

2024

Manual MaxCam-2020e-TE



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MaxCam2020e-TE User Manual.....	1
1 Product Description and Features.....	3
2 Camera parameters and performance.....	4
2.1 Camera parameters.....	4
2.2 Spectral response curve.....	4
2.3 Camera operating mode.....	5
2.4 DDR3 Buffer.....	5
2.5 Binning.....	5
2.6 Conversion Gain.....	5
2.7 DC19V power supply and cooling system.....	5
2.8 Camera performance analysis.....	6
3 Camera size and Design.....	8
3.1 Camera size.....	8
3.2 Camera Design and interface.....	8
3.3 Packing List.....	9
4 External IO connector and electrical characteristics.....	11
4.1 Pin Signal.....	11
4.2 I/O Electrical Characteristics.....	11
4.2.1 Opto-isolated input circuit (line0).....	11
4.2.2 Opto-isolated output circuit (line1).....	12
4.2.3 Input and output I/O circuit (line 2/line3).....	13
5 Trigger function.....	16
5.1 Trigger signal source selection.....	16
5.1.1 Software trigger.....	16
5.1.2 External hardware trigger.....	16
5.2 Trigger acquisition mode.....	17
5.2.1 Single frame trigger mode.....	17
5.2.2 Multi-frame trigger mode.....	17
5.2.3 Counter trigger mode.....	17
5.3 General Purpose I/O configuration.....	18
5.4 I/O signal configuration.....	19
5.4.1 Trigger edge.....	19
5.4.2 Debouncer time.....	20
5.4.3 Trigger delay.....	21
5.4.4 Output inverted.....	22
5.5 Output mode.....	23
5.5.1 Strobe.....	23
5.5.2 Exposure Active.....	25
5.5.3 Frame Trigger Wait.....	25
5.5.4 User Output.....	26
5.6 Advanced trigger function.....	26
5.6.1 Plan trigger.....	27
5.6.2 Sequence trigger.....	27
5.6.3 Always enable software triggering.....	28
5.6.4 UART function.....	28
6 Refrigeration and heating.....	30
6.1 Refrigeration.....	30
6.2 Heating.....	30

7 Application.....	32
7.1 Application installation.....	32
7.2 Introduction to EHDView.....	32
7.2.1 User interface design.....	32
7.2.2 Professional camera control panel.....	33
7.2.3 Professional and practical image processing functions	33
7.2.4 Super Compatibility	34
7.2.5 Basic hardware requirements	34
8 Software Development Instructions.....	35
8.1 SDK description	35
8.1.1 SDK Support Platform.....	35
8.1.2 Introduction to SDK Content	35
8.2 Third-party interfaces and software.....	37

1 Product Description and Features

MaxCam2020e-TE is powered by GSENSE2020e 1.2-inch image sensor. In view of the inherent thermal noise of the sensor, an efficient cooling module is specially designed to make the camera sensor work at 35-40 degrees lower than the ambient temperature. An anti-fogging mechanism is designed to prevent the fogging of the sensor and filter surface at low temperature. The video and image data is transmitted through the USB3 ultra high speed transfer interface for fast preview.

The basic features are as follows :

- GSENSE2020e Science CMOS sensor
- Wide Spectral response range: 400nm -1000nm
- Supports visible and near-infrared wavelengths
- Precise temperature control, the temperature difference can reach 35 degrees Celsius
- Resolution: 2048 x 2048
- 6.5 um pixel
- Rolling shutter
- USB3 interface
- 12-bit ADC/16-bit ADC combined HDR
- 4Gb memory
- Supports HCG/LCG/HDR mode
- Ultra-low readout noise: 2.06e-(HCG)
- Maximum SNR: 47.73 dB(LCG)
- Dynamic range: 66.72dB(HCG)/81.6dB(HDR)
- Support external IO trigger control

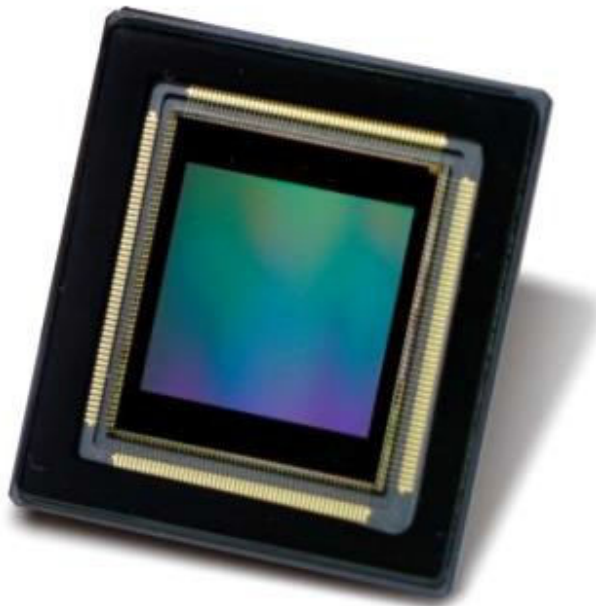


Figure 1 GSENSE2020e Sensor

2 Camera parameters and performance

2.1 Camera parameters

Parameter	Specification	
Sensor model	GSENSE2020e	
Sensor Type	Mono	
Spectral Range	400 - 1000nm	
Pixel Size	6.5 μ m \times 6.5 μ m	
Frame Rate & Resolution	16 bits	8bit
	45fps @ 2048*2048 45fps @1024* 1024	45fps@2048*2048 45fps@1024*1024
DDR3 Memory	512MB (4Gb)	
Conversion Gain	1.17(HCG) 3.62(LCG)0.69(HDR)	
Dynamic Range	66.72dB(HCG) 66.36dB(LCG)81.6dB(HDR)	
Readout Noise	2.06e-(HCG) 10.39e-(LCG)3.62e-(HDR)	
Full Well	19.17ke-(HCG)59.30ke-(LCG)45.02ke-(HDR)	
SNR	42.83dB(HCG)47.73dB(LCG)46.53dB(HDR)	
Sensitivity	8.11 $\times 10^7$ e-/((W/m ²).s)@595nm	
Dark Current	5.15e-/s/pix @ -10oC die temp	
Quantum efficiency	72%@595nm	
Exposure Time	0.011ms – 3600s	
Gain Range	1x – 8x	
Shutter	Rolling shutter	
Binning	Software 2x2 , 3x3, 4x4, hardware 2x2	
Data interface	USB3.0/USB2.0	
Digital I/O	One optical-coupling isolated input, one optical-coupling isolated output, tow non-isolated input and output	
Data Format	Mono8 / Mono16	
Cooling Performance	30-35 °C below ambient temperature	
General Parameters		
Power Supply	by USB3.0 interface / 19V power adapter	
Power Consumption	44.8W (cooled) / 6.65W(uncooled)	
Temperature	Working temperature -20 ~ 60 °C , storage temperature - 40 ~ 85 °C	
Humidity	20%-80% , no condensation	
Filter	AR-window	
Camera Size	110*110*121.5mm	
Camera Weight	1.7kg	
Lens Mount	C-mount	
Back focal length	17.5mm	
Software	Complete SDK (software development kit) / EHDView	
Operating System	Microsoft® Windows® XP / Vista / 7 / 8 /10 (32 & 64 bit) OSx(Mac OS X) Linux	
Certification	CE, FCC	

