User Manual for Machine Vision Cameras with EF Mount Lenses

20240511

Contents

1 Introduction to ToupCam machine vision cameras

1.1 Product Description

The cameras mentioned in this manual are imaging capture devices which use USB3.0 to transmit uncompressed images in real time. They support image acquisition and parameter setting (such as working mode, image parameter adjustment etc.) through client-side user-friendly software. The chip sizes of the IUCXXX-AFU-EF series of cameras are primarily APS or full-frame, and the cameras support control of Canon lenses via the EF mount for autofocus.

Figure 1-1 IUCXXX-AFU-EF series cameras

1.2 Characteristics

- Sony Exmor back-illuminated CMOS sensor; Some cameras also use GPixel series sensors and domestic sensors.
- USB 3.0 data transmission interface compatible with USB2.0 protocol;
- Provides advanced video and image processing application software ToupView, compatible with Windows/Linux/OSX multi-platform SDK, support native C/C++, C#/VB.Net, DirectShow, Twain API;
- Supports external triggering, software and capture modes;
- Supports ROI, flip, bit-depth switching and other features;
- Supports EF/EF-S mount lens control and autofocus;
- Supports firmware worksite upgrading;
- Compliant with CE, FCC requirements.

1.3 IUCXXXAFU-EF Series Camera Specifications (APS or full frame, 4)

Model Number	Image Sensor	Pixel Size(μm)	G Sensitivity/Dark Signal	FPS/Resolution	Binning	Exposure Time
IUC26000KMA-AFU-EF	26.0M/IMX571BLR(M, RS) 1.8“ (23.48x15.67, APS-C)	3.76x3.76	870.9mv with 1/30s 0.07mv with 1/30s	14fps@6224×4168(16bit) 37fps@3104×2084 110fps@2064×1388	1x1 2x2 3x3	150us~15s
IUC26000KPA-AFU-EF	26.0M/IMX571BQR(C, RS) 1.8“ (23.48x15.67, APS-C)	3.76x3.76	484.5mv with 1/30s 0.07mv with 1/30s	14fps@6224×4168(16bit) 37fps@3104×2084 110fps@2064×1388	1x1 2x2 3x3	150us~15s
IUC60000KMA-	60.0M/IMX455ALK (M,	3.76x3.76	870.9mv with 1/30s	6.1fps@9568×6380(16bit)	1x1	150us~15s

AFU-EF	RS) 2.7“ (35.96x23.99, Full Frame)		0.04mv with 1/30s	24.6fps@4784×3190 55.8fps@3184×2124 191.0fps@1040×706	2x2 3x3 9x9	
IUC60000KPA-AFU-EF	60.0M/IMX455AQK (C, RS) 2.7“ (35.96x23.99, Full Frame)	3.76x3.76	484.5mv with 1/30s 0.07mv with 1/30s	6.1fps@9568×6380(16bit) 24.6fps@4784×3190 55.8fps@3184×2124 191.0fps@1040×706	1x1 2x2 3x3 9x9	150us~15s

M: Monochromatic; C: Color; RS: Rolling Shutter; GS: Global Shutter.

1.4 Camera Lens Adaptation

IUCXXX-AFU-EF series cameras can be used with EF-mount lenses. When the lens is correctly mounted, you can read the lens focal length, aperture, focus, and other information, and you can control the lens aperture and focus electrically.

Verify that the adapted EF-mount lens models and functions are as follows:

Lens	Closest Focusing Distance	Aperture Control	Focus Control	Fixed Distance Focusing
Canon EF-S 10-18mm f/4.5-5.6 IS STM	About 0.22m	Support	Support	/
Canon EF-S 18-55mm f/3.5-5.6 IS STM	About 0.25m	Support	Support	Support
Canon EF-S 18-55mm f/4-5.6 IS STM	About 0.25m	Support	Support	/
Canon EF-S 15-85mm f/3.5-5.6 IS USM	About 0.35m	Support	Support	/
Canon EF-S 18-135mm f/3.5-5.6 IS USM	About 0.39m	Support	Support	Support
Canon EF-S 18-200mm f/3.5-5.6 IS	About 0.45m	Support	Support	/
Canon EF 24mm f/1.4L II USM	About 0.25m	Support	Support	/
Canon EF 24mm f/2.8 IS USM	About 0.2m	Support	Support	/
Canon EF 35mm f/1.4L II USM	About 0.28m	Support	Support	/
Canon EF 50mm f/1.2L USM	About 0.45m	Support	Support	Support
Canon EF 50mm f/1.4 USM	About 0.45m	Support	Support	/
Canon EF 85mm f/1.2L II USM	About 0.95m	Support	Support	/
Canon EF 16-35mm f/2.8L III USM	About 0.28m	Support	Support	/
Canon EF 16-35mm f/4L IS USM	About 0.28m	Support	Support	/
Canon EF 24-70mm f/2.8L II USM	About 0.38m （Macro mode is about 0.2m）	Support	Support	/
Canon EF 24-70mm f/4L IS USM	About 0.38m （Macro mode is about 0.2m）	Support	Support	/
Canon EF 24-105mm f/4L IS USM	About 0.45m	Support	Support	/
Canon EF 100-400mm f/4.5-5.6L IS II USM	About 0.98m	Support	Support	/
Sigma 150-600mm f/5-6.3 DG OS HSM|S	About 2.6m	Support	Support	/

Note: This camera theoretically supports any EF mount lens, but not all lenses have been tested. Use of lenses from manufacturers other than Canon may be uncontrollable or incompatible. If you need other lenses, please point out the model number of the desired lens, we will do a good job of testing for you.

Figure 1-2 Canon EF lenses currently supported by the IUCXXX-AFU-EF camera

Figure 1-3 IUCXXX-AFU-EF camera with Canon EF lenses

Figure 1-4 IUCXXX-AFU-EF camera, Canon EF lenses with TPS-600 fine focus bracket

Figure 1-5 IUCXXX-AFU-EF camera, Canon EF lenses with TPS-600 fine focus bracket

Figure 1-6 IUCXXX-AFU-EF camera, Canon EF lenses with TPS-600 fine focus bracket

Figure 1-7 Product illustration of machine vision cameras with EF lenses

2 IUCXXX-AFU-EF Series Technical Specifications(4)

2.1 IUC26000KMA-AFU-EF

Table 2-1 IUC26000KMA-AFU-EF camera specifications

Parameter \ Model	IUC26000KMA-AFU-EF
	26.0M pixels 1.8" (APS-C) CMOS USB3.0 industrial camera
Camera	
Sensor model	Sony IMX571BLR-J
Pixel size	3.76 μm x 3.76 μm
Sensor size	1.8" (APS-C)
Frame rate	14fps@6224 x 4168(16bit), 37fps@3104 x 2084, 110fps@2064 x 1388
Dynamic range	86.8dB
Signal-to-Noise ratio	47.1dB
Sensitivity	870.9mv
Dark current	0.07mv
Gain range	1x-50x
Exposure time	150us-15sec
Shutter	Rolling shutter
Binning	Hardware 2x2，3x3；Software 2x2，3x3，4x4
Data interface	USB3.0 (USB3.1 GEN1)
Digital I/O	One optical-coupling isolated input, one optical-coupling isolated output, two non-isolated input and output
Data Format	8bit / 16bit
General Specifications	
Power supply	12V Power adapter
Power consumption	<5.0W
Temperature	Working temperayure-10~50℃, storage temperature-30~70℃
Humidity	20%-80%, no condensation
Size	88mmx88mmx21.2mm
Weight	540g
Lens mount	M42 Interface
Software	ToupView/ SDK
Platform and architecture	Win32/WinRT/Linux/macOS/Android；X86/X64/armhf/armel/arm64
Certification	CE, FCC

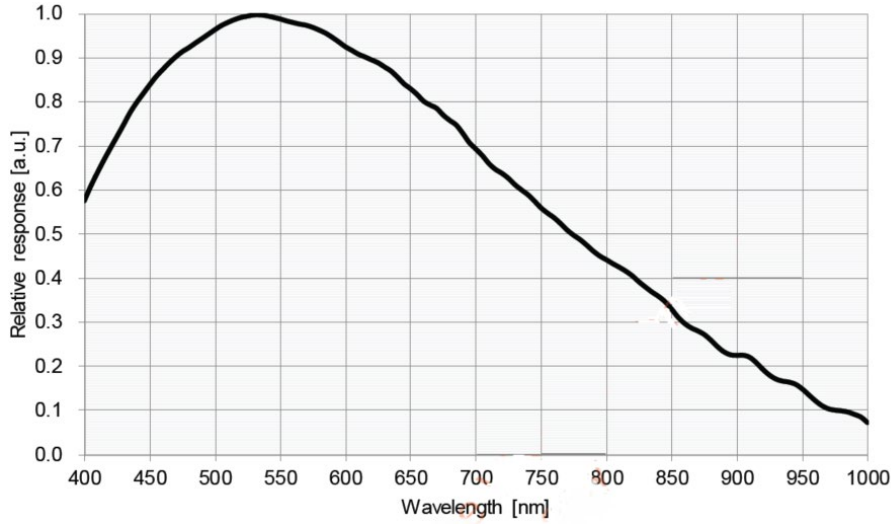


Figure 2-1 IUC26000KMA-AFU-EF spectral response curve

2.2 IUC26000KPA-AFU-EF

Table 2-2 IUC26000KPA-AFU-EF camera specifications

Parameter \ Model	IUC26000KPA-AFU-EF
	26.0M pixels 1.8" (APS-C) CMOS USB3.0 industrial camera
Camera	
Sensor model	Sony IMX571BQR-C
Pixel size	3.76 μm x 3.76 μm
Sensor size	1.8" (APS-C)
Frame rate	14fps@6224 x 4168(16bit), 37fps@3104 x 2084, 110fps@2064 x 1388
Dynamic range	86.8dB
Signal-to-Noise ratio	47.1dB
Sensitivity	484.5mv
Dark current	0.07mv
Gain range	1x-50x
Exposure time	150us-15sec
Shutter	Rolling shutter
Binning	Hardware 2x2，3x3；Software 2x2，3x3，4x4
Data interface	USB3.0 (USB3.1 GEN1)
Digital I/O	One optical-coupling isolated input, one optical-coupling isolated output, two non-isolated input and output
Data Format	8bit / 16bit
General Specifications	
Power supply	12V Power adapter
Power consumption	<5.0W
Temperature	Working temperayure-10~50℃, storage temperature-30~70℃
Humidity	20%-80%, no condensation
Size	88mmx88mmx21.2mm
Weight	540g
Lens mount	M42 Interface
Software	ToupView/ SDK
Platform and architecture	Win32/WinRT/Linux/macOS/Android；X86/X64/armhf/armel/arm64
Certification	CE, FCC

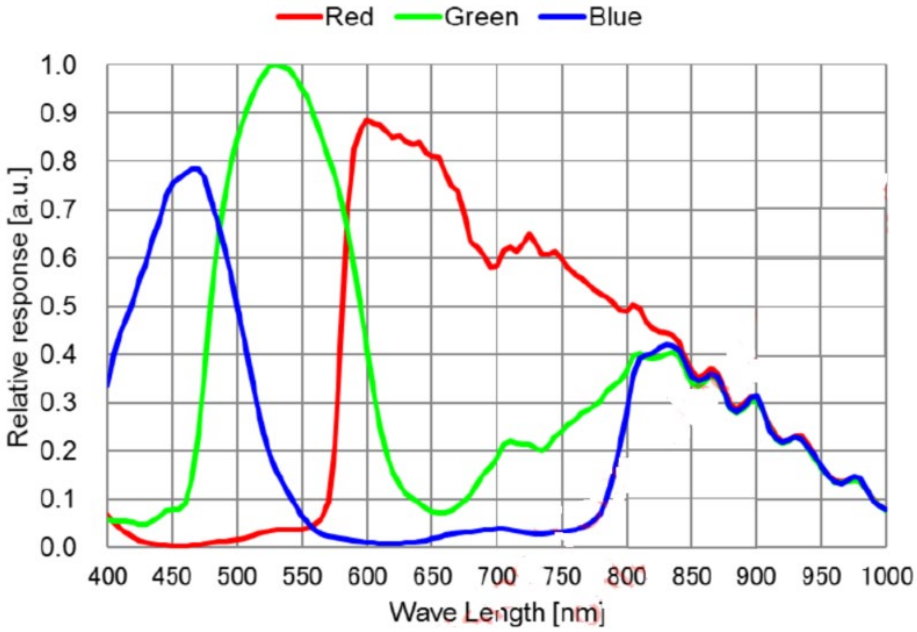


Figure 2-2 IUC26000KPA-AFU-EF spectral response curve

2.3 IUC60000KMA-AFU-EF

Table 2-3 IUC60000KMA-AFU-EF camera specifications

Parameter \ Model	IUC60000KMA-AFU-EF
	60.0M pixels 2.7" (Full Frame) CMOS USB3.0 industrial camera
Camera	
Sensor model	Sony IMX455ALK
Pixel size	3.76 μm x 3.76 μm
Sensor size	2.7" (Full Frame)
Frame rate	6.1fps@9568 x 6380(16bit), 24.6fps@4784 x 3190, 55.8fps@3184 x 2124, 191.0@1040 x 706
Dynamic range	88.3dB
Signal-to-Noise ratio	47.1dB
Sensitivity	870.9mV
Dark current	0.04mV
Gain range	1x-50x
Exposure time	150us-15sec
Shutter	Rolling shutter
Binning	Hardware 2x2, 3x3, 9x9; Software 2x2, 3x3, 9x9
Data interface	USB3.0 (USB3.1 GEN1)
Digital I/O	One optical-coupling isolated input, one optical-coupling isolated output, two non-isolated input and output
Data Format	8bit / 16bit
General Specifications	
Power supply	12V Power adapter
Power consumption	<5.5W
Temperature	Working temperayure-10~50℃, storage temperature-30~70℃
Humidity	20%-80%, no condensation
Size	88mmx88mmx21.2mm
Weight	540g
Lens mount	M52 Interface
Software	ToupView/ SDK
Platform and architecture	Win32/WinRT/Linux/macOS/Android；X86/X64/armhf/armel/arm64
Certification	CE, FCC

