along the vertical direction.
- Diagonal Grayscale Gradient: As shown in Figure 5-12, the preview displays a static grayscale gradient pattern along the diagonal direction.
- Moving Diagonal Grayscale Gradient: As shown in Figure 5-13, the preview displays a dynamically moving grayscale gradient pattern along the diagonal direction.



5.4.3. AcquisitionControl

Camera Frame Rate, Exposure, and Trigger Configuration Module is shown in Figure 5-14.

▼ AcquisitionControl			
AcquisitionMode	Continuous		
AcquisitionStart	Execute		
AcquisitionStop	Execute		
AcquisitionMaxFrameRat...	87.63		
AcquisitionFrameRate(Hz)	40.17		
CurrentFrameRate(Hz)	40.17		
BlackLevel	100		
AutoTargetGray(%)	90		
AutoMeteringRatio(%)	0.10		
▼ ExposureControl			
ExposureTime(us)	181		
ExposureAuto	Once		
ExposureAutoOnceP...	Execute		
AutoControlStatus	Idle		
TriggerMode	FreeRunning		
TriggerMultipleImages	100		
TriggerSoftwarePulse	Execute		
▶ TriggerHardwarePort			
		▼ TriggerHardwarePort	
		TriggerExposureType	TriggerTimec
		TriggerPort	Port1
		TriggerPortEnable	☒ True
		TriggerDirectionSelect	TriggerIn
		▼ TriggerInputControl	
		TriggerInputFilterWi...	0
		TriggerInputEdge	Rising
		TriggerInputDelay(us)	0
		▼ TriggerOutputControl	
		TriggerOutputSignal	ReadoutEnd
		TriggerOutputEdge	Rising
		TriggerOutputDelay(...	0
		TriggerOutputWidth(...	5,000

Figure 5-14

- 1) AcquisitionStart: Resumes streaming after pausing in FreeRunning. The Counter will not reset.
- 2) AcquisitionStop: Pauses streaming in FreeRunning. Streaming can be resumed by executing AcquisitionStart again.
- 3) AcquisitionMaxFrameRate (Hz): Displays the maximum frame rate.
- 4) AcquisitionFrameRate (Hz): Sets the frame rate. Minimum: 0.01 Hz, maximum: up to MaxFrameRate.
- 5) CurrentFrameRate (Hz): Displays the currently frame rate.
- 6) BlackLevel: Adjusts the image's base grayscale value (bias). Adjustable range: 12-bit: -255 to 255, 16-

bit: -65535 to 65535

- 7) AutoTargetGray(%): Target value for auto exposure. Range: 10% to 90%. Default: 90%.
- 8) AutoMeteringRatio(%): Pixel ratio for metering. Range: 0.01% to 50%. Default: 0.10%.
- 9) ExposureTime(μ s): Sets the exposure time.
- 10) ExposureAuto: Auto exposure. The software automatically adjusts exposure time based on image brightness and locks the exposure time.
 - Off: Disabled
 - Once: Enabled (requires coordination with the Execute button in ExposureAutoOncePulse parameter)
- 11) ExposureAutoOncePulse: Clickable only when ExposureAuto is set to Once.
- 12) AutoControlStatus: Displays auto exposure status (read-only).
- 13) TriggerMode: Selects data streaming mode. Options:
 - FreeRunning (internal trigger)
 - Standard (hardware trigger)
 - Software (software trigger)
- 14) TriggerMultipleImages: Sets the total number of images to capture automatically upon receiving a trigger signal. Default: 1. Range: 1 to 65535.
- 15) TriggerSoftwarePulse: Clickable only when TriggerMode is set to Software.
- 16) TriggerExposureType: Selects trigger input signal type. Options:
 - TriggerTimed (exposure time determined by software settings)
 - TriggerWidth (exposure time determined by external trigger pulse width)
- 17) TriggerPort: Selects trigger port.
 - Port1: Input (enables control of TriggerInputControl module)
 - Port2/3/4: Output (enables control of TriggerOutputControl module)

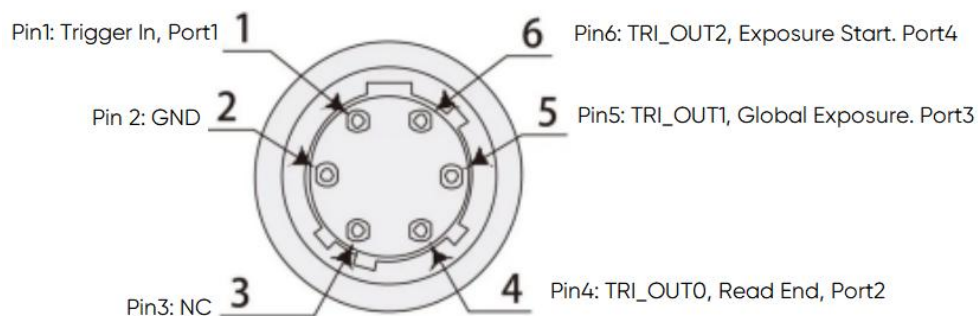


Figure 5-15

The correspondence between software ports and physical camera trigger pins is shown in Figure 5-15.