Table 1 camera parameters

2.2 Spectral response curve

The sensitivity of GSENSE2020e is 8.11 $\times 10^7$ e-/((W/m²).s)@595nm. Spectral response curve of sensor is shown in

Figure 2

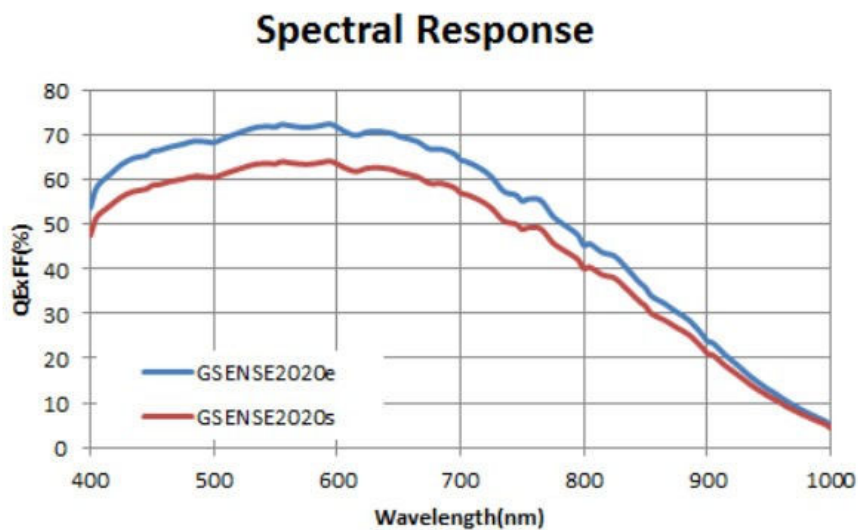


Figure 2 Spectral response curve

2.3 Camera operating mode

Camera operation mode support: video mode or trigger mode.

Camera trigger mode support: soft trigger mode or external trigger mode.

2.4 DDR3 Buffer

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

2.5 Binning

The 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.

2.6 Conversion Gain

The camera supports HCG、 LCG and HDR mode, HCG has low Readout Noise, LCG has higher Full Well, HDR has the highest Dynamic Range.



Figure 3 HCG、 LCG and HDR mode

2.7 DC19V power supply and cooling system

When the DC19V power supply is plugged in, both the camera cooling system and the imaging system use a unified 19V power supply.

When the DC19V 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 camera's cooling system is cooled by TEC. 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 30 - 35 °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.

2.8 Camera performance analysis

The performance of the camera can be evaluated by **e-/ADU**, **Readout Noise**, **Full Well** and **Dynamic Range**.

e-/ADU: The gain electron of the CCD/CMOS camera is converted into a conversion factor of a digital signal through a series of circuits such as readout, amplification, and analog-to-digital converter. The converted digital signal unit is called **ADU**.

Readout Noise: Readout noise is the most important reference indicator for measuring camera performance. Low readout noise usually means better signal-to-noise ratio and better image quality. Readout noise occurs when electrons go through steps such as analog-to-digital conversion, amplification, and processing to create an image during readout.

Full Well: Electrons are held in each pixel and converted into electric charge, which can be measured to reveal the amount of light falling on each pixel. The maximum charge is called the "full well". Under the same conditions of noise and A/D conversion, the larger the full-well charge capacity of the sensor, the wider the dynamic range.

Dynamic Range: Dynamic range is the ratio of the signal at saturation to the lowest signal the sensor can measure. Dynamic range represents the camera's ability to display the brightest and darkest parts of an image and how much there is variation between the two. There may be one part of an image that is completely black and another part that is completely saturated.

For Maxcam2020e-TE, when describing camera performance, **Gain Value** In xxx% mode, here use xxx as the x - axis (**Gain Value**)

$$Rel\ G(dB) = 20 * \log_{10} [xxx(Gain\ Value)/100]$$

The performance parameters of the camera in HCG mode are as follows:

- Maximum resolution
- RAW 16 Bit mode
- Temperature : -5 °C
- HCG mode

Sensor performance parameters															
Gain Value	100	125	158	199	251	316	398	501	630	794	1000	1258	1584	1995	2099
Rel Gain (dB)	0.00	0.00	2.43	4.11	6.16	8.14	9.83	12.13	13.78	16.10	17.73	20.16	21.65	23.65	23.83
e-/ADU	1.17	1.17	0.88	0.73	0.58	0.46	0.38	0.29	0.24	0.18	0.15	0.11	0.10	0.08	0.08
Read Noise (e-)	8.59	8.47	6.80	6.39	5.67	4.33	4.15	3.72	3.54	3.26	3.03	3.02	2.90	2.25	2.06
Full Well (ke-)	19.17	19.17	14.50	11.94	9.43	7.51	6.19	4.74	3.92	3.01	2.50	1.88	1.58	1.26	1.23
DR (stop)	11.12	11.15	11.06	10.87	10.70	10.76	10.54	10.32	10.12	9.85	9.68	9.28	9.09	9.13	9.23

Table 2 Sensor performance parameters in HCG mode

The performance parameters of the camera in LCG mode are as follows:

- Maximum resolution
- RAW 16 Bit mode
- Temperature : -5 °C
- LCG mode

Sensor performance parameters															
Gain Value	100	125	158	199	251	316	398	501	630	794	1000	1258	1584	1995	2099
Rel Gain	0.00	0.00	2.34	3.97	6.04	8.07	9.82	12.23	14.03	16.51	18.23	20.80	22.37	24.52	24.73
e-/ADU	3.62	3.62	2.76	2.29	1.81	1.43	1.17	0.89	0.72	0.54	0.44	0.33	0.28	0.21	0.21
Read Noise (e-)	27.78	26.89	22.56	23.91	20.38	16.11	13.96	14.21	12.42	11.96	10.35	9.71	9.33	9.56	10.39
Full Well(ke-)	59.30	59.29	45.29	37.54	29.60	23.43	19.15	14.50	11.79	8.86	7.27	5.41	4.51	3.52	3.44
DR(stop)	11.06	11.11	10.97	10.62	10.50	10.51	10.42	9.99	9.89	9.53	9.46	9.12	8.92	8.53	8.37

Table 3 Sensor performance parameters in LCG mode

The performance parameters of the camera in HDR mode are as follows:

- Maximum resolution
- RAW 16 Bit mode
- Temperature : -5 °C
- HDR mode

Gain Value	100	300	500	700	900	1100	1300	1500	1700	1900	2100
Rel Gain	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
e-/ADU	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
Read Noise (e-)	3.62	3.67	3.55	3.58	3.66	3.60	3.65	3.67	3.65	3.68	3.64
Full Well(ke-)	45.02	45.05	45.06	45.05	45.05	45.04	45.04	45.07	45.06	45.05	45.04
DR(stop)	13.60	13.58	13.63	13.62	13.59	13.61	13.59	13.58	13.59	13.58	13.59

Table 4 Sensor performance parameters in HDR mode

3 Camera size and Design

3.1 Camera size

Camera dimensions are shown in Figure 4.