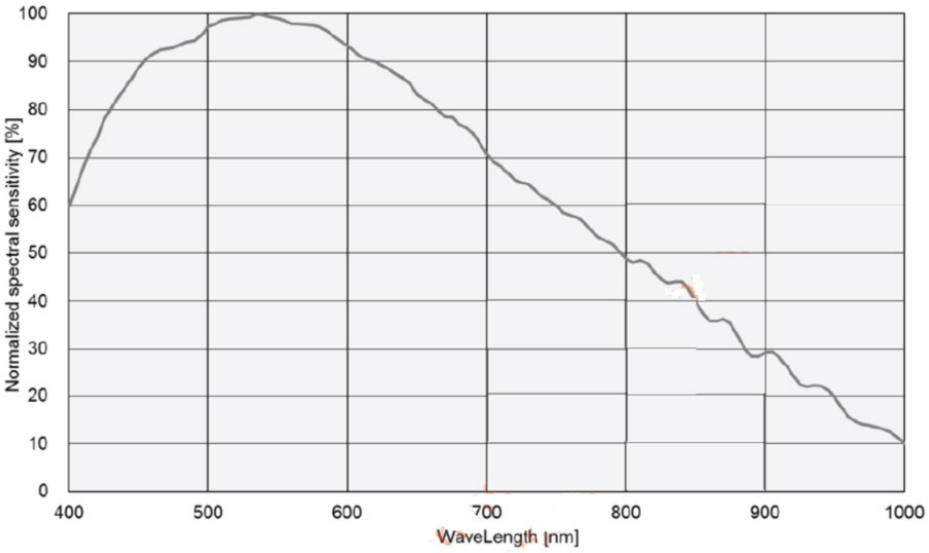


Figure 2-3 IUC60000KMA-AFU-EF spectral response curve

2.4 IUC60000KPA-AFU-EF

Table 2-4 IUC60000KPA-AFU-EF camera specifications

Parameter \ Model	IUC60000KPA-AFU-EF
	60.0M pixels 2.7" (Full Frame) CMOS USB3.0 industrial camera
Camera	
Sensor model	Sony IMX455AQK
Pixel size	3.76 μm x 3.76 μm
Sensor size	2.7" (Full Frame)
Frame rate	6.1fps@9568 x 6380(16bit), 24.6fps@4784 x 3190, 55.8fps@3184 x 2124, 191.0@1040 x 706
Dynamic range	85.8dB
Signal-to-Noise ratio	47.0dB
Sensitivity	484.5mV
Dark current	0.07mV
Gain range	1x-50x
Exposure time	150us-15sec
Shutter	Rolling shutter
Binning	Hardware 2x2, 3x3, 9x9; Software 2x2, 3x3, 9x9
Data interface	USB3.0 (USB3.1 GEN1)
Digital I/O	One optical-coupling isolated input, one optical-coupling isolated output, two non-isolated input and output
Data Format	8bit / 16bit
General Specifications	
Power supply	12V Power adapter
Power consumption	<5.5W
Temperature	Working temperayure-10~50℃, storage temperature-30~70℃
Humidity	20%-80%, no condensation
Size	88mmx88mmx21.2mm
Weight	540g
Lens mount	M52 Interface
Software	ToupView/ SDK
Platform and architecture	Win32/WinRT/Linux/macOS/Android；X86/X64/armhf/armel/arm64
Certification	CE, FCC

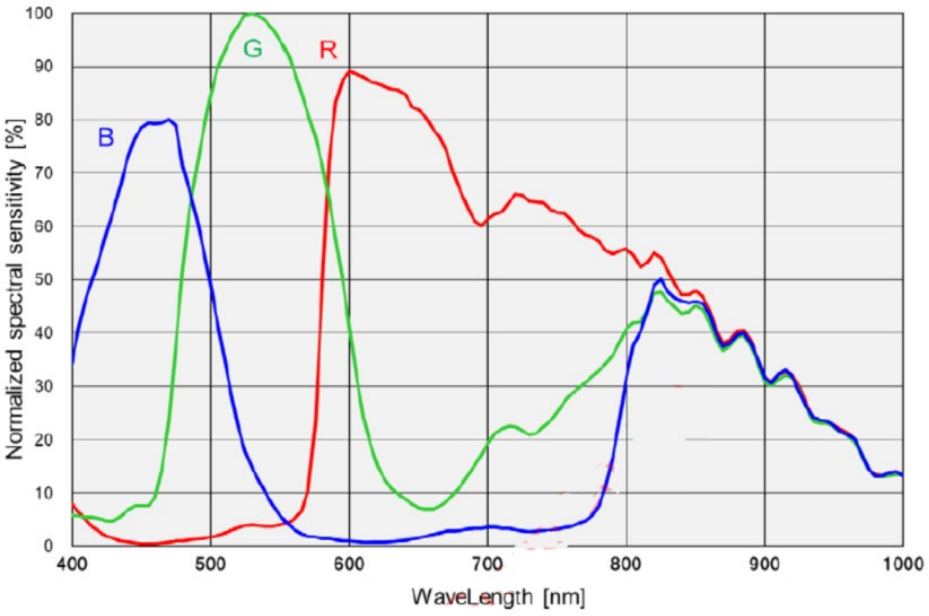


Figure 2-4 IUC60000KPA-AFU-EF spectral response curve

3 Camera Dimension and Interface

3.1 IUCXXX-AFU-EF Series

3.1.1 IUCXXX-AFU-EF Series Camera Mechanical Housing Dimensions

Figure 3-1 IUCXXX-AFU-EF series camera

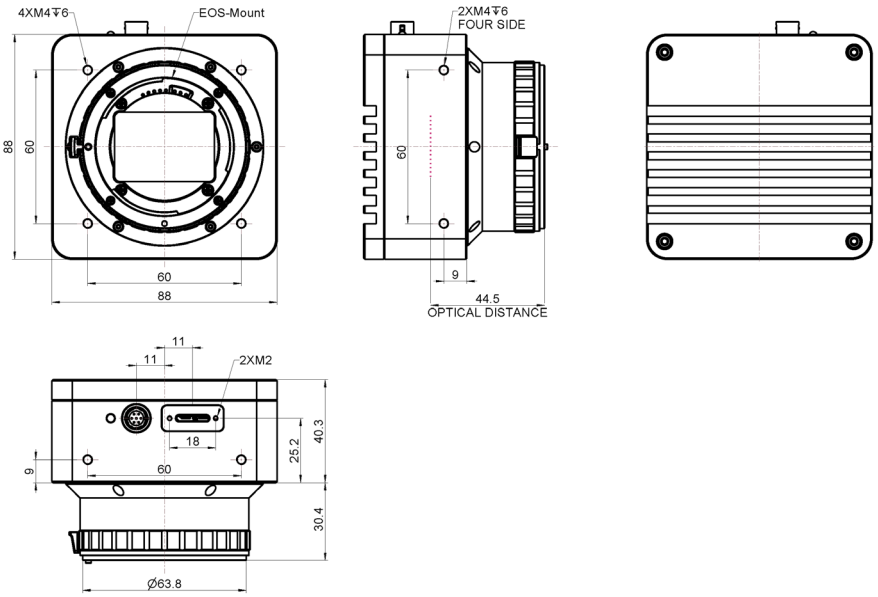


Figure 3-2 Dimensions of IUCXXX-AFU-EF camera housing (mm)

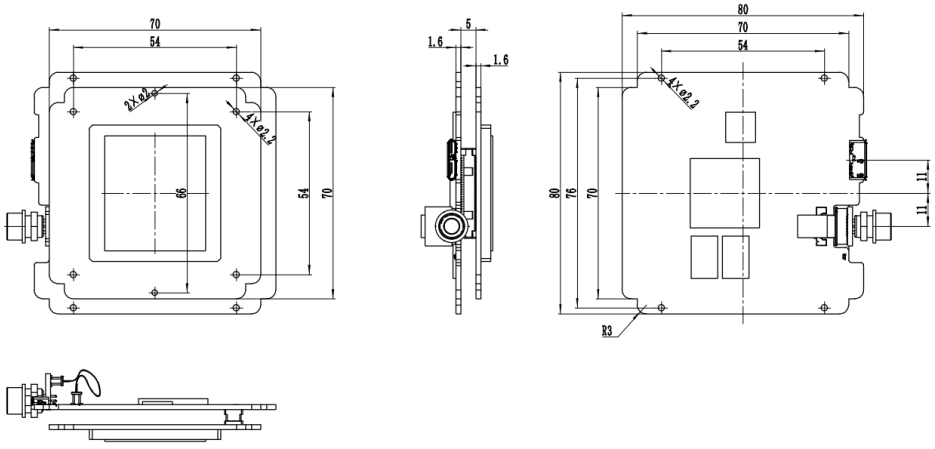


Figure 3-3 Dimensions of IUCXXX-AFU-EF circuit board (mm)

3.1.2 IUCXXX-AFU-EF Series Camera Interface

The back of the industrial camera is shown in Figure 3-4. It has standard USB3.0 output, 7 Pin I/O port (aviation head) and on/off indicator. It has two M2 screw holes on both sides of USB 3.0 port to fix the cable. The holes reduce cable loosening caused by field vibration.

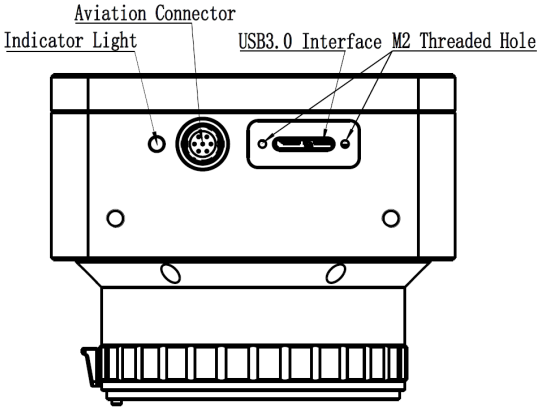
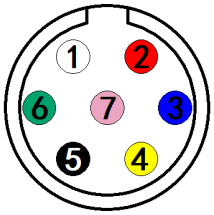


Figure 3-4 Schematic diagram of IUCXXX-AFU-EF camera back panel

3.1.3 IUCXXX Series Camera Power Supply and I/O Connector

The pin signal definition for the IUCXXX series camera 7 Pin I/O connector is shown in Table 3-1.

Table 3-1 IUC series pin signal definitions



Color	Pin	Signal	Signal description
White	1	GND	Direct-coupled signal ground
Red	2	12V	5VDC power input or output
Blue	3	OPTO_GND	Opto-isolated signal ground
Yellow	4	DIR_GPIO0	Direct-coupled General Purpose I/O (Software configurable input/output) (line2)
Black	5	DIR_GPIO1	Direct-coupled General Purpose I/O (Software configurable input/output) (line3)
Green	6	OPTO_IN	Opto-isolated input signal (line0)
Pink	7	OPTO_OUT	Opto-isolated output signal (line1)

3.1.4 Packing Information

For normal use of industrial cameras, please prepare the required accessories as shown in Table 3-2 before installation.