- 18) **TriggerPortEnable**: Enables or disables trigger output signals. Port2, Port3, and Port4 can be controlled individually; Port1 does not support this setting.
- 19) **TriggerDirectionSelect**: Read-only. Automatically displays **TriggerIn** or **TriggerOut** based on the TriggerPort configuration.
- 20) **TriggerInputFilterWidth** (μ s): Filters glitches on low/high levels to suppress interference in external trigger signals. Adjustable range: 1 to 100,000 μ s. Default: 1 μ s.
- 21) **TriggerInputEdge**: Selects trigger input. Options: Rising (rising edge) or Falling (falling edge).
- 22) **TriggerInputDelay** (μ s): Configures delay for trigger input signals. Adjustable range: 0 to 10,000,000 μ s. Not supported for TriggerWidth signals.

5.4.4. TriggerOutputControl

- 1) **TriggerOutputSignal**: Selects the trigger output signal. As shown in Figure 5-16, it supports 8 signals: High, Low, ReadoutEnd, GlobalExposure, ExposureStart, TriggerReady, AnyRow, and FirstRow.
 - Port1 defaults to ReadoutEnd
 - Port2 defaults to GlobalExposure
 - Port3 defaults to ExposureStart

Additionally, any of the other 7 signals can be selected for each port.

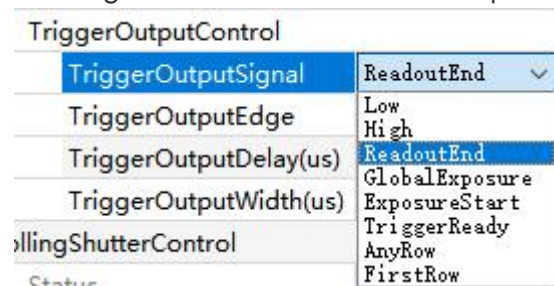


Figure 5-16

- 2) **TriggerOutputEdge**: Selects the trigger output signal. Options: Rising or Falling.
- 3) **TriggerOutputDelay** (μ s): Configures the delay for the trigger output signal. Adjustable range: 0 to 10,000,000 μ s.
- 4) **TriggerOutputWidth** (μ s): Configures the pulse width of the trigger output signal. Adjustable range: 0 to 10,000,000 μ s.

5.4.5. RollingShutterControl

The RollingShutter Configuration Module is shown in Figure 5-17.

RollingShutterControl	
Status	Off
LineTimeDelay	0
SlitHeight	1
RollingSpeed(us/row)	3.75
ReadoutDirection	Down
ReadoutDirectionReset	☒ True

Figure 5-17

- 1) Status: Enable/disable switch for the functional module;
- 2) LineTimeDelay: When the "Rolling Shutter Control Mode" is set to "Line Time Delay" mode, the rolling speed (Rolling Speed) can be increased by inserting a specified number of line time delays (range: 1–100 line times, unit: number of Line times) between the "Reset" and "Readout" signals. The actual value of Rolling Speed ranges from $2 \times \text{Line time}$ to $100 \mu\text{s/row}$ (unit: microsecond/row), and the specific value will be automatically calculated and displayed by the software.

Formula:

$$\text{Rolling Speed} = \text{Line time(sensor)} + (\text{Line time(sensor)} \times \text{Line Time Delay})$$

In this mode, the frame rate during imaging depends on the number of rows to be imaged and the line time. The calculations are as follows:

$$\text{Readout time image} = \text{Rolling Speed} \times N_{\text{rows}}$$

$$\text{Frame rate} = 1 / (\text{Readout time image} + \text{Exposure time})$$

N_{rows} : the total number of rows to be imaged.

Notes:

- 1) When the exposure time is less than the readout time (i.e., $\text{Line time} \times 2048$), the camera consistently operates at the **maximum frame rate**.
- 2) The actual light sheet readout time slightly differs from the formula calculation. The specific implementation is:

$$\text{Readout time} = \text{Rolling Speed} \times (N - 1) + \text{Line Time}$$

This is because the **last row does not include the Rolling Speed delay**.

- 3) If the scan direction is set to top-bottom alternating mode, the row scanning sequence progresses as $1 \rightarrow 3200$ (or 2400), then 3200 (or 2400) $\rightarrow 1$. In this case, whether to add Rolling Speed for the last row can be flexibly chosen based on actual requirements.

- 3) **SlitHeight**: When the [Status] is set to [Slit Height] mode, you can set the scan slit height, which directly changes the scan row width to define the size of the [active pixel] region. [Slit Height] is the number of pixel rows between the "Reset" and "Readout" signals. The range for [Slit Height] is 1~2048. Additionally, in HighSpeed mode, which reads out every 2 rows, the range for [Slit Height] is 2~2048 and must be an even number.