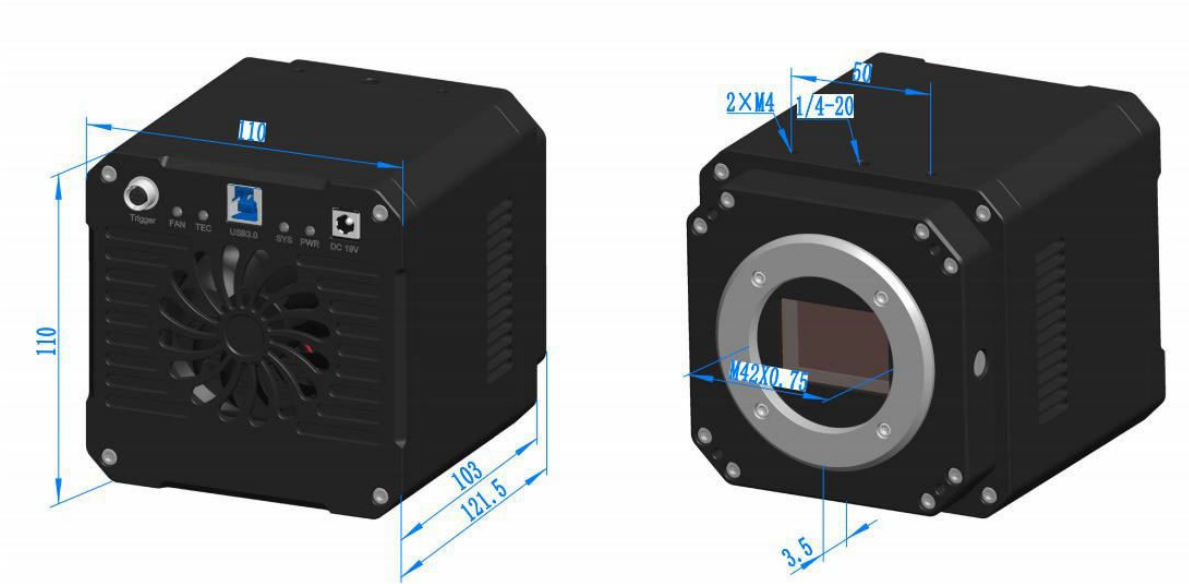


Figure 4 Maxcam2020e-TE Dimensions

parameter	Specification
Size	100*100*121.5mm
Mount	C mount

Table 5 Dimensions

3.2 Camera Design and interface

Appearance of the camera is shown in Figure 5, and the interface description is shown in Table 6.

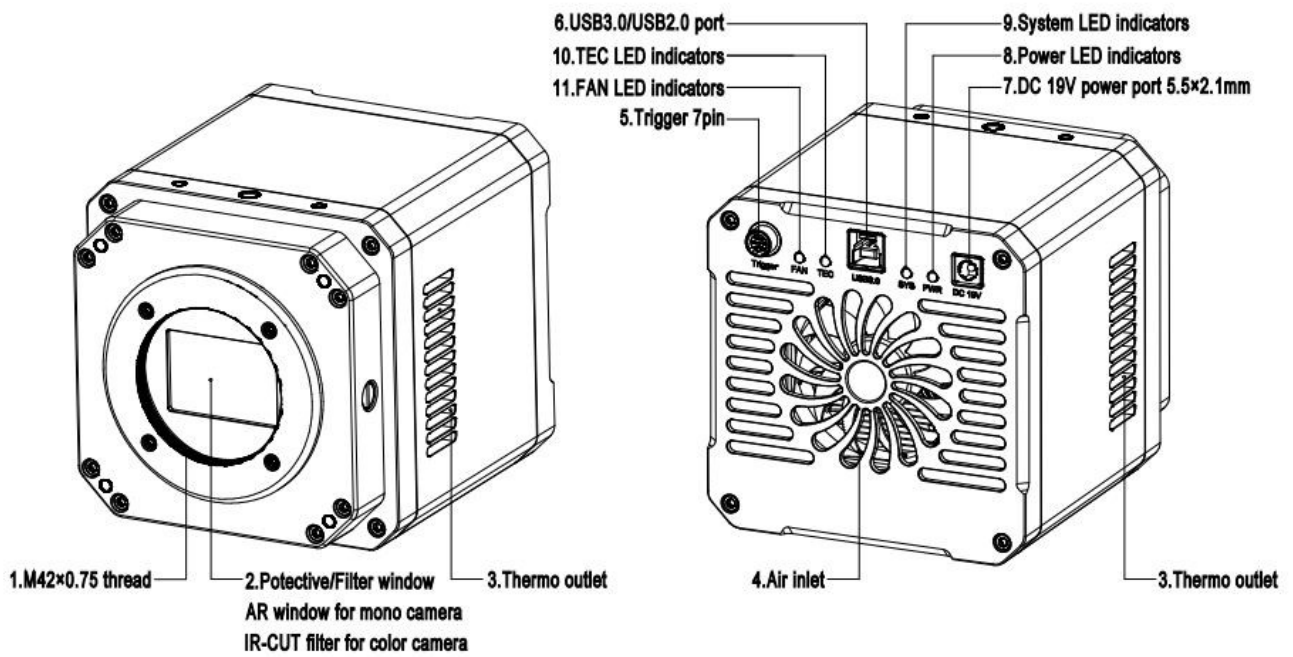


Figure 5 Camera Design and interface

Sequence	Specification
1	C mount
2	Filter window,AR window for mono camera
3	Thermo outlet
4	Air inlet
5	Trigger 7PIN
6	USB 3.0/ USB 2.0 port
7	DC 19V power port, 5.5 × 2.1mm
8	Power LED indicators
9	System LED indicators
10	TEC LED indicators
11	FAN LED indicators

Table 6 Camera Interface

3.3 Packing List



Figure 6 packing information

Standard Packing		
A	Packing case specifications L:50cm W:30cm H:30cm (20pcs, 12~17Kg/ carton) , Not shown in the figure	
B	3-A instrument safety box: L:28cm W:23.0cm H:15.5cm (1pcs, 2.8Kg/box) ; Packing size : L:28.2cm W:25.2cm H:16.7cm	
C	Maxcam2020e-TE	
D	Power adapter : input: AC 100~240V 50Hz/60Hz,output: DC 19V 4A	
E	High-speed USB3.0 A male to B male gold-plated head data cable/1.5m	
F	I/O cable	
G	CD (Driver and application software, Ø12cm) OPTIONAL	
Optional accessories		
H	Micrometer	106011/TS-M1(X=0.01mm/100Div.) 106012/TS-M2(X,Y=0.01mm/100Div.) 106013/TS-M7(X=0.01mm/100Div., 0.10mm/100Div.)

Table 7 packing list

4 External IO connector and electrical characteristics

4.1 Pin Signal

Rear appearance of the camera is shown in Figure 7, and the pin signals definition of the external IO connector are in Table 8.



Figure 7 packing information

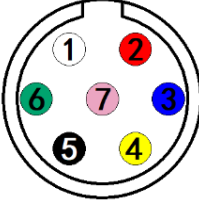
	Color	Pin	Signal	Description of the signal
	White	1	GDN	Direct-coupled signal ground
	Red	2	19V	19VDC power input
	Blue	3	OPTO_GND	Opto-isolated signal ground
	Yellow	4	DIR_GPIO1	Direct-coupled General Purpose I/O (Software configurable input/output) (line2)
	Black	5	DIR_GPIO2	Direct-coupled General 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)

Table 8 pin signal definition

4.2 I/O Electrical Characteristics

4.2.1 Opto-isolated input circuit (line0)

In the I/O control of the camera, the Opto-isolated input circuit is shown in Figure 8.