Table 3-2 Recommended accessories for IUC series camera

Order number	Accessories name	Quantity	Instruction
1	Camera	1	Camera referred in this manual
2	I/O cable	1	7 Pin cable or extended cable
3	USB3.0 cable	1	Suitable length of Micro USB3.0 cable
4	Power (IUC)	1	Power adapter for IUC series
5	Lens (optional)	1	C-mount lens

4 Electrical Characteristics

4.1 SWIR and IUX Series Camera's I/ O Electrical Properties

4.1.1 Opto-isolated Input Circuit (line0)

In the camera I/O control, opto-isolated input circuit is shown in Figure 4-1.

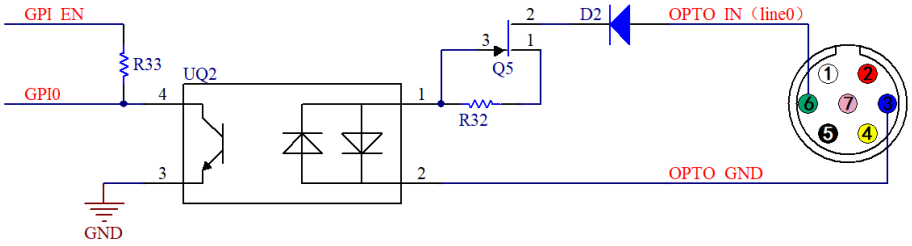


Figure 4-1 Opto-isolated input circuit

Logic 0 input level: 0~2.2VDC (OPTO_IN pin)

Logic 1 input level: 3.3~24VDC (OPTO_IN pin)

Maximum input current: 30mA

The input level is between 2.2V and 3.2V, the circuit action state is uncertain, please avoid the input voltage working in this range.

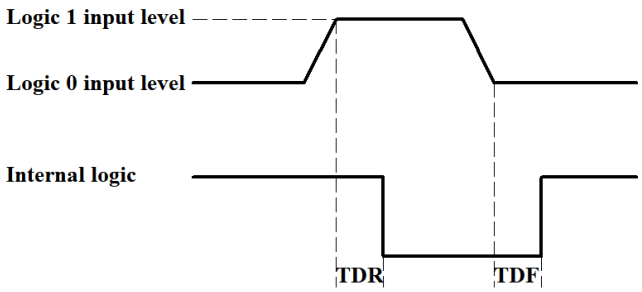


Figure 4-2 Input logic level

Input rise delay (TDR): 6us

Input drop delay (TDF): 6us

4.1.2 Opto-isolated Output Circuit(line1)

In camera I/O control, opto-isolated output circuit is shown in Figure 4-3.

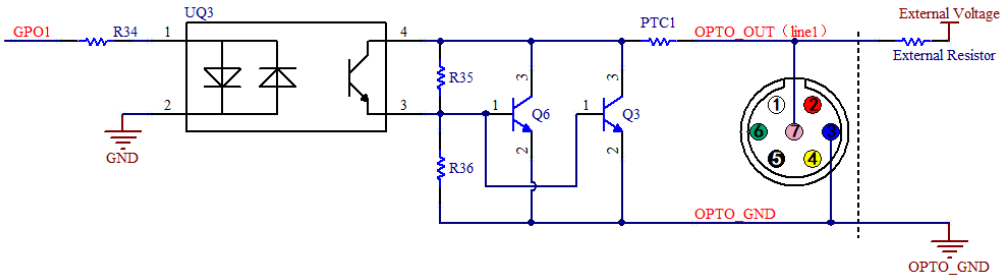


Figure 4-3 Opto-isolated output circuit

Opto-isolated output maximum current: 30mA

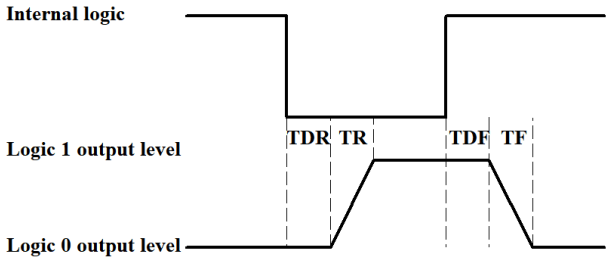


Figure 4-4 Output logic level

The electrical characteristics of the opto-isolated output signal (external voltage 5V, external resistor 1K) are shown in Table 4-1.

Table 4-1 Opto-isolated output signal's electrical characteristics

Parameter name	Parameter symbol	Parameter values
Output logic low level	VL	742mV
Output logic high	VH	4.134V
output rise time	TR	4us
Output downtime	TF	1.8us
Output rising delay	TDR	12us
Output drop delay	TDF	2us

The corresponding current and output logic low level parameters are shown in Table 4-2 when different voltage and resistors are used in external circuit.

Table 4-2 Opto-isolated output logic's low level parameters

External voltage	Non-essential resistance	VL	Output current
3.3V	1KΩ	510mV	2.82mA
5V	1KΩ	742mV	4.31mA
12V	2.4KΩ	795mV	4.68mA
24V	4.7KΩ	850mV	4.97mA

4.1.3 Input and Output I/O Circuit(line2/line3)

Non-isolated configurable input, output I/O circuit is shown in Figure 4-5, Figure 4-6.

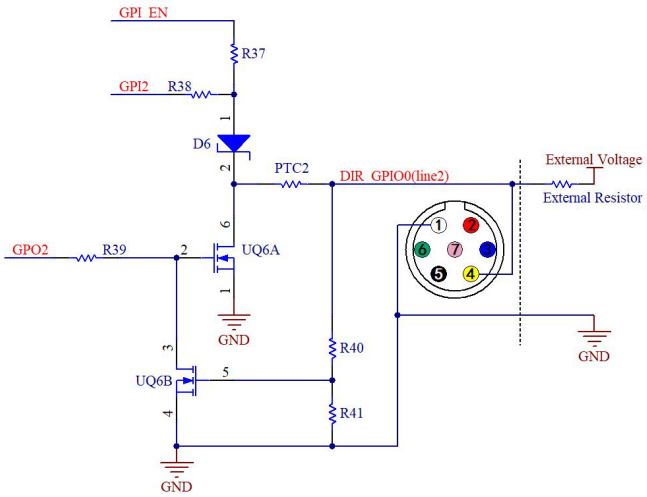


Figure 4-5 Non-isolated configurable input, output I/ O circuit (line2)

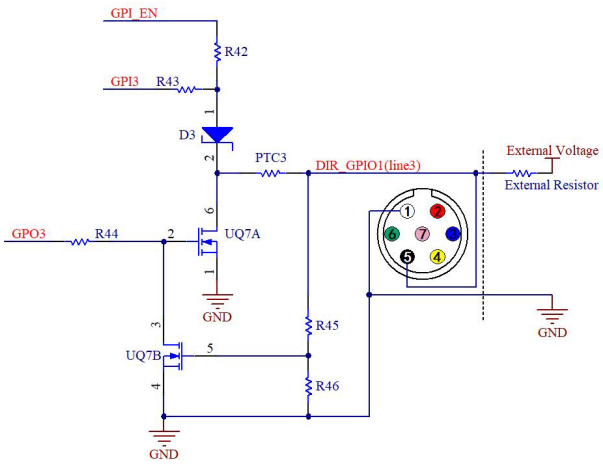


Figure 4-6 Non-isolated configurable input, output I/ O circuit (line3)

1, Line2/line3 set as input pin:

Logic 0 input level: 0-0.6 VDC (DIR_GPIO1/DIR_GPIO2 pin)

Logic 1 input level: 2.0~24VDC (DIR_GPIO1/DIR_GPIO2 pin)

Maximum input current: 25mA

The input level is between 0.6V and 2.0V, the circuit action state is uncertain. Please avoid the input voltage working in this range.

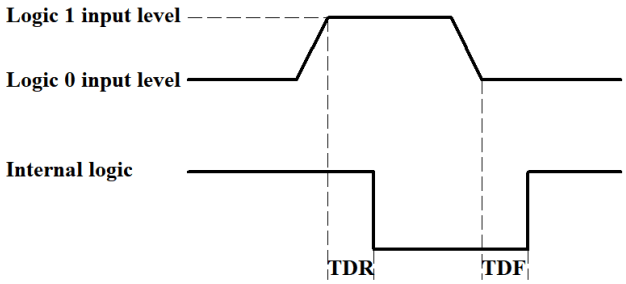


Figure 4-7 Input logic level

To prevent damage to the GPIO pin, connect the GND pin before entering voltage to the Line2 pin.

Input rise delay (TDR): 0.02us

Input drop delay (TDF): 0.02us

2, Line2/line3 set as output pin

The maximum current allowed through this pin is 25 mA.

When the ambient temperature is 25 degrees Celsius, the relationships between the external voltage, resistance and output low level are shown in Table 4-3.

Table 4-3 Non-isolated output logic's low level parameters

External voltage	Non-essential resistance	VL (GPIO)
3.3V	1KΩ	0.11V
5V	1KΩ	0.167V
12V	2.4KΩ	0.184V
24V	4.7KΩ	0.385V

The external pull-up voltage 5V pull-up resistance 1KΩ, GPIO output logic level, electrical characteristics are shown in Figure 4-8.

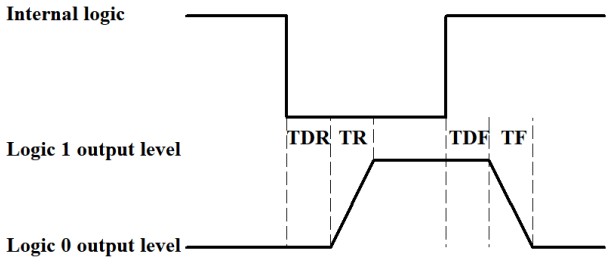


Figure 4-8 Output logic level

Table 4-4 Non-isolated output's electrical characteristics

Parameter name	Parameter symbol	Parameter values
Output rise time	TR	0.08us
Output downtime	TF	0.02us
Output rising delay	TDR	0.1us
Output drop delay	TDF	0.04us

4.2 I3 Series Camera's I/ O Electrical Properties

4.2.1 Opto-isolated Input Circuit (line0)

In the camera I/O control, opto-isolated input circuit is shown in Figure 4-9.

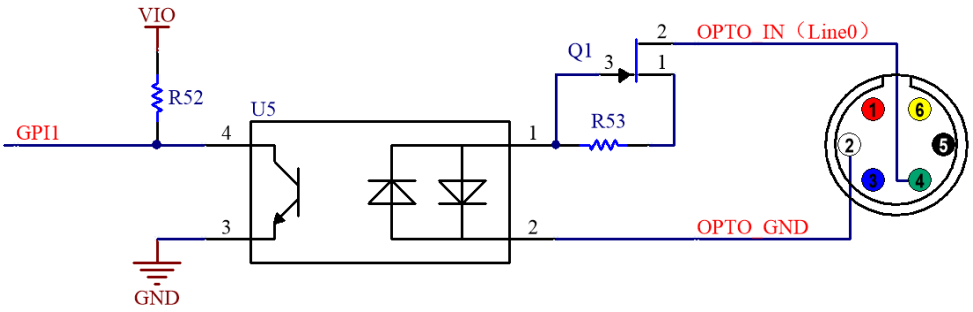


Figure 4-9 Opto-isolated input circuit

Logic 0 input level: 0~1.4VDC (OPTO_IN pin)

Logic 1 input level: 2.2~24VDC (OPTO_IN pin)

Maximum input current: 30mA

The input level is between 1.4V and 2.2V, the circuit action state is uncertain, please avoid the input voltage working in this range.

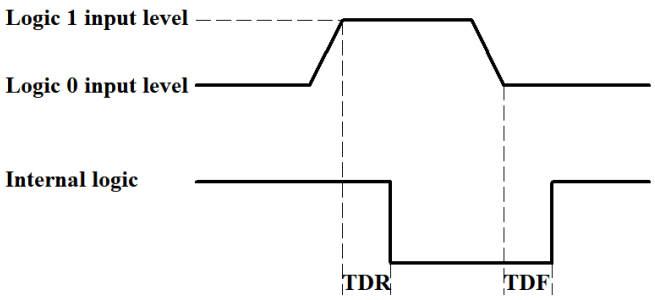


Figure 4-10 Input logic level

Input rise delay (TDR): 5us

Input drop delay (TDF): 25us

4.2.2 Opto-isolated Output Circuit(line1)

In camera I/O control, opto-isolated output circuit is shown in Figure 4-11.