In this state, the software automatically calculates the required [Line Time Delay] and Rolling Speed. The formulas are as follows:

For HighSpeed mode:

$$\text{Line Time Delay} = \text{Exposure time}_{(\text{Lines})} \div (\text{Slit Height}_{(\text{Lines})} \div 2)$$

$$\text{Slit Height} = (\text{Exposure time}_{(\text{Lines})} \div \text{Line Time Delay}) \times 2$$

For other modes (non-HighSpeed):

$$\text{Line Time Delay} = \text{Exposure time}_{(\text{Lines})} \div \text{Slit Height}_{(\text{Lines})}$$

$$\text{Slit Height} = \text{Exposure time}_{(\text{Lines})} \div \text{Line Time Delay}$$

$$\text{Rolling Speed} = \text{Line time}_{(\text{sensor})} + (\text{Line time}_{(\text{sensor})} \times \text{Line Time Delay})$$

Notes:

- 1) When [Status] is set to **[Auto] Off**, **[Line Time Delay]** and **[Slit Height]** cannot be set; **[Rolling Speed]** is not grayed out, and **[Readout Direction]** is selectable.
- 2) When Status is set to **[Line Time Delay]**, changing this parameter value increases or decreases the **[Rolling Speed]** value. **[Slit Height]** is read-only and cannot be set; its value is displayed based on the formula below.
- 3) **[Line Time Delay]**, **[Exposure time (Lines)]**, and **[Slit Height (Lines)]** must maintain the relational formula above. When two parameter values are determined, the third value should be automatically recalculated.
- 4) **RollingSpeed(us/row)**: Configures the rolling speed.
- 5) **ReadoutDirection**: Controls the readout direction of the rolling shutter. When the status is set to Off, it also supports scan direction control. Switching to the Down-up cycle results in decreasing frame rate.
 - **Down**: The downward scanning direction is the default scanning direction for sCMOS cameras. The rolling shutter starts at the top of the sensor and scans down to the bottom of the last line.

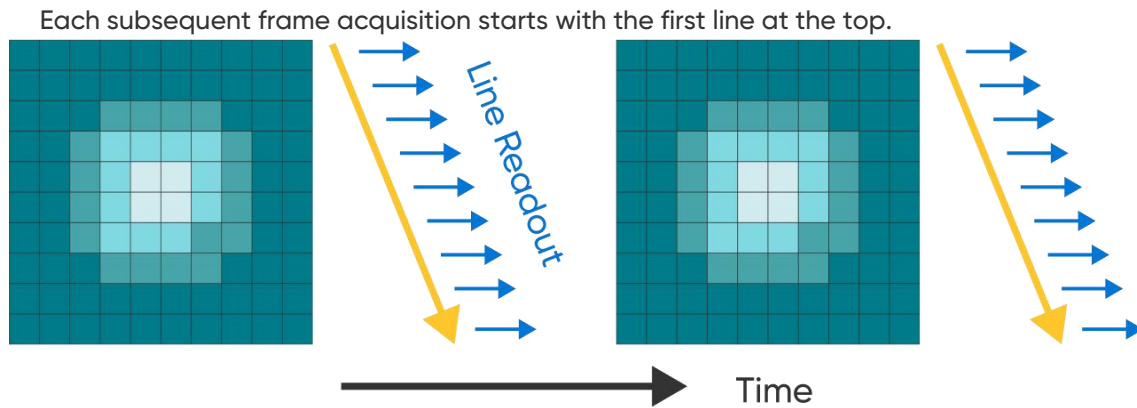


Figure 3-18 Schematic diagram of Down scanning

- **Up:** Upward scanning mode, the rolling shutter scans upwards from the bottom line to the top first line. Each subsequent frame acquisition starts with the bottom line. The image orientation acquired in this mode is not reversed and is consistent with the image in scan down mode.

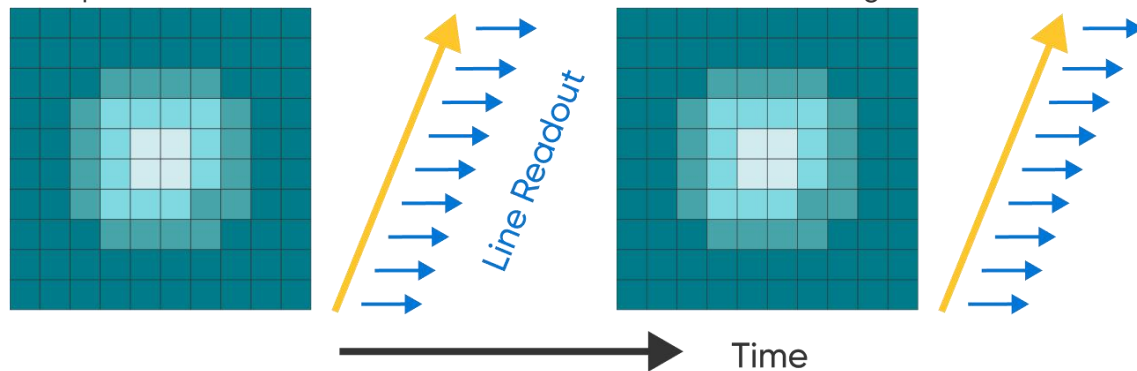


Figure 3-19 Schematic diagram of Up scanning

- **Down-up cycle:** When scanning up and down, the rolling shutter starts at the top of the first row and goes down to the bottom of the last line. For the next frame, the rolling shutter will start at the bottom row and sweep up to the top first row, and so on. The image acquired in this mode is oriented in the same direction as the downward scan direction.