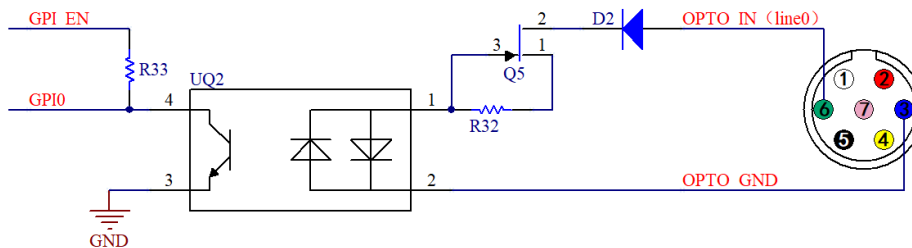


Figure 8 Opto-isolated input circuit

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

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

Maximum input current: 30mA

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

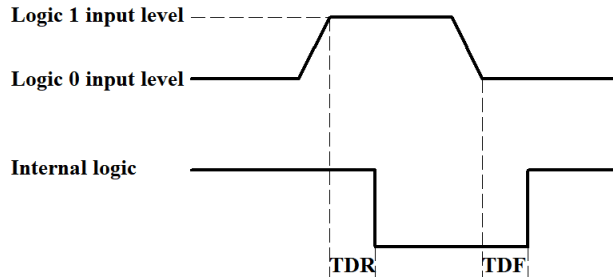


Figure 9 Input logic levels

Input Rise Delay (TDR): 6us

Input Fall Delay (TDF): 6us

4.2.2 Opto-isolated output circuit (line1)

In the camera I/O control, the opto-isolated output circuit is shown in Figure 10.

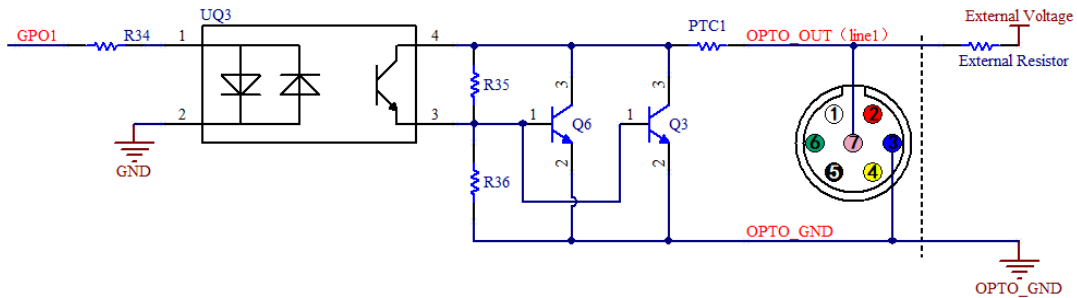


Figure 10 Optocoupler output circuit

The opto-isolated output maximum current is 30mA.

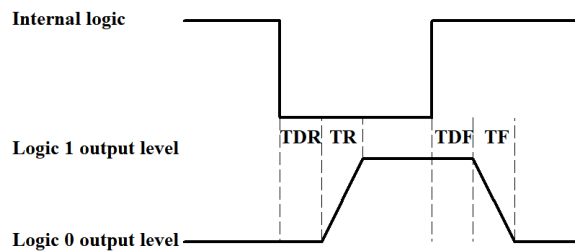


Figure 11 Output logic levels

The electrical characteristics of the opto-isolated output (external voltage 5V, external resistor 1K) are shown in Table 9.

parameter name	parameter notation	parameter value
output logic low	VL	742mV
output logic high	VH	4.134V
Output rise time	TR	4us

output fall time	TF	1.8us
Output rise delay	TDR	12us
Output fall delay	TDF	2us

Table 9 Opto-isolated output signal's electrical characteristics

The parameters of the corresponding current and output logic low level when different voltages and resistors are used in external circuit are shown in Table 10.

external voltage	External resistor	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

Table 10 Opto-isolated output logic's low level parameters

4.2.3 Input and output I/O circuit (line 2/line3)

The non-isolated configurable input and output I/O circuits are shown in Figure 12 and Figure 13.

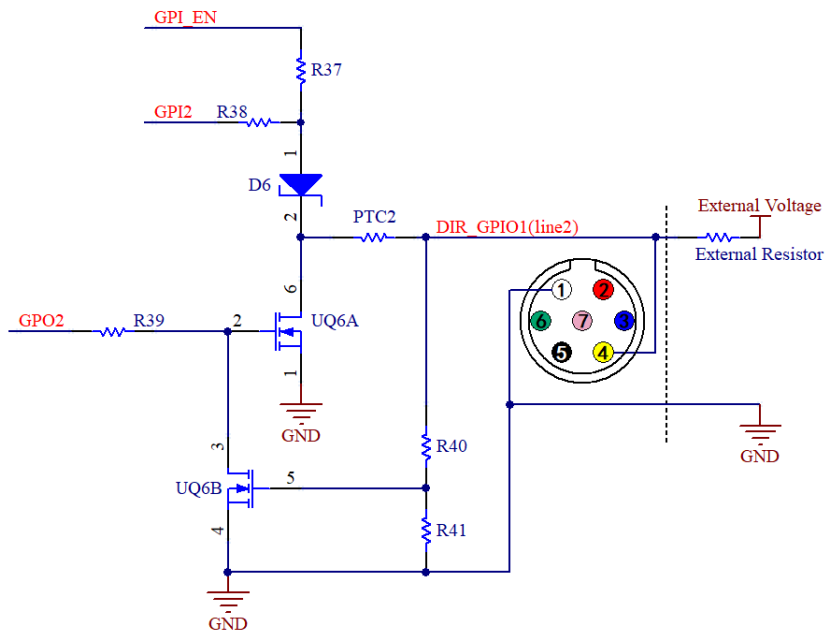


Figure 12 Non-isolated configurable input and output I/O circuit (line2)

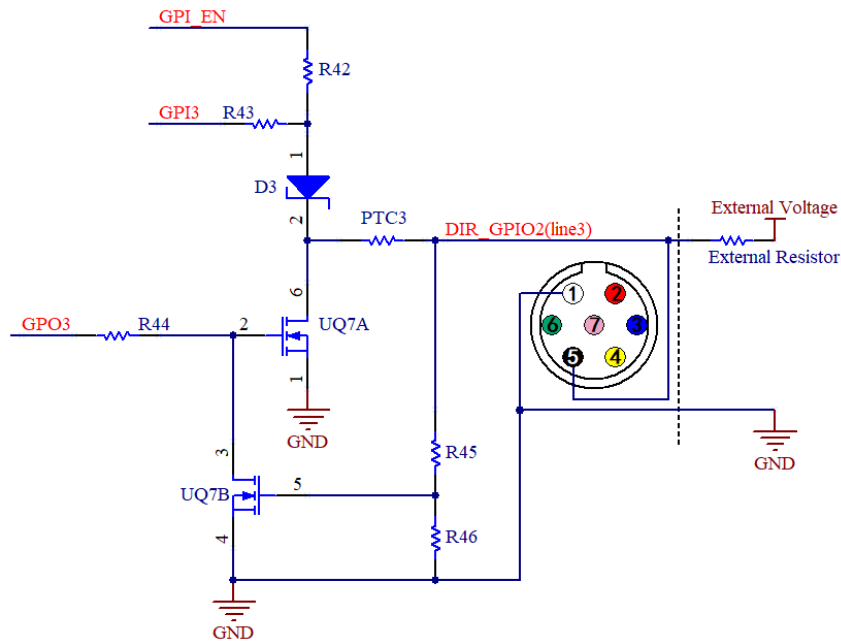


Figure 13 Non-isolated configurable input and output I/O circuit (line3)

1. Line2/line3 is set as input pin

Logic 0 input level: 0~0.6VDC (DIR_GPIO1/DIR_GPIO2 pins)

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

Maximum input current: 25mA

When 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.