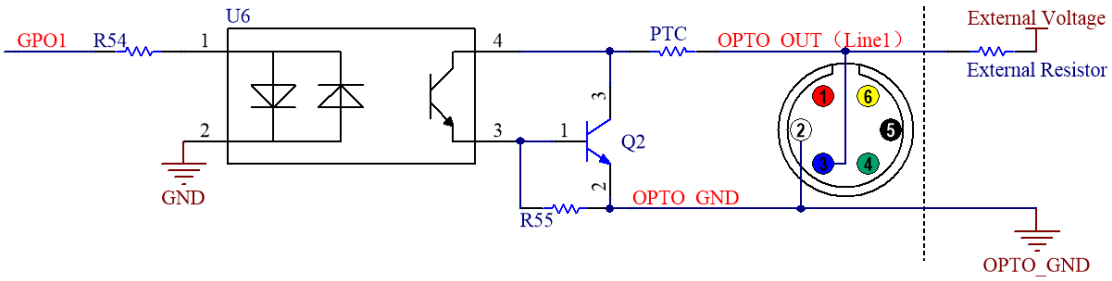


Figure 4-11 Opto-isolated output circuit

Opto-isolated output maximum current: 30mA

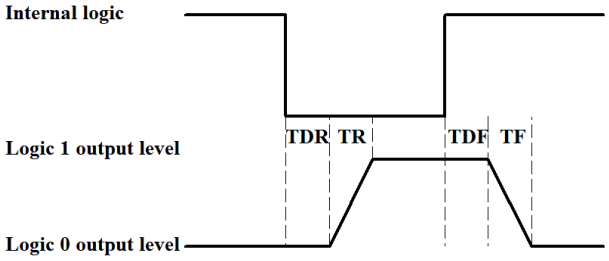


Figure 4-12 Output logic level

The electrical characteristics of the opto-isolated output signal (external voltage 5V, external resistor 1K) are shown in Table 4-5.

Table 4-5 Opto-isolated output signal's electrical characteristics

Parameter name	Parameter symbol	Parameter values
Output logic low level	VL	760mV
Output logic high	VH	5V
output rise time	TR	8.6us
Output downtime	TF	2.2us
Output rising delay	TDR	17.5us
Output drop delay	TDF	4.2us

The corresponding current and output logic low level parameters are shown in Table 4-6 when different voltage and resistors are used in external circuit.

Table 4-6 Opto-isolated output logic's low level parameters

External voltage	Non-essential resistance	VL	Output current
3.3V	1KΩ	668mV	2.82mA
5V	1KΩ	760mV	4.31mA
12V	2.4KΩ	798mV	4.68mA
24V	4.7KΩ	833mV	4.97mA

4.2.3 Input and Output I/O Circuit(line2/line3, applicable to V1.0 hardware version)

In camera I/O control with hardware version number V1.0, non-isolated input, output I/O circuit is shown in Figure 4-13.

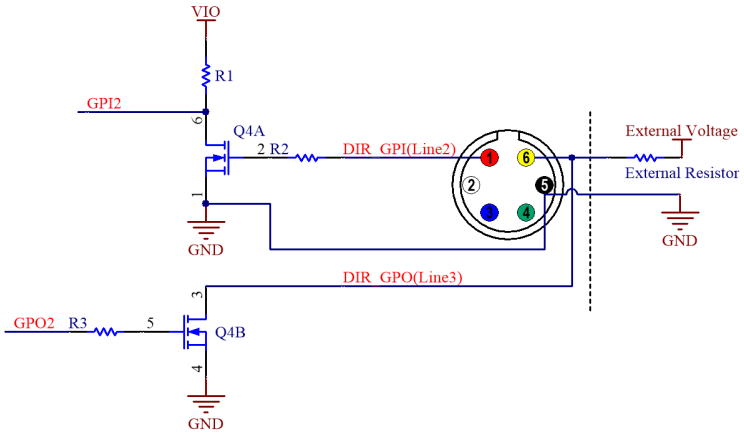


Figure 4-13 Non-isolated input, output I/ O circuit(line2)

1, GPI2 input level parameter:

Logic 0 input level: 0~0.9 VDC (DIR_GPI pin)

Logic 1 input level: 1~20VDC (DIR_GPI pin)

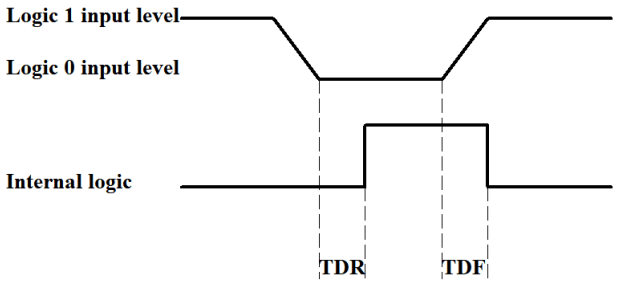


Figure 4-14 Input logic level

To prevent damage to the GPI pin, connect the GND pin before entering voltage to the DIR_GPI pin.

2, GPO2 output level parameter:

The maximum current allowed through this pin is 25 mA.

When the ambient temperature is 25 degrees Celsius, the relationships between the external voltage, resistance and output low level are shown in Table 4-7.

Table 4-7 Non-isolated output logic's low level parameters

External voltage	Non-essential resistance	VL(GPO2)
3.3V	1KΩ	0V
5V	1KΩ	0V
12V	2.4KΩ	0V
24V	4.7KΩ	0V

The external pull-up voltage 5V pull-up resistance 1K Ω, GPO2 output logic level, electrical characteristics are shown in Figure 4-15.

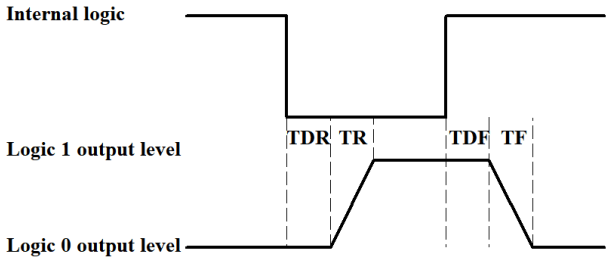


Figure 4-15 Output logic level

Table 4-8 Non-isolated output's electrical characteristics

Parameter name	Parameter symbol	Parameter values
Output rise time	TR	0.01us
Output downtime	TF	0.01us
Output rising delay	TDR	0.02us
Output drop delay	TDF	0.04us

4.2.4 Input and Output I/O Circuits(line2, the hardware version is V2.0 or later)

Camera with hardware version V2.0 and above, its input and output I/O circuits are shown in Figure 4-16.

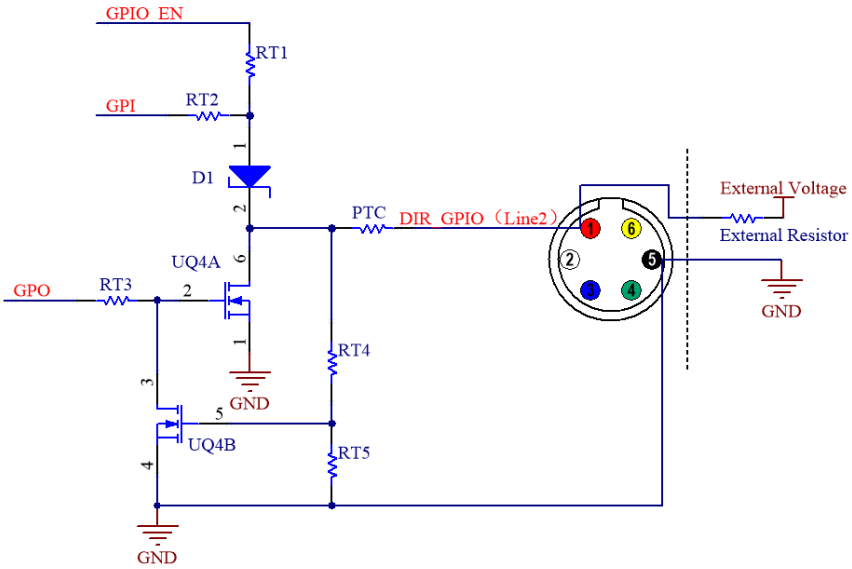


Figure 4-16 Non-isolated configurable input / output I/O circuits

Line2 is set as input pin

Logic 0 input level: 0~0.6VDC (DIR_GPIO pin)

Logic 1 input level: 2~24VDC (DIR_GPIO pin)

Maximum input current: 25mA

When the input level is between 0.6 V and 2 V, the circuit action is uncertain. Please avoid the input voltage working in this range.

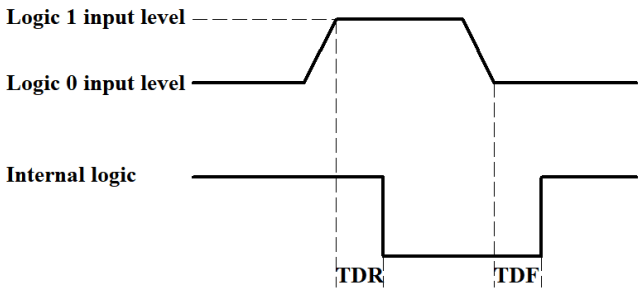


Figure 4-17 Input logic level

To prevent the GPIO pin from being damaged, first connect the ground pin GND and then input the voltage to the Line2 pin.

Input rise delay (TDR): 0.02us

Input drop delay (TDF): 0.02us

Line2 is set as output pin

The maximum current allowed through this pin is 25 mA.

When the ambient temperature is 25 degrees Celsius, the relationships between external voltage, resistance and output low level are shown in Table 4-9.

Table 4-9 Non-isolated output logic low level parameters

External voltage	Non-essential resistance	VL(GPIO)
3.3V	1KΩ	0.11V
5V	1KΩ	0.167V
12V	2.4KΩ	0.184V
24V	4.7KΩ	0.385V

The external pull-up voltage is 5V, the pull-up resistance is 1KΩ, the GPIO is configured as the output logic level and the electrical characteristics are shown in Figure 4-18.

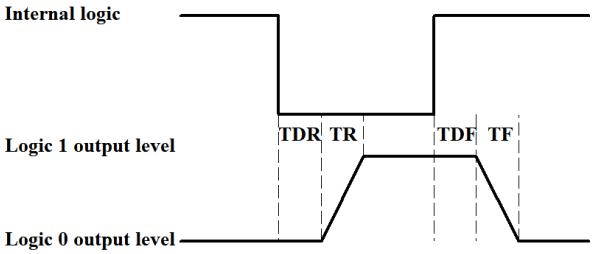


Figure 4-18 Output logic level

Table 4-10 Non-isolated output's electrical characteristics

Parameter name	Parameter symbol	Parameter values
Output rise time	TR	0.08us
Output downtime	TF	0.02us
Output rising delay	TDR	0.1us
Output drop delay	TDF	0.04us

5 Description of Functions

5.1 Camera Capture Mode

Camera operation mode support: Video Mode or Trigger Mode.

Camera trigger mode supports: Soft Trigger Mode(Software) or External Trigger Mode(Isolated input, GPIO0, GPIO1, Counter or PWM).

5.2 ROI Control

Partial cameras supports hardware ROI. The smaller the ROI size, the faster the frame rate.

5.3 Auto Focus

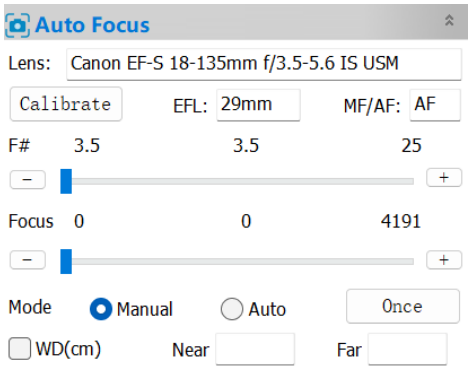


Figure 5-1 Lens control and autofocus

Lens Information	Lens	Lens **Name**.
	EFL	Lens **effective focal length**/mm.
	MF/AF	Check the status of the **MF/AF** button on the lens. Lens control is possible only when it is in the **AF** state.
Calibrate		When there is an error in the lens information, aperture range, or focus range, click on the **Calibration** to re-read it. The aperture will return to the maximum aperture after calibration, and the focus motor will return to the closest focus position and cause the system to reacquire the focus range.
Lens Control	"F#" control	Displays the current lens settable **aperture range** and allows the user to move the slider on the scroll bar with the mouse for **aperture control**. Note that when the focal length changes, the settable aperture range will also change.
	"Focus" control	Displays the current **focus range** of the lens. The user can change the **focus position** of the lens by dragging the slider on the focus slider with the mouse.
Focus Mode	Manual	**Manual mode** allows aperture and focus control via the slider or the "+" "-" buttons.
	Auto	The system will autofocus based on the current scene in the **focus region** until it is clear.
	Once	Click this button to perform a single autofocus operation on the **focus region**. Note that modifying the focus region restarts single focusing.
	WD (Fixed Distance)	Input the object distance range of the **closest focusing distance** and the **farthest focusing distance** in the text box, and perform autofocus within this range. Note that it is normal to perform this function without fixing the focus after zooming, and the fixing function will be performed once first. Not all lenses support the Fixed Distance Focus function.