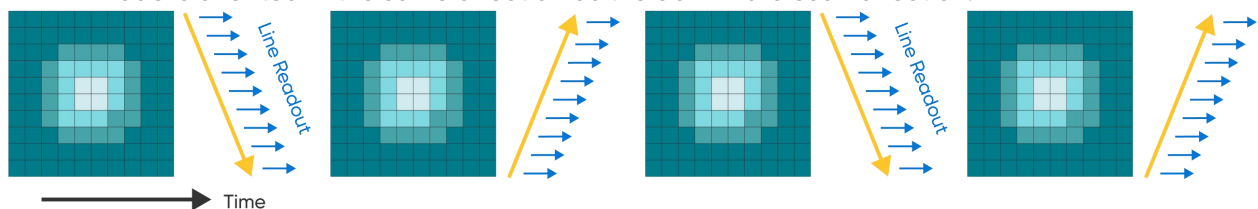


Figure 3-20 Schematic diagram of Down-up cycle scanning

- 6) **Readout Direction Reset:** This function is only available in [Down-up cycle] mode and affects the direction of the first image in each set.

Readout Direction Reset Function Description

Default Setting: "Yes" . When set to "Yes", it ensures that the first frame of each new acquisition

sequence starts scanning from the topmost row and proceeds downward.

When Set to "No" . The first frame of each new acquisition sequence starts from the position where the last frame of the previous sequence ended. If the last frame ended at the bottom row, the subsequent acquisition will start from the bottom row and scan upward.

Example Verification: Sequence Mechanism for Each Image Set

- (1) When each trigger signal outputs only one image:
 - Readout Direction Reset = Yes: Each image scans from top to bottom: Down-Down-Down-Down.
 - Readout Direction Reset = No: The scanning direction alternates per image: Down-Up-Down-Up (each image is an independent sequence).
- (2) When multiple trigger signals are sent or one trigger signal in Standard mode with Total Frame set to multiple images (outputting a sequence of images):
 - Readout Direction Reset = Yes:
First sequence: Down-Up-Down; Second sequence: Down-Up-Down; Third sequence: Down-Up-Down
 - Readout Direction Reset = No: If the number of images is odd, the direction differs:
First sequence: Down-Up-Down; Second sequence: Up-Down-Up; Third sequence: Down-Up-Down
 - If the number of images is even, the scanning direction is the same for each image:
First sequence: Down-Up; Second sequence: Down-Up; Third sequence: Down-Up

Notes:

- 1) Rolling Shutter Control is supported under both CameraLink and USB3.0 interfaces, and in both streaming and trigger modes. It is not supported in Global Reset gain mode but is available in other gain modes.
- 2) When Rolling Shutter Control is enabled with [Live], parameters can be adjusted in real-time with live preview.
- 3) The Rolling Shutter Control function is supported under ROI (Region of Interest) settings.
- 4) Parameters such as [Line Time Delay], [Slit Height], and those under "Adjustment" can be manually entered via text boxes.
- 5) In Standard/Width mode, setting Total Frame is not supported because the second image cannot replicate the first—the software or camera cannot remember the pulse width of the external signal

when generating the second image. This means there is no high-level signal for exposure. In Time mode, the exposure time is always taken from the software interface.

- 6) During continuous image output in Trigger Standard/Time Total Frame mode, the following operations (which involve live/stop actions) will immediately stop image output:
- Changing exposure (or directly clicking exposure OK)
 - Switching gain modes
 - Setting ROI
 - Toggling horizontal mirroring
 - Configuring trigger output parameters
 - Setting light sheet parameters
- 7) Operations such as toggling DSNU, PRNU, LED, adjusting fan speed, vertical mirroring, grayscale levels, or capturing images do not affect triggered image output.

5.4.6. UserSetControl

This module is used to save the parameters set by the user, and supports up to 2 groups. The settings interface is shown in Figure 5-21;

▼ UserSetControl	
UserSetSelector	Default
UserSetLoad	Execute
UserSetSave	Execute
UserSetDefault	Default

Figure 5-21

- 1) UserSetSelector: User Settings Storage offers three configurations: Default, User Set1, and User Set2. The Default setting is the factory default parameter and cannot be modified. User Set1 and User Set2 can be saved through the UserSetSave command;
- 2) UserSetLoad: The camera loads the camera configuration parameters selected by UserSetSelector;
- 3) UserSetSave: Saves the modified configuration parameters in the camera configuration selected by UserSetSelector. Saving is invalid when Default is selected;
- 4) UserSetDefault: A set of user configurations that are loaded by default after the camera is reset or restarted. If the default load setting for the user configuration module is User Set1, the parameters loaded after the camera is reset or restarted are those of User Set1;

5.4.7. ChunkDataControl

Serial Port Data Display. This entire module is read-only, as shown in Figure 5-22.