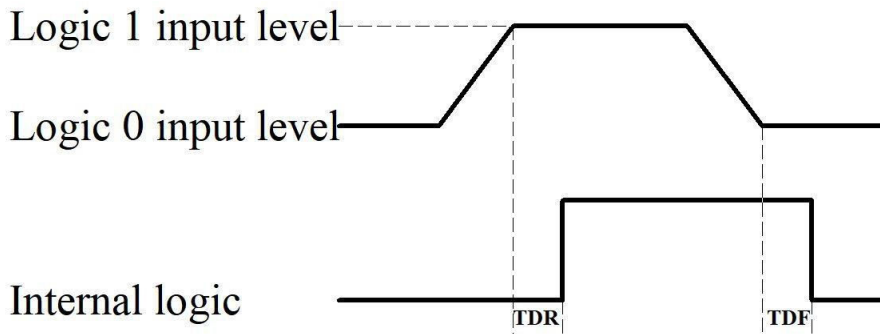


Figure 14 Input logic levels

To prevent damage to the GPIO pins, please connect the pin GND first, and then input voltage to the Line2 pin.

Input Rise Delay (TDR): 0.02us

Input Fall Delay (TDF): 0.02us

2. Line2/line3 are set as output pins

The maximum current allowed through this pin is 25mA.

When the ambient temperature is 25 degrees Celsius, the relationship between the external voltage, resistance and output low level is shown in Table 11.

external voltage	External resistor	VL (GPIO)
3.3V	1K Ω	0.11V
5V	1K Ω	0.167V
12V	2.4K Ω	0.184V
24V	4.7K Ω	0.385V

Table 11 Non-isolated output Logic's low level parameters

The external pull-up voltage is 5V, the pull-up resistor is 1K Ω , and the GPIO is configured to output the logic level and electrical characteristics as shown in Figure 15.

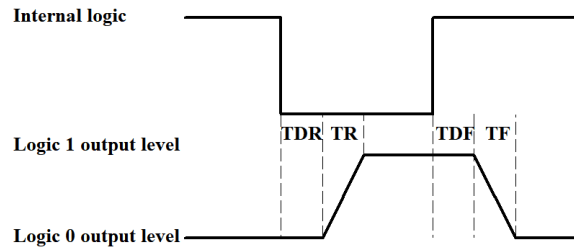


Figure 15 Output logic levels

parameter name	parameter notation	parameter value
Output rise time	TR	0.08us
output fall time	TF	0.02us
Output rise delay	TDR	0.1us
Output fall delay	TDF	0.04us

Table 12 Non-isolated output electrical characteristics

5 Trigger function

After the camera enters the trigger mode, it automatically enters the wait-for-trigger state. After receiving a trigger signal, the camera starts exposure, and starts to output image data after exposure.

5.1 Trigger signal source selection

In trigger mode, the type of trigger signal source can be the trigger signal given by the software, or it can be connected by an external level signal. The external trigger signal can be input through the pin isolated by the optocoupler, or it can be input through the non-isolated tube pin input.

Soft trigger delay is ms level, generally not more than 5ms; external trigger delay is generally us level.

5.1.1 Software trigger

The camera supports software trigger mode. When a software trigger is executed, the client software will send the command through USB3.0 to activate the camera to acquire and transmit images.

Figure 16, in EHDView, first click "Trigger Mode" in the "Capture and Resolution" column to enter the trigger, and then click "Software" to select software as the trigger source. "Single" and "Cyclic" are only supported in soft trigger mode.

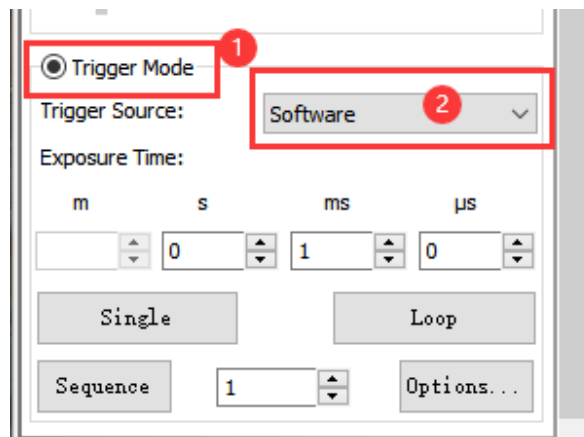


Figure 16 Soft trigger settings

5.1.2 External hardware trigger

The camera provides an opto-isolated input line Opt_in and two non-isolated GPIO input ports on the hardware, and the user can select the corresponding line as the trigger source.

Figure 17, first click "Trigger Mode" in EHDView to enter the trigger, select a trigger source at "Trigger Source", and then generate a high pulse on the corresponding line to trigger.

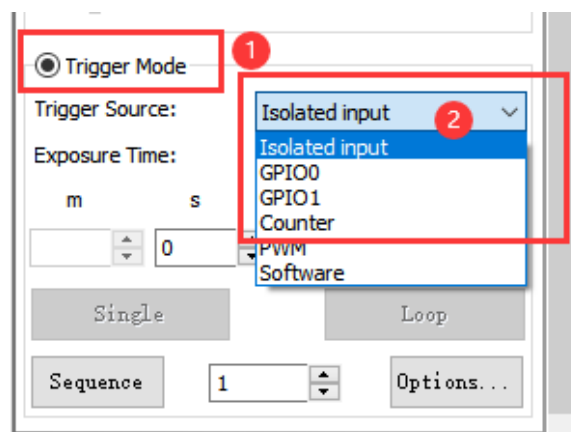


Figure 17 External trigger settings

5.2 Trigger acquisition mode

In the trigger mode, the acquisition mode is divided into: single-frame trigger, multi-frame trigger, counter trigger mode.

5.2.1 Single frame trigger mode

The single-frame trigger mode refers to the operation mode in which the camera receives one trigger signal, exposes once, and outputs one frame of image.

5.2.2 Multi-frame trigger mode

Multi-frame trigger mode refers to the operation mode in which the camera receives a trigger signal and outputs multiple frames of images.

Trigger number can be set in the range of 1~ 65535. “Burst Count = 1” means a one-frame image output, Figure 18, “Burst Count = 3” means a three-frame image output. The settings in EHDView are shown in Figure 19 .