5.4 Bandwidth and Precise Frame Rate Control

5.4.1 Bandwidth

Partial cameras supports bandwidth adjustment from 1% to 100%. As shown in Figure 5-2, the camera is with 100% bandwidth by default, and you can drag the slider to set the desired bandwidth.

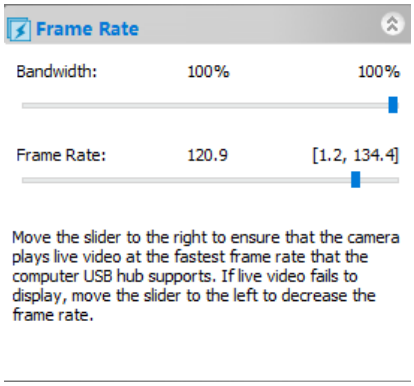


Figure 5-2 Bandwidth and precise frame rate settings

5.4.2 Precise Frame Rate Control

Partial cameras series supports precise frame rate control. The frame rate range will vary based on bandwidth, bit depth, resolution, ROI. As shown in Figure 5-2, the current frame rate can be set by dragging the Bandwith or Frame Rate slider bar left or right.

5.5 DDR3 Buffer

Camera has a built-in 512MB (4Gb) DDR3 buffer, which can effectively improve the stability of USB3.0 data transmission and ensure that the camera does not lose frames when working.

5.6 Binning

Camera supports additive or averaged 1x1 to 8x8 digital binning, and averaged 1x1 to 2x2 hardware binning. Hardware binning can achieve higher frame rates than software binning.

5.7 DC12V Power Supply and Cooling System

For the SWIR series camera, when the DC12V power supply is plugged in, both the camera cooling system and the imaging system use a unified 12V power supply.

When the DC12V power supply is disconnected, the camera cooling system stops working, and the imaging system will automatically switch to the USB 5V power supply and the camera can work normally in passive cooling mode.

The cooling system of SWIR series has a built-in or external TEC cooling for the sensor. It uses an external heat dissipation structure and a fan to assist heat dissipation. The working temperature can be adjusted to a specific value, and the effective cooling temperature can be lower than the ambient temperature by 10 - 25 °C. The efficient cooling system guarantees extremely low dark current levels.

The TEC system is controlled by PID algorithm, so that the TEC can be accurately adjusted to the target temperature, and the temperature deviation is 0.1°C.

6 Trigger Mode and its Configuration

6.1 Video Mode and Trigger Mode

The trigger function can be found on the Capture & Resolution group on the Camera Sidebar in ToupView. When the camera is opened, it is in Video Mode as shown in Figure 6-1 on the left. In Video Mode, Auto Exposure, Exposure Target, Exposure Time and Gain can be set. One can switch to Trigger Mode by checking the Trigger Mode check box.

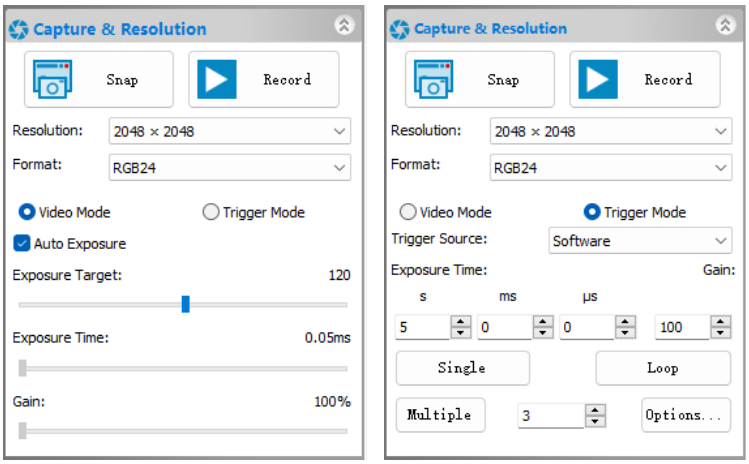


Figure 6-1 Video Mode and Trigger Mode on the Capture & Resolution group in ToupView

After the Trigger Mode is checked, the Capture & Resolution group will switch to Trigger Mode as shown in Figure 6-1 on the right. Where, the Trigger Source, Exposure Time, Gain, Single, Loop, Multiple, Frame Box, and Options can be set.

6.2 Trigger Sources and Their Capture Style

The Trigger Source can be any external input signal inputted into the camera which is called Hardware (Trigger Source), it can also be a command from the application which is called Software (Trigger Source). For the Software Trigger Source, it can be Single, Loop, Multiple, or Sequence style. Figure 6-2 shows the possible Trigger Sources. Table 6-1 shows the designed Trigger Source descriptions and possible capture styles for ToupTek camera.

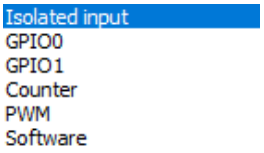
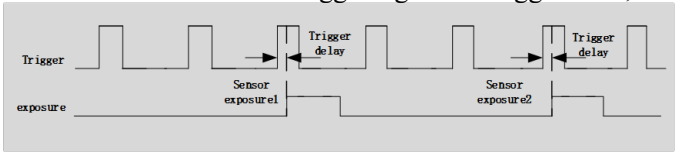
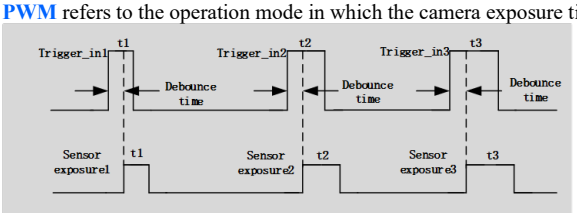
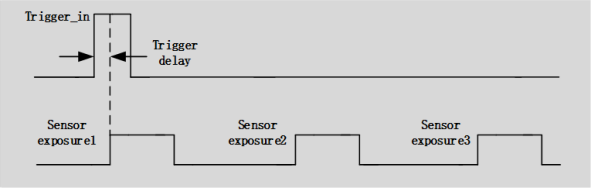


Figure 6-2 Possible Trigger Sources

Table 6-1 Description of possible Trigger Sources and their capture styles

Trigger Source	Description
Isolated input	Logic 0 input level: 0~2.2VDC; Logic 1 input level: 3.3~24VDC;. Maximum input current: 30mA;
GPIO0	Logic 0 input level: 0~0.6VDC (DIR_GPIO0/DIR_GPIO1 pins); Logic 1 input level: 2.0~24VDC (DIR_GPIO0/DIR_GPIO1 pins); Maximum input current: 25mA; If **GPIO0** is chosen as **Trigger Source**, it should be configurated as **Input** in the **GPIO Mode**'s combo box on the **Options>IO Control** page;
GPIO1	Logic 0 input level: 0~0.6VDC (DIR_GPIO0/DIR_GPIO1 pins); Logic 1 input level: 2.0~24VDC (DIR_GPIO0/DIR_GPIO1 pins); Maximum input current: 25mA; If **GPIO1** is chosen as **Trigger Source**, it should be configurated as **Input** in the **GPIO Mode**'s combo box on the **Options>IO Control** page;
Counter	**Counter** refers to the operation mode in which the camera can divide the frequency of the external input trigger signal through the preset **Counter Value** and perform image acquisition according to the customer's logic. For example, when the counter value(Counter Value: 3 [1,1023]) is set to 3, the

	camera needs to receive 3 trigger signals to trigger once;  When **Counter** is chosen in **Trigger Source** combo box in the **Capture & Resolution** group, the **Counter Source** can be **Isolated input**, **GPIO0** or **GPIO1** which can be chosen on **Options>IO Control** page; If **GPIO0** or **GPIO1** is chosen in the **Counter Source** combo box on **Options>IO Control** page. It should be configured as **Input** in the **GPIO Mode** combo box; Check **Options>IO Control** page's **Line Select** related items and **Counter** related items for details;
PWM	**PWM** refers to the operation mode in which the camera exposure time is controlled by the input trigger signal's pulse width;  **PWM Trigger Source** can be **Isolated input**, **GPIO0** or **GPIO1**. If **GPIO0** or **GPIO1** is chosen in the **PWM Source** combo box on the **Options>IO Control** page, it should be configured as **Input** in the **GPIO Mode** combo box; Check **Options>IO Control** page's **Line Select** related items and **PWM** related items for details;
Software	When **Software** trigger is chosen, the client software can send the command through USB3.0 to trigger, acquire and transfer images, In ToupView, **Single**, **Loop**, **Multiple,** or **Sequence** can be used to send the **Software** trigger command; If the **Plan** or **Hardware** is chosen in the **Type** combo box on the **Options>Sequence** page, the **Multiple** button will switch to **Sequence** button and the camera will use the **Exposure Time** and **Gain** in the **Sequence table** on this page one by one to capture the specified frames. Check **Single**, **Loop**, **Multiple,** or **Sequence** on **Capture & Resolution** group for the **Software** capture operations; Check **Options>Sequence** page and **Options>Advanced** page for the related **Sequence** and **Software** capture setup options;
Single	When **Single** is clicked, the camera will start to capture the image. At the same time the **Single** button will switch to **Stop** button. Clicking **Stop** button to stop the current **Single** capture operation, the **Stop** button will switch to **Single** button again for the next capture operation; Note: 1) The captured frames will always **Show in the video window** to prevent too many captures; 2) Enabled when **Software** in the **Trigger Source** combo box is chosen or **Always enable software trigger** checkbox is checked on the **Options>Advanced** property page;
Loop	When **Loop** is clicked, the camera will start to capture the image continuously and the **Loop** button will switch to **Stop** button. Clicking **Stop** button to stop **Loop** captures and the **Stop** button will switch to **Loop** button for the next **Loop** capture operation; Note: 1)The captured frames will always **Show in the video window** to prevent too many captures; 2)Enabled to capture continually when **Software** in the **Trigger Source** combo box is chosen or **Always enable software trigger** checkbox is checked on the **Options>Advanced** property page;
Multiple	**Multiple** refers to the operation mode in which the camera receives **Software** trigger signal or command and exports multiple frames of images. An edit box with spin(we call it **Frames Box**) is designed and affiliated to the **Multiple** button (Multiple 3 Options...) for the setting of the frames to be captured; The **Frames Box** can be set in the range of 1~65535. If the **Frames Box** is 3, a three-frame image will be captured and exported;  Note: 1)**Multiple** capture is enabled to capture continually when **Software** in the **Trigger Source** combo box is chosen; 2) **Multiple** capture is enabled when **Always enable software trigger** is checked on the **Options>Advanced** property page, no matter whether **Trigger Source** is **Software** or **Hardware** on the **Capture & Resolution** group; 3) If the **Plan** or **Hardware** is chosen in the **Type** combo box on the **Options>Sequence** page, the **Multiple** button will switch to **Sequence** button and the camera will use the **Exposure Time** and **Gain** in the **Sequence table** on this page. The captured frames will be displayed either in **Show in the video window**, or **Show in a new window** or **Save to disk** which can be specified on **Options>Output** page;
Sequence	When **Sequence** is clicked, the camera will start to capture the image until the specified frames in the **Frames Box** are captured. At the same time the **Sequence** button will switch to **Stop** button. Clicking **Stop** button will stop the current **Sequence** capture and the **Stop** button will switch to **Sequence** again for the next **Sequence** capture operation; Note: 1) Switched from **Multiple** to **Sequence** to capture the specified frames in the edit box with spin(**Frames Box**) when **Plan** or **Hardware** in the **Type** combo box is chosen on the **Options>Sequence** property page; 2)If the **Plan** or **Hardware** is chosen in the **Type** combo box on the **Options>Sequence** page, the **Sequence** button will be enabled and the capture will use the **Exposure Time** and **Gain** in the **Sequence table** list below one by one on the