▼ ChunkDataControl	
ChunkModeActive	☒ True
ChunkFrameCounter	43,437
ChunkTimestamp(us)	523,997,742
ChunkExposureTime(us)	10,005
ChunkBitDepth	16

Figure 5-22

- 1) ChunkModeActive: Mode activation status (read-only);
- 2) ChunkFrameCounter: Serial port frame counter;
- 3) ChunkTimeStamp (μs): Timestamp functionality;
- 4) ChunkExposureTime (μs): Total time from sensor exposure start to end (internal operation);
- 5) ChunkBitDepth: Bit depth display;

5.4.8. CustomControl

Resolution, Camera Runtime, and Calibration Settings Module is shown in Figure 5-23.

▼ CustomControl	
▼ DeviceMonitor	
Resolution	ROI3200X3200
SegmentsPerBu...	1
DeviceWorking...	5.46
GigEMode	DoubleGigE
FPGAVersion	20250717

Figure 5-23

- 1) Resolution: Sets the camera resolution. Supports 3200×3200, 2720×2720, and 2400×2400.
- 2) SegmentsPerBuffer: Configures multi-frame stitching. Users can define how many images are stitched into a single composite image (vertical direction stitching).
- 3) DeviceWorkingDuration(H): Displays the camera's cumulative operating time since power-on. Unit: H (hours), with a precision of 0.01h.
- 4) GigEMode: Displays the number of active Gigabit Ethernet ports used by the camera.
- 5) FPGAVersion: Displays the current FPGA version information of the camera.

5.4.9. PeripheralControl

Peripheral Control is shown in Figure 5-24. This module is used for temperature setting and monitoring of the camera.

▼ PeripheralControl	
DeviceTemperatureTarget(C)	0
DeviceWarningTemperature(C)	90.0
DeviceFanEnable	☒ True
DeviceFanSpeed	Medium
DeviceLedEnable	☒ True

Figure 5-24

- 1) DeviceTemperatureTarget (°C): Sets the target temperature for the sensor. Supports selection of 0°C or -10°C.
- 2) DeviceWarningTemperature (°C): Displays the warning threshold temperature. When the FPGA temperature reaches this value, a buzzer alarm is triggered. If the FPGA temperature continues to rise to 93°C, a protection mechanism is activated: the TEC is automatically shut down, and the fan operates at maximum speed for cooling. When the FPGA temperature drops back to 70°C, the system returns to its original state.
- 3) DeviceFanEnable: Controls the fan switch. Enabled when checked, disabled when unchecked.
- 4) DeviceFanSpeed: Selects the fan speed. When DeviceFanEnable is checked, three levels are supported: Low, Medium, and High.
- 5) DeviceLedEnable: Controls the status indicators for the Ethernet port and camera. The light is on when checked and off when unchecked.

5.4.10. MultiROIControl

MultiROI Control is used to configure the camera's ROI (Region of Interest) settings. The Aries 6510 supports multiple ROI configurations. The specific setup interface is shown in Figure 5-25.

▼ MultiROIControl	
MultiROIMode	☐ False
MultiROISelector	Region0
MultiROIWidth	3,200
MultiROIHeight	3,200
MultiROIOffsetX	0
MultiROIOffsetY	0

Figure 5-25

- 1) MultiROIControl: Enables/disables multi-ROI functionality. When checked, parameters can be configured and multi-ROI is activated.
- 2) MultiROISelector: Selects the multi-ROI group. Supports up to 16 groups (Region 0 to 15) for simultaneous parameter settings.
- 3) MultiROIWidth: Sets the width dimension. Maximum value cannot exceed WidthMax. Minimum values: Region 0: 8; Regions 1–15: 0; Adjustable in steps of 8.
- 4) MultiROIHeight: Sets the height dimension. Maximum value cannot exceed HeightMax. Minimum values: Region 0: 6; Regions 1–15: 0; Adjustable in steps of 2.
- 5) MultiROIOffsetX: Sets the horizontal starting position. Minimum value: 0. Adjustable in steps of 8.
- 6) MultiROIOffsetY: Sets the vertical starting position. Minimum value: 0. Adjustable in steps of 2

5.4.11. DPCControl

The Aries 6510 supports both dynamic and static bad pixel correction. The configuration interface in SamplePro is shown in the corresponding figure.

▼ DPCControl	
▼ DDPC	
DDPCEnable	☒ True
DDPCLLevel	Medium
▼ SDPC	
SDPCEnable	☒ True

Figure 5-26

- 1) DDPCEnable: Dynamic Defective Pixel Correction enable switch. Reduces image artifacts caused by defective pixels.
- 2) DDPCLLevel: Supports three correction levels: Low, Medium, and High.
- 3) SDPCEnable: Static Defective Pixel Correction enable switch. Supports only On or Off

5.4.12. DSNUControl

DSNU Interface in SamplePro is shown in Figure 5-27.

▼ DSNUControl	
DSNUEnable	☒ True
DSNUGenerate	Execute
DSNUGenerateAll	Execute
DSNUSave	Execute
DSNULoad	Execute

Figure 5-27

- 1) DSNUEnable: DSNU enable switch. When checked, DSNU is activated.
- 2) DSNUGenerate: Performs online DSNU for the current gain mode by clicking this button. Requires short exposure time under dark-field (no light) conditions.
- 3) DSNUGenerateAll: Performs online DSNU for all gain modes supporting DSNU by clicking this button. Requires short exposure time under dark-field conditions.
- 4) DSNUSave: Saves the current DSNU results to non-volatile memory. The saved DSNU data can be directly loaded for future use.
- 5) DSNULoad: Loads previously saved DSNU data from non-volatile memory.