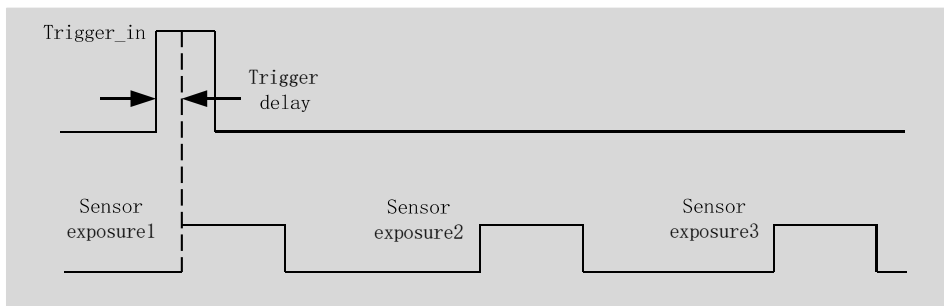


Figure 18 Multi-frame trigger timing

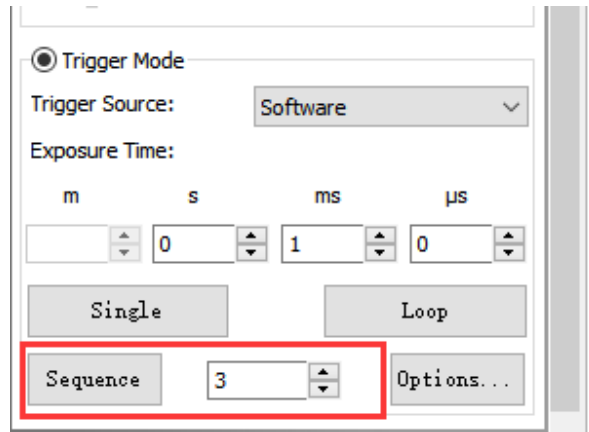


Figure 19 Multiple settings

5.2.3 Counter trigger mode

The counter trigger mode refers to the operation mode in which the camera can divide the frequency of the external input trigger signal through the preset counter and perform image acquisition according to the customer's logic. For example, when the counter is set to 3, the camera needs to receive 3 trigger signals to trigger once, and the timing is shown in Figure 20.

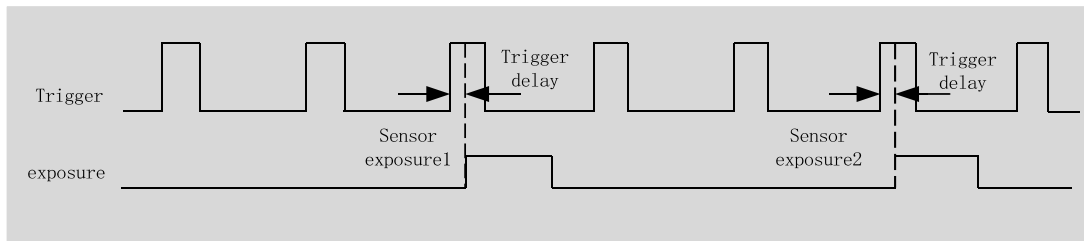


Figure 20 Counter Mode Timing

The specific operation steps in EHDview are shown in Figure 21. First, select the trigger source as " Counter Frequency Dividing Mode " under " Trigger Source " , then click " Options " , and in the pop-up interface, click " IO Control", Select the external trigger source that needs frequency division at " Counter Mode Signal Source " , and configure the frequency division coefficient in " Counter Value " , the range is 1~1023. " Counter reset " can clear the current divided counter.

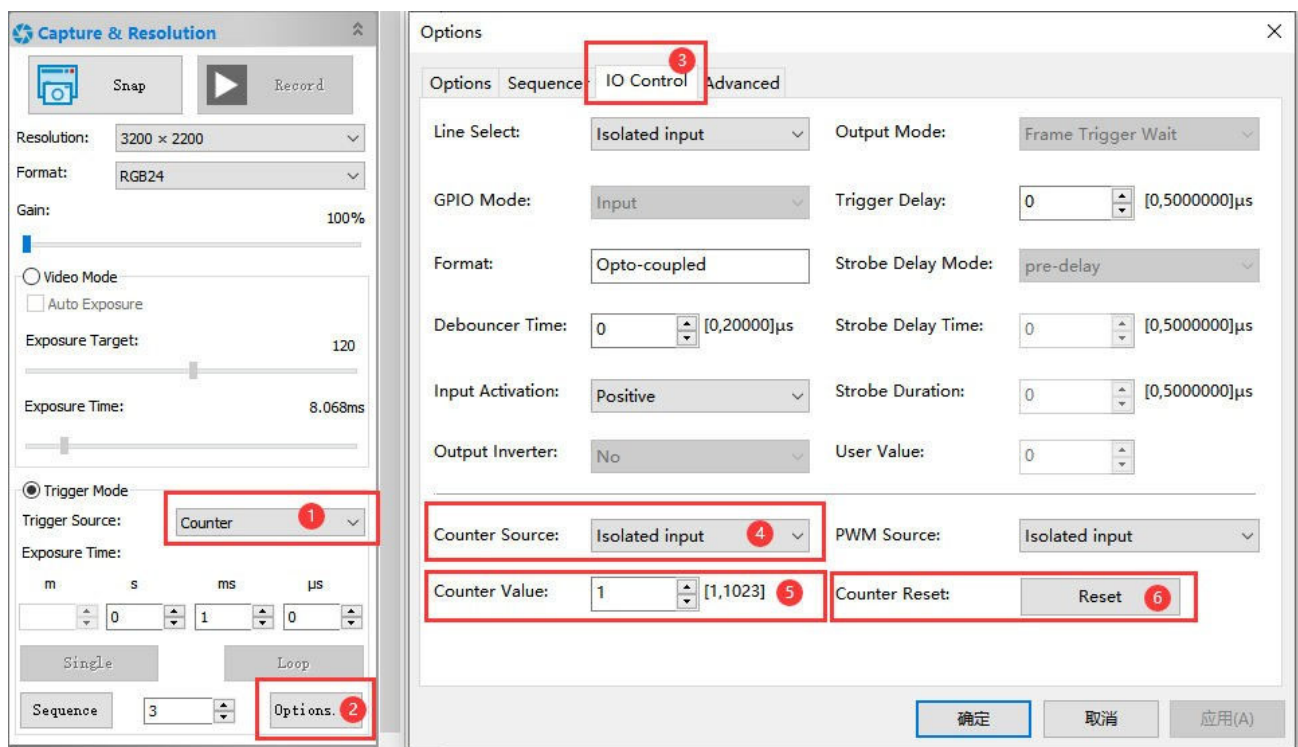


Figure 21 Counter frequency division mode setting

5.3 General Purpose I/O configuration

Figure 22, in EHDView , enter the "IO Config" dialog , you can select " GPIO 0 /GPIO1" in the " Line Selection " , and then click the "GPIO Mode" to configure the input or output.