	Options>Sequence page; 3) If the **Plan** or **Hardware** is chosen in the **Type** combo box on the **Options>Sequence** page and **Always enable software trigger** is checked on the **Options>Advanced** property page, the **Sequence** button will not switch to **Multiple** button and will be enabled only when the still in Sequence enable 4)If the **Plan** is chosen in the **Type** combo box on the **Options>Sequence** page and the **Software** is chosen in the **Trigger Source** combo box, the **Sequence** button will be enabled. 5)If the **Hardware** is chosen in the **Trigger Source** combo box, the **Sequence** button will be disabled, but the **Frame Box** will still be enabled and the **Sequence** will switch to the **Hardware Sequence** capture. One **Hardware** trigger signal will capture the specified frames on the **Frame Box** using the **Exposure Time** and **Gain** in the **Sequence table** on **Options>Sequence** page; 6)Check **Options>Sequence** page for the related **Sequence** setup options;

6.3 The trigger capture and IO Control configurations

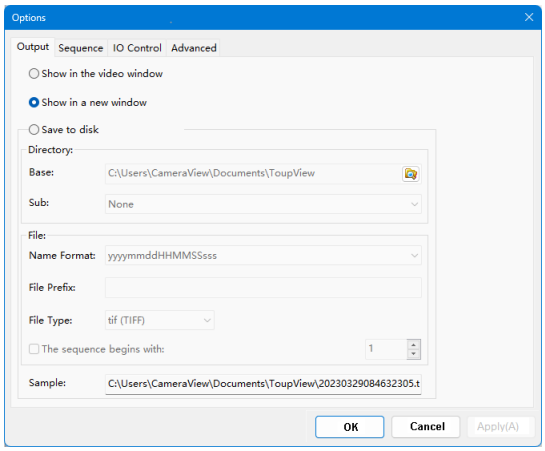


Figure 6-3 Options>Output page

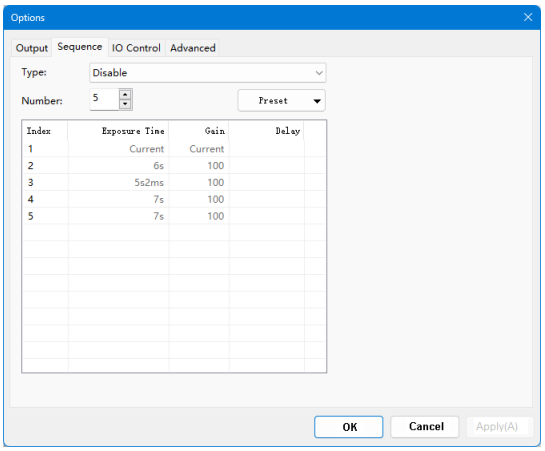


Figure 6-4 Options>Sequence page

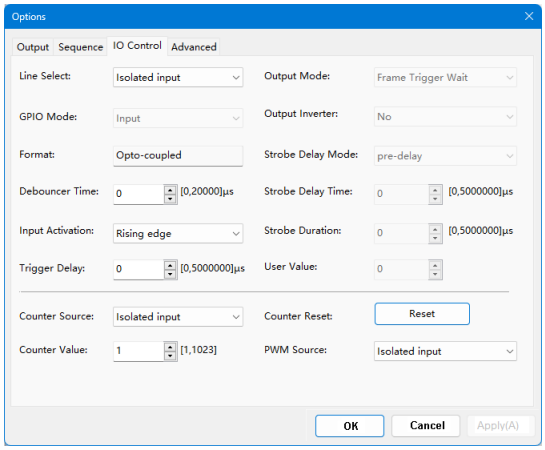


Figure 6-5 Options>IO Control page

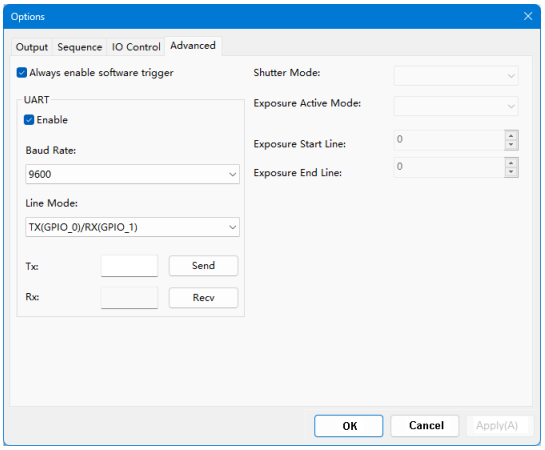


Figure 6-6 Options>Advanced page

The Trigger Source can be Isolated input, GPIO0, GPIO1(when configured as input), Counter, or PWM which can be configurated on the Options property sheet. Also the camera's Isolated output, GPIO0 or GPIO1(can be configurated as Output) can be used as Output or UART (GPIO0, GPIO1 only) applications. All of these configurations can be realized on the Options property sheet described in Table 6-2 below.

About the captured file operation style, one can find it on the Option>Output page;

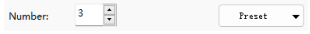
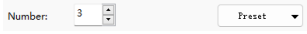
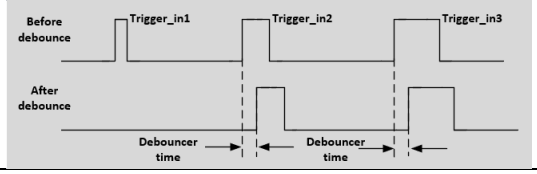
About the Sequence setup, one can find it on the Option>Sequence page;

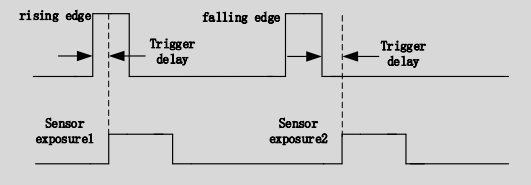
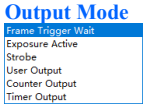
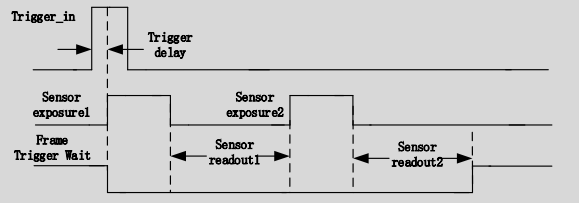
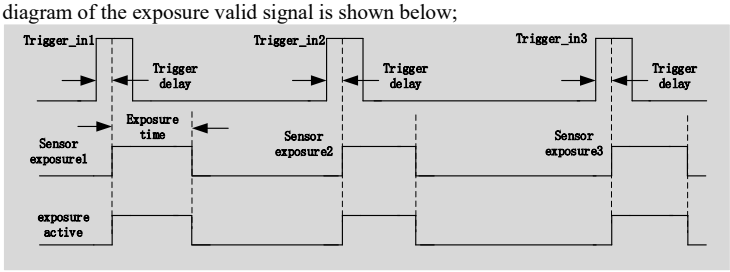
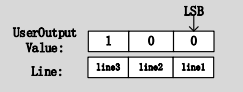
About the camera pin IO Control style, one can find it on the Options>IO Control page;

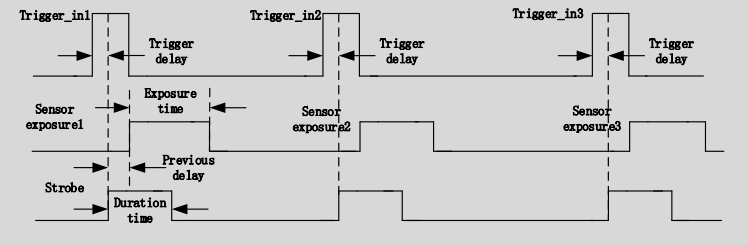
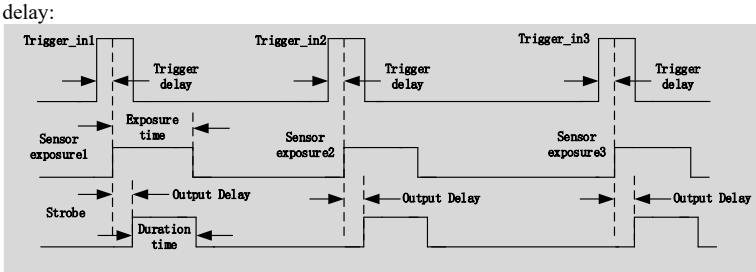
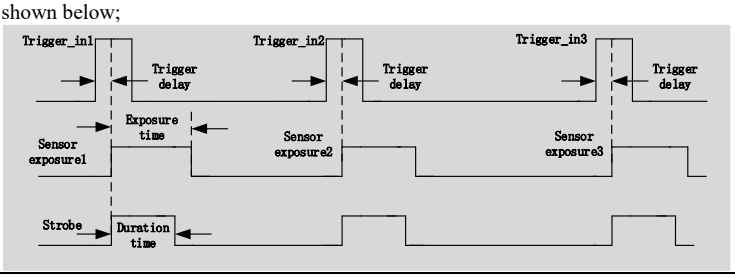
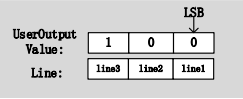
About the Always enable software trigger and UART setup, Shutter Mode, and Exposure Active Mode, one can find it on the Options>Advance page.

Table 6-2 Options property sheet for Trigger Source or camera pin configuration

Pages	Items	Descriptions

Output page	**Output Destination**	Used to set the captured frame's **Output** destination, can be **Show in the video window**, **Show in a new window** or **Save to disk**; When **Save to disk** is checked, the  button will be enabled clicking it to choose the **Base** directory, clicking the **Sub** combo box's dropdown button to choose the **Sub** directory; The **File Name Format**, **File Prefix**, **File Type**, and even **The sequence begin with** can be chosen, set, or defined. Note: 1)Valid only for **Sequence** or **Multiple** capture setup; 2)For **Single** or **Loop** capture, the captured image will be always displayed on the video window;
Sequence page	**Type** Disable Plan Hardware	**Disable**: If the **Disable** button is chosen in the **Type** combo box on the **Options>Sequence** page, the **Sequence** button on the **Capture & Resolution** page will switch to **Multiple** button;
		Plan: 1)If **Plan** is chosen in the **Type** combo box on the **Options>Sequence** page, the **Multiple** button on the **Capture & Resolution** group will switch to **Sequence** button; 2) If the **Software Trigger Source** is chosen in the **Capture & Resolution** group or the **Always enable software trigger** is checked on the **Options>Advanced** property page, the **Sequence** button will be enabled After the **Software** trigger signal is arrived(By clicking **Single**, **Loop**, or **Sequence** button), the camera will capture frames specified in the edit box with spin  (we call it **Frames Box**) affiliated to the **Sequence** button; The whole captures will use the **Exposure Time**, **Gain** and **Delay** in the **Sequence table** list under  one by one by the software; 3) If the **Disable** button is chosen in the **Type** combo box on the **Options>Sequence** page, the **Sequence** button on the **Capture & Resolution** page will switch to **Multiple** button; 4) The **Sequence** button will be enabled only when a) the **Plan** in the **Type** combo box is chosen on the **Options>Sequence** page and b) he **Software Trigger Source** is chosen in the **Capture & Resolution** group or c) **Always enable software trigger** is checked on the **Options>Advanced** property page;
		Hardware: 1) if **Hardware** is chosen in the **Type** combo box on the **Options>Sequence** page, the **Multiple** button on the **Capture & Resolution** group will switch to **Sequence** button and will be disabled for **Hardware** trigger. But users can still set the frames number in the **Frame Box** on the **Capture & Resolution** group; 2) After the **Hardware** trigger signal arrives, the camera will capture frames specified in the edit box with spin  (we call it **Frame Box**) affiliated to the **Sequence** button; The whole capture will use the **Exposure Time**, **Gain** (**Delay** is not used) in the **Sequence table** list under  one by one but stored in the camera hardware for the quick operation; 3) If the **Disable** button is chosen in the **Type** combo box on the **Options>Sequence** page, the **Sequence** button on the **Capture & Resolution** page will switch to **Multiple** button. 4) The **Sequence** button is always disabled if a) The **Hardware** is chosen in the **Type** combo box on the **Options>Sequence** page and b)the **Hardware Trigger Source** is chosen in the **Capture & Resolution** group; 5) The **Sequence** button will be enabled if a) the **Software Trigger Source** is chosen in the **Capture & Resolution** group or b) the **Always enable software trigger** checkbox is checked on the **Options>Advanced** property page, in this case, both the **Plan** and **Hardware Sequence** capture are supported;
	Number	The possible **Sequence**(capture) frames to be captured. If the **Number** is larger than the **Sequence Number** in the **Frames Box** on the **Capture & Resolution** group, the other **Indices** will be executed at the next **Sequence** operation one by one recycled;
	Index	The order of the **Number** group;
	Exposure Time	The camera **Exposure Time** for the specified capture **Index** in the **Sequence** capture;
	Gain	The camera **Gain** for the specified capture **Index** in the **Sequence** capture;
	Delay	The **Delay** time for the specified capture **Index** in the **Plan Sequence** capture(Valid for **Plan Sequence** capture only);
	Preset	Choosing **Save** to save the current **Sequence table**'s settings; Clicking **Management** to **Rename** the saved **Sequence table**'s setting files or **Remove** them from the **Management** list;
IO Control page	**Line Select**	Choosing which line to set. Can be **Isolated input**, **Isolated output**, **GPIO0** or **GPIO1 et al**;
	GPIO Mode	To configure whether the line selected in **Line Select** is for **Input** or **Output**. Only **GPIO0** or **GPIO1** can be configured as either **Input** or **Output**; If **Isolated input** or **Isolated output** is chosen, the **GPIO Mode** will be specified as **Input** or **Output** (Not configurable) respectively;
	Format	Specify the current selected signal's **Format** in the **Line Select** combo box, can be **Opto-coupled**(**Isolated input**, **Isolated output**)or **TTL** (**GPIO0** or **GPIO1**)for clarity(Unconfigurable);
	Debouncer Time	Since there may be a glitch in the external trigger input signal if it directly enters into the internal logic circuit of the camera, it will cause false triggering, so the input trigger signal should be debounced. In addition, the effective pulse width of the trigger signal input by the user should be greater than the **Debouncer Time**, otherwise, the trigger signal will be ignored; When **Isolated input**, **GPIO0** or **GPIO1** is chosen in the **Line Select** combo box and **GPIO0** or **GPIO1** is configured as **Input** in the **GPIO Mode** combo box, the **Debouncer Time** will be enabled for the user to input the **Debounter Time** between 0 to 20000us; 