5.4.13. DSNUControl

PRNU Interface in SamplePro is shown in Figure 5-28.

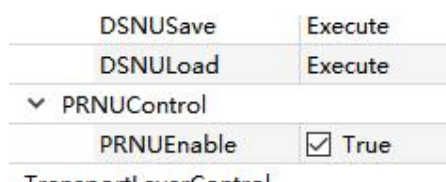


Figure 5-28

- 1) PRNUEnable: PRNU enable switch. When checked, PRNU is activated.

5.4.14. TransportLayerControl

This module follows the GigE Vision Standard protocol. For detailed specifications, please refer to the official GigE Vision Standard documentation.

▼ TransportLayerControl	
PayloadSize	15,364,096
▼ GigEVision	
Gev Version Ma...	2
Gev Version Mi...	2
Gev Interface Se...	0
Gev MACAddress	00:0C:6B:00:01...
Supported Opti...	User Defined ...
Gev Supported ...	☒ True
Gev Current IPC...	☒ True
Gev Current IPC...	☒ True
Gev Current IPC...	☒ True
Gev Current IPA...	169.254.100.100
Gev Current Sub...	255.255.0.0
Gev Current Def...	0.0.0.0
Gev First URL	Local:Aries651...
Gev Second URL	File:Aries6510...
Gev Number Of...	1

Figure 5-29

5.5. Image Adjustment

This module includes histogram, gamma, and contrast settings. The settings interface is shown in Figure 5-30.

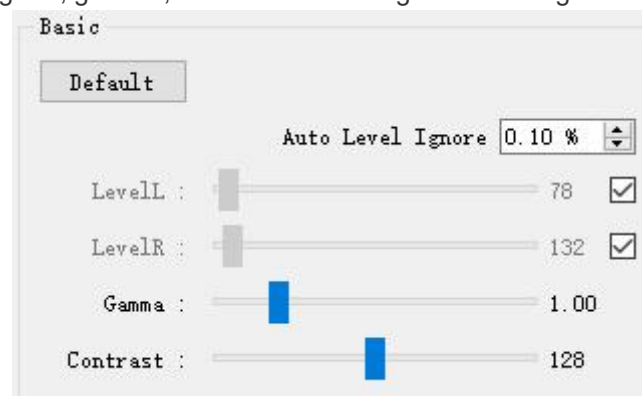


Figure 5-30

- 1) Default: Clicking the "Default" button will restore the parameters of the image adjustment module to the default values set by the software.
- 2) LevelL: Users can change the left color level value by manually entering or dragging the color level slider;
- 3) LevelR: Users can change the right color level value by manually entering or dragging the color scale slider;
- 4) Auto: Automatically defines the brightest and darkest pixels in each channel as white and black, and then reallocates the pixel values between them proportionally;
- 5) Gamma: The gamma value can change the brightness of the image and increase the contrast. The

larger the value, the greater the grayscale and higher the brightness. The range is 0.64–2.55, with a default value of 1.00;

- 6) Contrast: The difference in brightness levels between the brightest white and the darkest black in an image, ranging from 0 to 255, with a default of 128;

6. Maintenance

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

6.1. 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.

6.2. 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

6.3. Cooling Hoses and Connectors

Users should regularly check all coolant hoses and connections for signs of leakage, damage, or wear. All seals must be intact before the camera system can be turned on, and any worn or damaged components must be replaced immediately.

6.4. 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.

6.5. 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.

7. Troubleshooting

7.1. 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;
 - (1) Confirm the connection sequence of the two cables through CameraLink connection;
 - (2) USB connection, please use the USB 3.0 interface on the backend of the desktop computer;
- 3) Confirm that the driver is working properly and check if the image device recognizes the camera in the computer device manager.

7.2. 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.

7.3. The Camera Cannot Reach the Target Cooling Temperature

- 1) Confirm the ambient temperature, the maximum cooling temperature difference of the camera is - 45 °C (water-cooled);
- 2) Confirm if the air outlet is blocked;
- 3) Confirm whether the fan rotates normally;
- 4) If water-cooling is used, make sure that the water-cooling cycle is functioning properly.

7.4. The Frame Rate Cannot Reach the Nominal Level

- 1) Confirm whether the exposure time affects the frame rate, and set the minimum exposure time to confirm the frame rate;
- 2) The frame rate in the table is the measured frame rate under ideal bandwidth, and the actual frame rate in the usage scenario will be affected by data transmission, which is related to the type of data interface used and the length of the transmission line;
- 3) Confirm whether the correct PCIe slot is being used. We recommend using PCIe 4.0 or higher slots. Otherwise, the frame rate may not reach the specification.
- 4) The Aries 6510 and Aries 6506 feature dual data interfaces. If only one data interface is connected, the frame rate may not reach the specification.
- 5) If the bandwidth is sufficient but the recording frame rate is lower than the preview frame rate, check whether the disk write speed is adequate. For full-resolution (3200×3200) recording at 83 fps, the disk must sustain a write speed of at least 1620 MB/s.