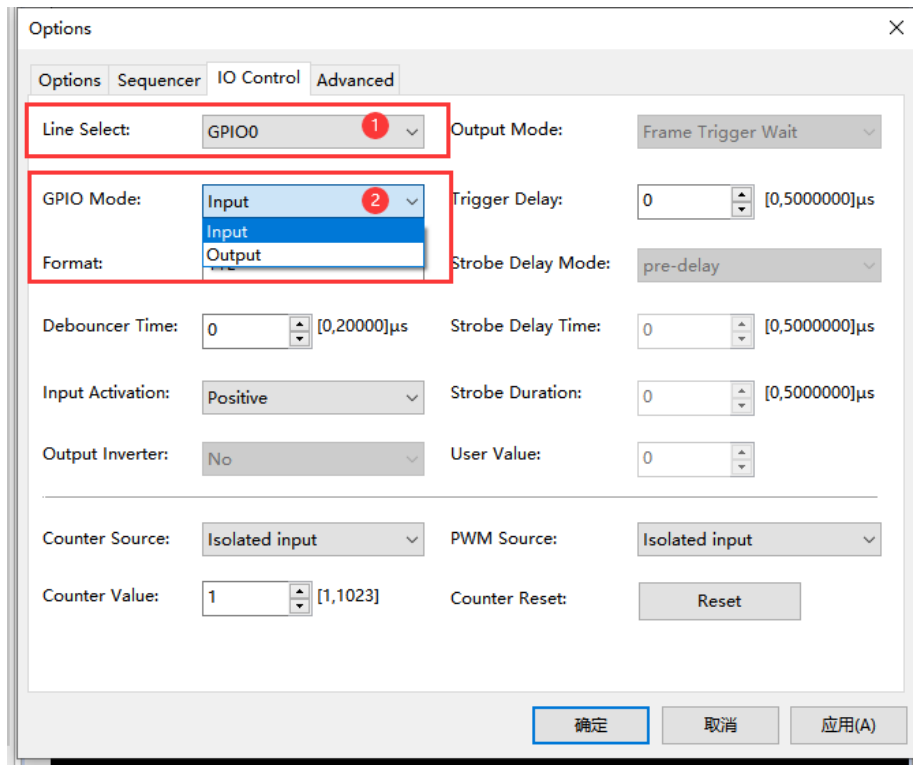


Figure 22 GPIO configuration

5.4 I/O signal configuration

Configurable parameters of input signal: input signal trigger edge, debounce time, trigger delay.

Configurable parameters of the output signal: output inversion.

5.4.1 Trigger edge

Input signal trigger edge can be selected as rising edge or falling edge, as shown in Figure 23. The trigger edge timing diagram is shown in Figure 24.

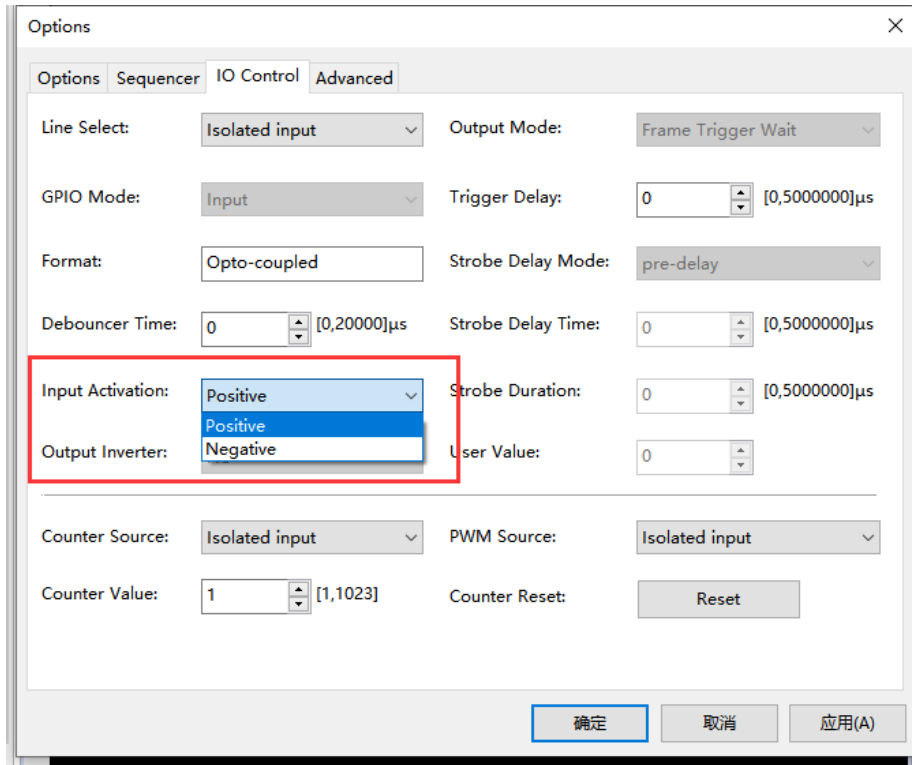


Figure 23 Input signal trigger edge

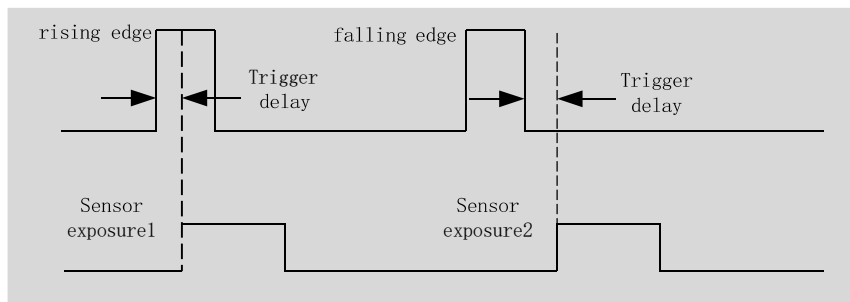


Figure 24 Trigger edge timing diagram

5.4.2 Debouncer time

Since there may be burr in the external trigger input signal of the camera, if it directly enters the internal logic 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. The timing is shown in Figure 25. If the effective pulse width of Trigger_in1 is less than the debouncer time, the trigger signal will be ignored.

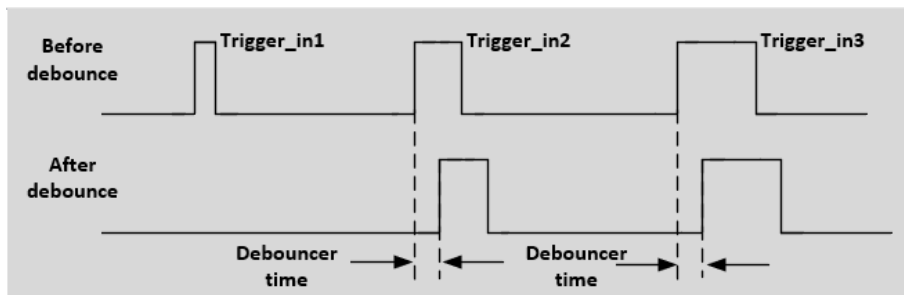


Figure 25 Signal debounce timing

Figure 26, in EHDView, enter "IO After the Control " interface, click " Line Selection " to select the input line, and then set the debounce time value at " Debounce Time " , the range is 0-20000, and the unit is microseconds.