	Input Activation	When **Isolated input**, **GPIO0** or **GPIO1** is chosen in the **Line Select** combo box and **GPIO0** or **GPIO1** is configured as **Input** in the **GPIO Mode** combo box; The **Input Activation** combo box will be enabled to configure the **Input Activation** as either **Rising Edge** or **Falling Edge**;  Also can be configure as **high level** or **low level**. When **high level** is selectd, the camera keeps triggering the frame when the input signal is high; When **low level** is selectd, the camera keeps triggering the frame when the input signal is low;
	Trigger Delay	When **Isolated input**, **GPIO0** or **GPIO1** is chosen in the **Line Select** combo box and **GPIO0** or **GPIO1** is configured as **Input** in the **GPIO Mode** combo box, the **Trigger Delay** will be enabled for the user to input the **Trigger Delay** time between 0 to 5000000us; If the **Trigger Delay** time is set to 1000000us, the camera will wait for 1s to capture the image after receiving the trigger signal;
	Output Mode 	When **Isolated output**, **GPIO0** or **GPIO1** is selected in the **Line Select** combo box and **GPIO0** or **GPIO1** is configured as **Output** in the **GPIO Mode** combo box, the **Output Mode** will be enabled. It can be **Frame Trigger Wait**, **Exposure Active**, **Strobe, User Output, Counter Output** or **Timer Output**. The chosen mode can be used for diversified applications;
		The Frame Trigger Wait signal is pulled low at the start of exposure and pulled high when the last frame of data is read out. The trigger signal input by the user should be in the valid period. If the user inputs a trigger signal when the signal is low, the trigger signal input at this time will be ignored. The following example is the case when Burst Count = 2, as shown below; 
		Exposure Active: when this signal is high, it means the sensor is exposing. This signal can be used to control an external mobile device to remain stationary or move at low speed while the camera is at exposure. The timing diagram of the exposure valid signal is shown below;  When the relative position of the camera and the object to be photographed changes, you can refer to **Exposure Active** signal to prevent the captured image from being affected by movement and focus adjustment during the exposure process;
		When Strobe is chosen, **Strobe Delay Mode**, **Strobe Delay Time**, **Strobe Duration** will be enabled;
		When User Output is chosen, **User Value** will be enabled. lines3, line2, line1 are the combination of **GPIO1, GPIO0** and **Isolated output** respectively. If **User Value** is 001, then line **GPIO1** and **GPIO0** will be disabled and **Isolated output** will be enabled; 
		When the Counter Output is selectd, when the counter value is “m”, the camera triggers “m” times to output a signal.
		When the Timer Output is selectd, the camera keeps output signals. When the **Strobe Delay Time** is **delay**, the pulse width of the high level is determined by the **Strobe Duration**. The pulse width of low level is determined by the **Strobe Delay Time**.
	Output Inverter	When **Isolated output**, **GPIO0** or **GPIO1** is selected in the **Line Select** combo box and **Output** is chosen for **GPIO0** or **GPIO1** in the **GPIO Mode** combo box, the **Output Inverter** will be enabled to configure the current selected line’s output as either inverted or not(**Yes** or **No**).
	Strobe Delay Mode	Strobe can be used to control external devices such as the strobe, and the effective level duration, delay time, and pre-delay time of the strobe signal can be set; When the **Output Mode** is **Strobe**, **Strobe Delay Mode** will be enabled. It can be **pre-delay** or **delay**;
	Strobe Delay Time	When exposure starts, the strobe does not take effect immediately, and the output is delayed according to the value set by **Strobe Delay Time** which is between 0 to 5000000us. The **Strobe Delay Mode** can be **pre-delay** or **delay**; It is described below;

		pre-delay:  delay: 
	Strobe Duration	The high level duration of the strobe is determined by the **Strobe Duration** which is between 0 to 5000000us as shown below; 
	User Value	Users can input a value at **User Value** edit box with spin to control the line as disable or enable. Enabled when **User Output** is chosen in the **Output Mode** combo box. The logical value 0 or 1's combination of **GPIO1**(line3), **GPIO0**(line2) and **Isolated output**(line1); When the output mode is selected as **User Output**, the user can input a value at **User Value** edit box to control the corresponding line output with 0 or 1; The value here is only valid for the lower three bits of a binary. For example, when line 1 and line 3 are set to **User Output** mode, and its **User Value** is set to 4 ('b100), then line 3 outputs 1, and line 1 outputs 0, as shown below. 
	Counter Source	When **Counter** is chosen in the **Trigger Source** combo box in the **Capture & Resolution** group, the **Counter Source** can be chosen from **Isolated input**, **GPIO0** or **GPIO1** in this combo box on the **Option>IO Control** page;
	Counter Value	The **Counter Value** is used to divide the frequency of the external input trigger signal when the **Counter Trigger Source** is chosen in the **Capture & Resolution** group; See **Counter** in Table 6-1 for detail;
	Counter Reset	Click **Reset** button can clear the current counting process and begin a new one;
	PWM Source	When **PWM** is chosen in the **Trigger Source** combo box in the **Capture & Resolution** group, the **PWM Source** can be from **Isolated input, GPIO0,** or **GPIO1** in this combo box et al. ;
Advanced page	**Always enable software trigger**	When this button is checked, no matter whether **Trigger Source** is **Software** or **Hardware**, the software trigger buttons(**Single**, **Loop**, **Multiple**) are always enabled; If the **Plan** or **Hardware** is chosen in the **Type** combo box on the **Options>Sequence** page, the **Multiple** button will switch to **Sequence** button; The **Sequence** button will be enabled if a)the **Software Trigger Source** is chosen in the **Capture & Resolution** group or b) the **Always enable software trigger** checkbox is checked on the **Options>Advanced** property page, in this case, both the **Plan** and **Hardware Sequence** captures are supported;
	UART	There is a serial port function on the **Advanced** page, which can be used to communicate with external devices via serial port. Check **Enable** to enable this function. When enabled, **GPIO0** and **GPIO1** can only be used as **UART** transfers; The **Baud Rate** supports 9600-115200. **Cable Select** can configure **GPIO0** and **GPIO1**, which can be configured as **TX** or **RX** respectively. Setting a value at **TX**, clicking **Send** to send the set value out; click **Accept** at **RX** to receive the value from the external device;
	Shutter Mode	Enabled if the camera supports. Users can select **Rolling Shutter** or **Global Reset**;
	Exposure Active Mode	Enabled if the camera supports. Users can select **Specified lines** or **Common exposure time**;
	Exposure Start Line	Enabled when **Specified lines** in the **Exposure Active Mode** combo box is selected. To configure when the Exposure Active signal is valid;

	Exposure End Line	Enabled when **Specified lines** in the **Exposure Active Mode** combo box is selected. To configure when the Exposure Active signal is invalid;

7 Cooling

For the SWIR series cameras, there is a Cooling group on the left sidebar in ToupView. To enable the Cooling function, an external 12V power supply is required. By default, the TEC is turned on. One can set the Target Temperature. After entering the value, click "Apply", and the sensor temperature will gradually approach to the Target Temperature. At the same time, ToupView can display the current temperature in real time. And the cooling effect can reach about 10-25 degrees lower than the ambient temperature, as shown in Figure 7-1.

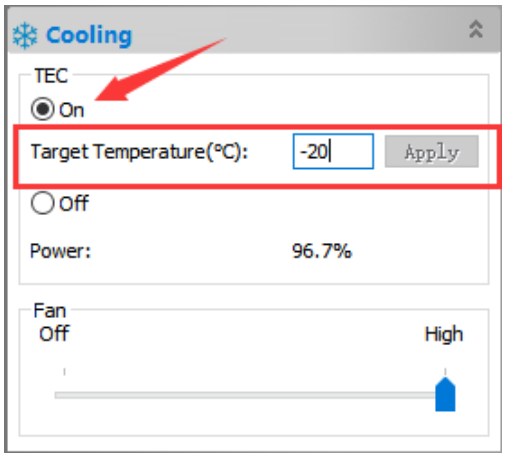


Figure 7-1 TEC settings

The Fan has two gears from Off to High. When High, the Fan speed reaches the highest. When Off, the Fan is turned off, the TEC is also turned off, and the power is 0, as shown in Figure 7-2.

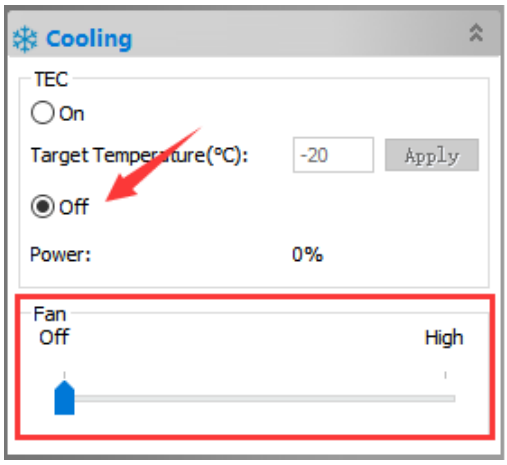


Figure 7-2 Fan settings

When the TEC is turned on, the Fan will automatically turn on preventing the abnormal situation such as the housing temperature is too high if the Fan stops running when the TEC is working; when the Fan is turned off, the TEC will automatically turn off.

8 Application

8.1 Application installation

In terms of software, customers are welcome to visit our website: https://www.touptekphotonics.com/ to download the latest ToupView, also be used with ASCOM, DirectShow interface. If the third-party software is compatible with these interfaces, customers can also download software drivers from our website and install them into the third-party software.