8. FAQs

8.1. 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).

8.2. 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.

9. 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

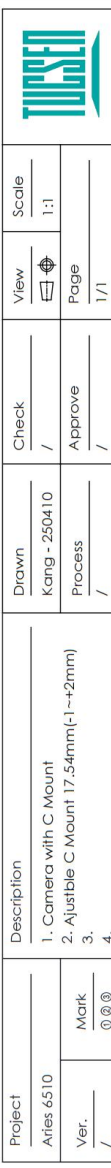
- Email: service@tucsen.com
- Visiting the official website to leave a message: <http://www.tucsen.com>

4) Please prepare the following information in advance:

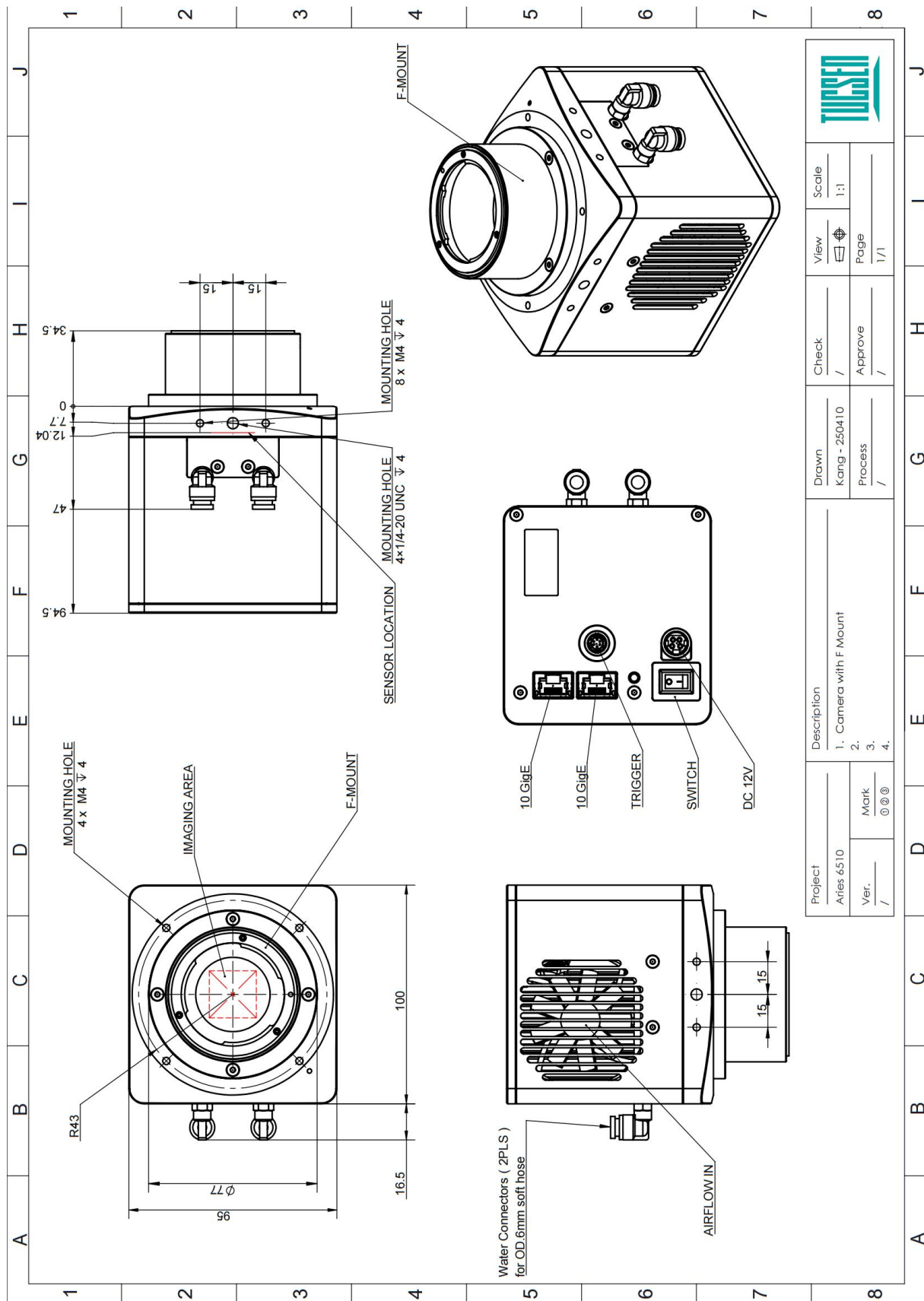
- Camera model and S/N (product serial number);
- Software version number and computer system information;
- Description of the problem and any related images.

Appendix 1: Dimensions

Aries 6510/Aries 6506 Structural Line Diagrams. The Aries 6510 supports three optical interfaces: T-mount, F-mount, and C-mount, while the Aries 6506 only supports the C-mount.