8.2 Introduction to ToupView

ToupView is a professional software that integrates camera control, image acquisition and processing, image browsing and analysis functions. ToupView has the following characteristics:

- x86: XP SP3 and above ; CPU supports SSE2 and above
- x64: Win7 and above
- Support video mode and Trigger Mode (Raw format or RGB format)
- Automatic capture and quick recording capabilities
- Supports multiple languages
- Hardware ROI and digital binning capabilities
- Rich image processing functions, such as image stitching, real-time overlay, flat field correction, dark field correction, etc.
- Supports all ToupTek cameras

8.2.1 User interface design

- The menus and toolbars are properly set to ensure quick operation
- Professionally integrated with 5 sidebars - Camera, Folders, Undo/Redo, Layers, Measure
- Comfortable operation method (double-click or right-click context menu)
- Detailed help manual

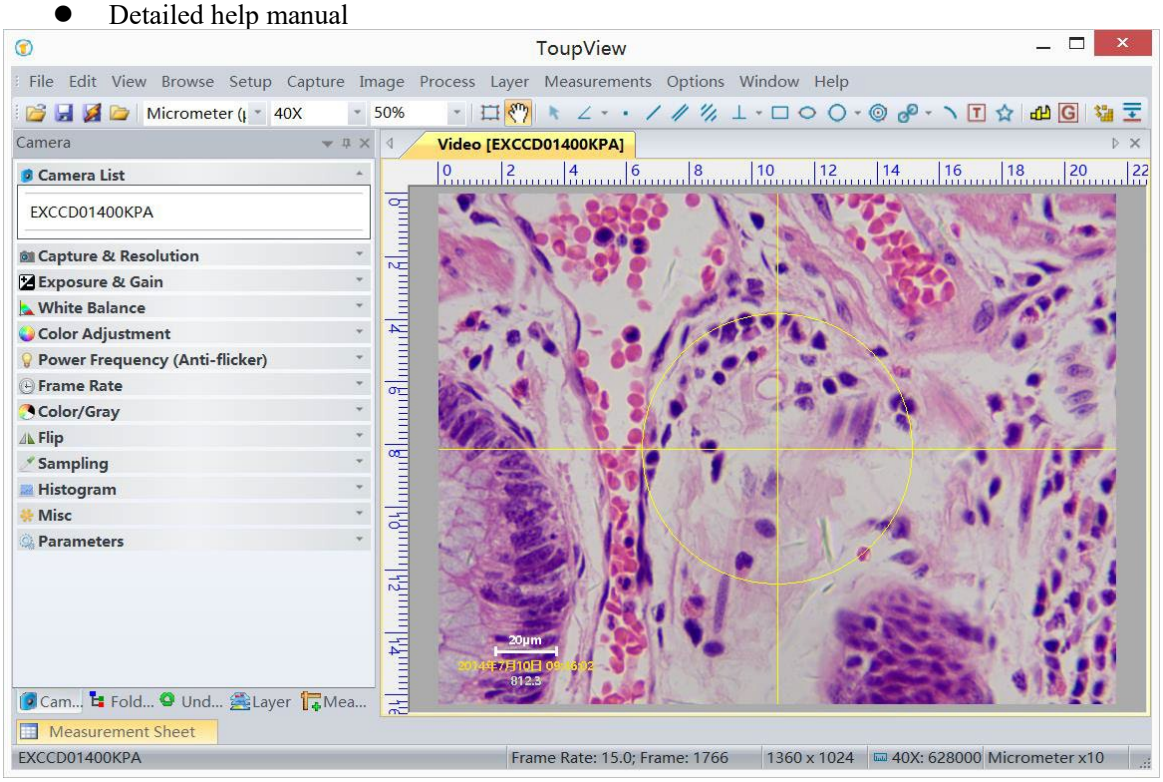


Figure 8-1 ToupView video window

8.2.2 Professional Camera Control Sidebar

Capture & Resolution	Set up live and still capture, snap images, or record video
Exposure & Gain	Auto exposure (preset exposure target value), manual exposure (exposure time can be manually entered and set by slider); gain up to 5 times
White Balance	Advanced one-click smart white balance settings, and you can adjust white balance by manually setting

	color temperature and color
Color Adjustment	Color, saturation, brightness, contrast, gamma initial high-speed adjustment function
Frame Rate Control	For different computer and USB performance, the camera can be super compatible by adjusting the frame rate
Flip	Select "Horizontal" or "Vertical" to adjust the sample orientation to ensure the same orientation as the visual system
Sampling	Neighborhood averaging can improve the signal-to-noise ratio of the video stream; while the sampling extraction mode can ensure the sharpness of the video stream. Supports histogram expansion of video stream, image negative and positive switching, grayscale calibration, and sharpness factor calculation to facilitate video focusing
Bit Depth	8, 12-bit switching, 8-bit is the basic Windows image format. 12-bit has higher image quality but reduces frame rate
Roi	ROI, Region of interest. This function can set the ROI value of the video window. After the ROI group is expanded, a rectangular box will appear in the middle of the video window, and the ROI can be changed. The mouse can adjust the size of the ROI. If there is no problem with the ROI, click "Apply" to set the video to the size of the ROI, and the default value will be restored to the original size.
Dark Field Correction	To enable darkfield correction, you should first capture a field image, then click Enable. Check Enable to enable darkfield correction. Uncheck it to disable darkfield correction
Cooling	Set TEC Target Temperature, fan on/off
Parameter Save	Load, save, overwrite, load, export custom camera panel controls (including calibration information, exposure parameters and color settings information, etc.)

8.2.3 Professional and practical image processing functions

Video Function	Various video professional processing functions: video broadcasting, timing capture, video recording, video watermarking, watermark mobile alignment, watermark rotation alignment, video grid overlay, video measurement, video scaling, gray scale calibration, video high dynamic (HDR), video depth of field extension, video image stitching, video scale, date, etc.
Image Processing and Enhancement	Image contrast control and adjustment, image denoising, various image filtering algorithms, image mathematical morphology algorithms, image rotation, image scaling and image printing, etc.
Image Overlay	The ToupView image overlay denoising function introduces advanced image matching technology. Users only need to record a short video of the image to be superimposed, and they can superimpose and output high fidelity in the case of displacement, rotation and magnification change between multiple frames of the video. images, easy to use

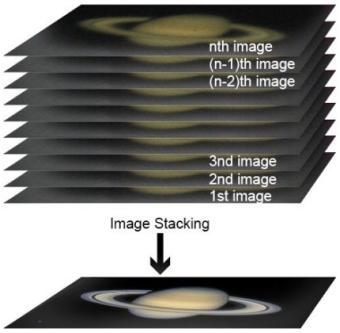


Figure 8-2 Image overlay denoising

8.2.4 Super compatibility

Camera Video Interface	Provide Twain, DirectShow, Labview, SDK installation package (native C++, C#)
Supported Platform and architectures	Compatible with Microsoft® Windows® XP / Vista / 7 / 8 /10 /11(32 & 64 bit), Mac OSX, Linux
Language Support	Language support can be added manually, currently supports English, Simplified Chinese, Traditional Chinese, German, Japanese, Russian, French, Italian, Polish, Turkish

8.2.5 Basic hardware requirements

PC Basic Configuration Requirements	CPU: Intel Core 2 2.8GHz or higher
	RAM: 2GB or more
	USB Port: USB3.0 / USB 2.0
	Monitor: 17" or higher
	CD-ROM

9 Software development instructions

9.1 SDK description

The download link of the SDK is as follows:

https://www.touptekphotonics.com/download/

9.1.1 SDK support platform

- Win32:
  x86: XP SP3 and above; the CPU needs to support at least the SSE2 instruction set.

  x64: Win7 and above.

  arm: Win10 and above.

  arm64: Win10 and above.
- WinRT: x86, x64, arm, arm64; Windows 10 and above.
- macOS: x86 and x64 bundle; macOS 10.10 and above.
- Linux: core 2.6.27 and above.
  x86: The CPU needs to support at least the SSE3 instruction set; GLIBC 2.8 and above.

  x64: GLIBC 2.14 and above.

  armel: GLIBC 2.17 and above; compiled by toolchain arm-linux-gnueabi (version 4.9.2).

  armhf: GLIBC 2.17 and above; compiled by toolchain arm-linux-gnueabihf (version 4.9.2).

  arm64: GLIBC 2.17 and above; compiled by toolchain aarch64-linux-gnu (version 4.9.2).
- Android: arm, arm64, x86, x64; compiled by android-ndk-r18b.

9.1.2 Introduction to SDK content

ToupCam series cameras support a variety of APIs, including: Native C/C++,.NET/C#/VB.NET, Python, Java, DirectShow, Twain, LabView, Matlab, etc. Compared with other APIs, Native C/C++ API as a low-level API is characterized by using pure C/C++ development without relying on other runtime libraries. The interface is simple and the control is flexible. This SDK zip package contains all the resources and information needed. The directory is as follows:

- inc:
  toupcam.h, the C/C++ header file.
- win: Microsoft Windows platform file
  - dotnet:

    toupcam.cs, supports C#. toupcam.cs uses P/Invoke to call toupcam.dll. Please copy toupcam.cs to your C# project for use.

    toupcam.vb, supports VB.NET. toupcam.vb uses P/Invoke to call toupcam.dll. Please copy toupcam.vb to your VB.NET project for use.
  - x86:

    toupcam.lib, x86 lib file.

    toupcam.dll, x86 dynamic library file.

    democpp.exe, x86 C++ demo execute the procedure.
- x64:
  toupcam.lib, x64 lib file.

  toupcam.dll, x64 dynamic library file.

  democpp.exe, x64 C++ demo execute the procedure.
- arm:
  toupcam.lib, arm lib file.

toupcam.dll, arm dynamic library file.

- arm64:
  toupcam.lib, arm64 lib file.

  toupcam.dll, arm64 dynamic library file.

- winrt:
  They can be applied for Dynamic library files of WinRT/ UWP (Universal Windows Platform)/ Windows Store App. They are compatible with Windows Runtime and can be referenced by Universal Windows Platform apps. If you use C# to develop UWP, you can use the toupcam.cs wrapper class.

  Please pay attention to the Device Capability of uwp. Refer to how to add USB device capabilities to the app manifest. (Microsoft seems to limit the Device entry under DeviceCapability to no more than 100) demouwp.zip is a simple example of uwp. Please modify vid and pid. under DeviceCapability in the file Package.appxmanifest before compiling the run example.

- Drivers: (Cameras produced after 2017.1.1 support WinUSB, and drivers no longer need to be installed on Windows 8 and above)
  The x86 folder contains the x86 kernel-mode driver files, including toupcam.cat, toupcam.inf and toupcam.sys.

  The x64 folder contains the x64 kernel-mode driver files, including toupcam.cat, toupcam.inf and toupcam.sys.

- samples:
  1. democpp, C++ example. This example demonstrates enumerating devices, opening devices, previewing videos, capturing images, setting resolution, triggering, saving images to files in various image formats (.bmp,.jpg,.png, etc.), wmv format video recording, Trigger ModeTrigger Mode, IO control and so on. This example uses the Pull Mode mechanism. To keep the code clean, the WTL library used by the examples can be downloaded from this link http://sourceforge.net/projects/wtl/.

  2. demopush, C++ example, using the Push Mode mechanism, StartPushModeV3.

  3. demomfc, a simple C++ example, uses MFC as a GUI library, supports opening devices, previewing videos, capturing images, setting resolution, saving images to files in various image formats (.bmp,.jpg,.png, etc.), etc. This example uses the Pull Mode mechanism.

  4. demowinformcs1, take C# winform for example, it supports opening devices, previewing videos, capturing images, saving images to files, and setting white balance. This example uses the Pull Mode mechanism, StartPullModeWithWndMsg.

  5. demowinformcs2, take C# winform for example, it supports opening devices, previewing videos, capturing images, saving images to files, and setting white balance. This example uses the Pull Mode mechanism, StartPullModeWithCallback.

  6. demowinformcs3, take C# winform for example, it supports opening devices, previewing videos, capturing images, saving images to files, and setting white balance. This example uses the Push Mode mechanism, StartPushMode.

  7. demowinformvb, take VB.NET winform for example, it supports opening devices, previewing videos, capturing images, saving images to files, and setting white balance. This example uses the Pull Mode mechanism.

- linux: Linux platform files
  Udev: 99-toupcam.rules, udev rule file.

  Please refer to: http://reactivated.net/writing_udev_rules.html.

- c#: toupcam.cs, Support. Net Core C#. toupcam.cs uses P/Invoke to call libtoupcam.so. Please copy toupcam.cs to your C# project for use.
- x86: libtoupcam.so, x86 version so file.
- x64: libtoupcam.so, x64 version so file.
- armel: libtoupcam.so, armel version so file, toolchain is arm-linux-gnueabi.
- armhf: libtoupcam.so, armhf version so file, toolchain is arm-linux-gnueabihf.

- arm64: libtoupcam.so, arm64 version so file, toolchain is aarch64-linux-gnu.
- android: libtoupcam.so for four architectures of Android platform arm, arm64, x86, x64.
- mac: macOS platform files.
- python: toupcam.py and example code.
- java: toupcam.java and example code (console and Swing).
- doc: SDK usage documentation, Simplified Chinese, English.
- sample:
- de emosimplest, the simplest example, is about 60 lines of code.
- demoraw, RAW data and still shots, about 120 lines of code.
- extras:
- directshow: DirectShow SDK and demo program.
- twain: TWAIN SDK.
- labview: Labview SDK and demo program.
- matlab: MatLab demo program.