Appendix 2 : Specifications

Model	Aries 6510		
Sensor Type	BSI sCMOS		
Peak QE	95%		
Color / Mono	Mono		
Array Diagonal	29.4 mm		
Effective Area	20.8 mm x 20.8 mm		
Resolution	3200 (H) x 3200 (V)		
Pixel Size	6.5 μm x 6.5 μm		
Readout Mode	Dynamic	Speed	Sensitivity
	HDR	High / Mid / Low gain	Standard / Low Noise
Bit Depth	16bit	11bit	12bit
Frame Rate	83 fps	150 fps	88 fps / 5.2 fps
Readout Noise(Middle)	1.8 e-	1.8 e- / 3.6 e- / 9.8 e-	1.3 e- / 0.7 e-
Full-Well Capacity	13.7 Ke-	1.24 Ke- / 4.5 Ke- / 20 Ke-	1.55 Ke- / 0.73 Ke-
Dynamic Range	77dB @ Dynamic-HDR		
Shutter Type	Rolling , Global Reset		
Exposure Time	6 μs-10 s		
Cooling Method	Air , Liquid		
Max. Cooling	25°C below ambient (Air), 30°C below ambient (Liquid)		
Dark Current	1.3 e-/pixel/s @ 0°C; 0.6 e-/pixel/s @ -10°C		
Image Calibration	DPC		
Binning	2 x 2, 4 x 4		
ROI	Support		
Timestamp Accuracy	1 μs		
Trigger Mode	Hardware, Software		
Output Signals	Trigger	Low, High, Readout End, Global, Exposure Start, Trigger Ready, FirstRow, AnyRow	
Trigger Interface	Hirose-6-pin		
Data Interface	2x10 GigE		
Optical Interface	T / F / C Mount		
Power Supply	12 V / 8.5 A		

Power Consumption	≤ 55W
Dimensions	95 mm (H) x 100 mm (W) x 100 mm (L)
Weight	1350 g
Software	Mosaic V3, SamplePro, LabVIEW, MATLAB, Micro-manager 2.0
SDK	C / C++ / C# / Python
Operating System	Windows, Linux
Operating Environment	Working: Temperature 0~40°C, Humidity 10~85% Storage: Temperature 0~60°C, Humidity 0~90%

Model	Aries 6506		
Sensor Type	BSI sCMOS		
Peak QE	95%		
Color / Mono	Mono		
Array Diagonal	22 mm		
Effective Area	15.7 mm x 15.7 mm		
Resolution	2400 (H) x 2400 (V)		
Pixel Size	6.5 μm x 6.5 μm		
Readout Mode	Dynamic	Speed	Sensitivity
	HDR	High / Mid / Low gain	Standard / Low Noise
Bit Depth	16bit	11bit	12bit
Frame Rate	111 fps	200 fps	117 fps / 6.9 fps
Readout Noise(Middle)	1.8 e-	1.8 e- / 3.6 e- / 9.8 e-	1.3 e- / 0.7 e-
Full-Well Capacity	13.7 Ke-	1.24 Ke- / 4.5 Ke- / 20 Ke-	1.55 Ke- / 0.73 Ke-
Dynamic Range	77 dB @ Dynamic-HDR		
Shutter Type	Rolling , Global Reset		
Exposure Time	6 μs-10 s		
Cooling Method	Air , Liquid		
Max. Cooling	25°C below ambient (Air), 30°C below ambient (Liquid)		
Dark Current	1.3 e-/pixel/s @ 0°C; 0.6 e-/pixel/s @ -10°C		
Image Calibration	DPC		
Binning	2 x 2, 4 x 4		

ROI	Support
Timestamp Accuracy	1 μ s
Trigger Mode	Hardware, Software
Output Signals Trigger	Low, High, Readout End, Global, Exposure Start, Trigger Ready, FirstRow, AnyRow
Trigger Interface	Hirose-6-pin
Data Interface	2x10 GigE
Optical Interface	C Mount
Power Supply	12 V / 8.5 A
Power Consumption	$\leq$ 55W
Dimensions	95 mm (H) x 100 mm (W) x 100 mm (L)
Weight	1350 g
Software	Mosaic V3, SamplePro, LabVIEW, MATLAB, Micro-manager 2.0
SDK	C / C++ / C# / Python
Operating System	Windows, Linux
Operating Environment	Working: Temperature 0~40°C, Humidity 10~85% Storage: Temperature 0~60°C, Humidity 0~90%

Appendix 3 : Certification

	
Certificate of Compliance	
Certificate No. : FQII-DZ-25020	
Certificate Holder :	FUJIAN TUCSEN PHOTONICS CO., LTD
Address :	West 1# Building, Zone D, Fuzhou Software Park, 89 Software Avenue, Gulou District, Fuzhou City, 350003, Fujian Province, PRC
Product Description :	Scientific Level High Sensitive Camera
Model Reference :	Aries 6510, Aries 6506
Brand Name :	TUCSEN
Report No. :	(2025) MJDZ-E0062
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.	
	 Authorized Signatory Date of Issue : Oct 21 , 2025
FUJIAN INSPECTION AND RESEARCH INSTITUTE FOR PRODUCT QUALITY No.8, Shuangfeng Road, Hongshan Gulou District, Fuzhou, Fujian, China	

Tucsen Photonics Co., Ltd.

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