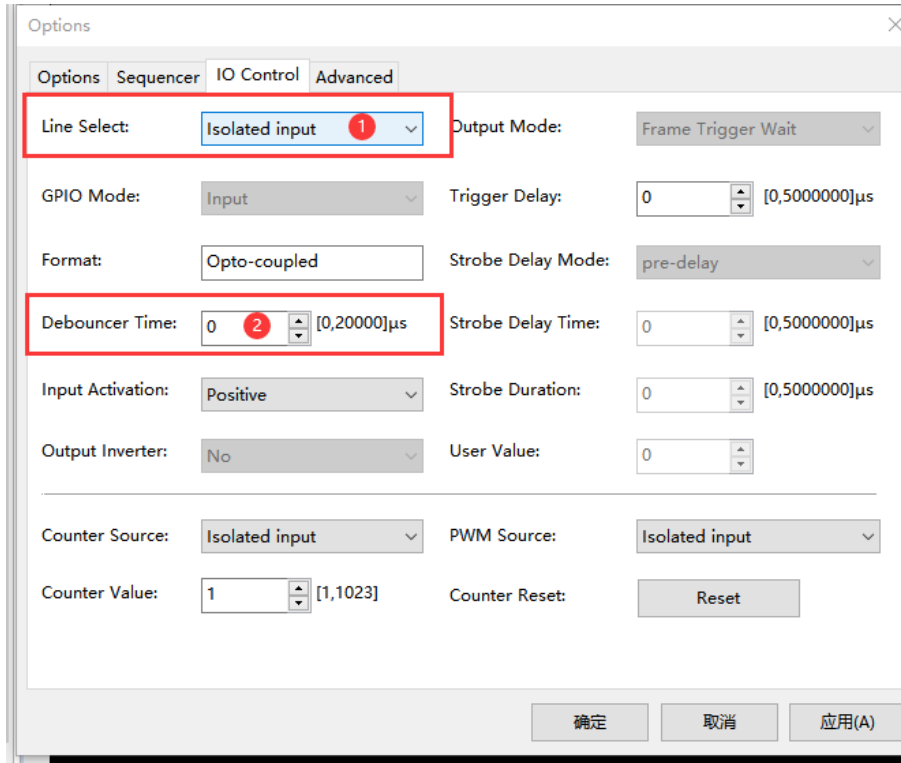


Figure 26 Setting the debounce time

5.4.3 Trigger delay

The trigger delay time (unit us) can also be set in the input signal, as shown in Figure 27. If the delay time is set to 1000000 (1s), the camera will wait for 1s to capture the image after receiving the trigger signal.

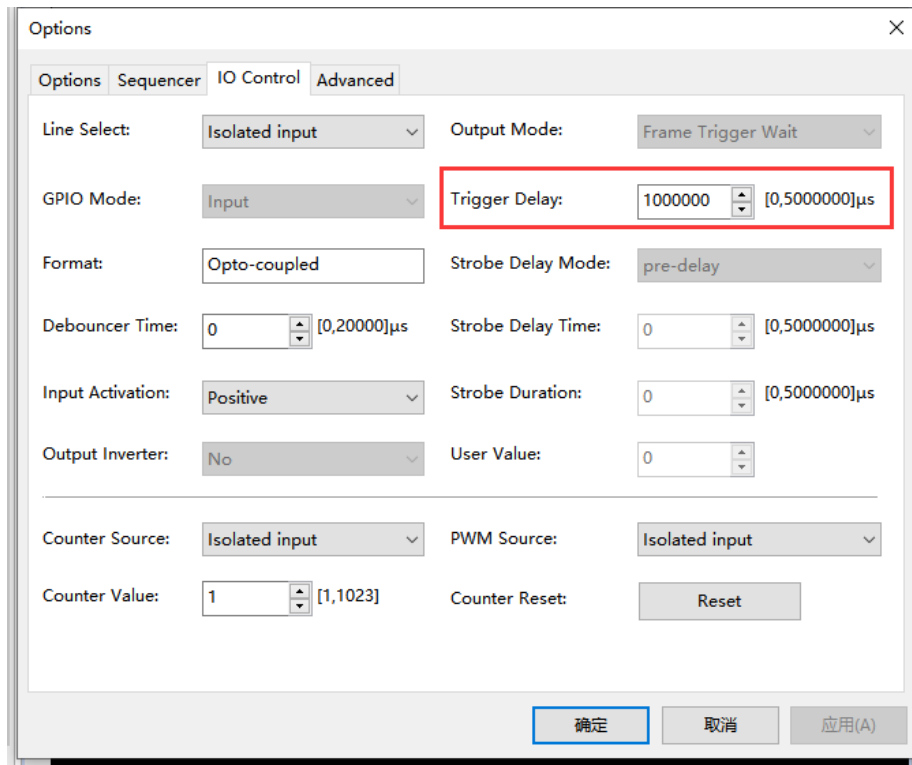


Figure 27 Trigger Delay Time

5.4.4 Output inverted

Figure 28, first select the output line in " Line Selection ", then select the mode of the output signal in " Output Mode ", and click " Output Invert " to invert the output signal.

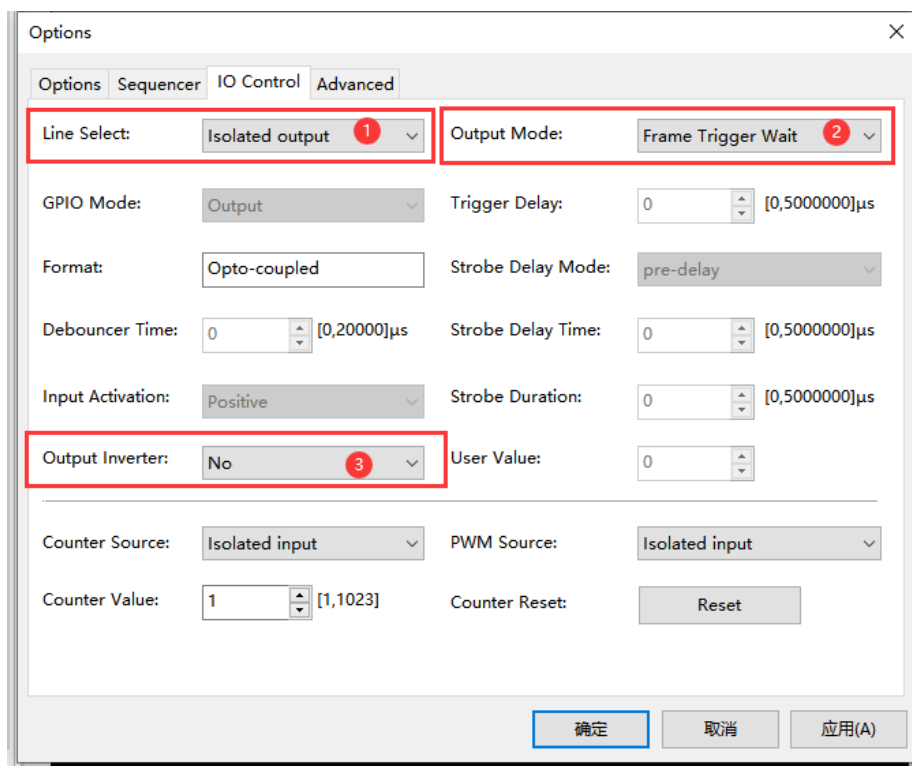


Figure 28 Output Inverting

5.5 Output mode

The camera provides 4 output modes: Frame Trigger Wait, Exposure Active, Strobe and User Output.

5.5.1 Strobe

Strobe can be used to control external devices such as flash, and the effective level duration, delay time and pre-delay time of the flash signal can be set.

Figure 29, in democpp's "IO Config" interface, select the output line mode as flash signal, click "Flash Signal Delay Mode" to select the "delay" or "pre-delay", and set the delay time in "Flash Signal Delay Time", and "Flash Pulse Width" can set the flash signal active level duration.

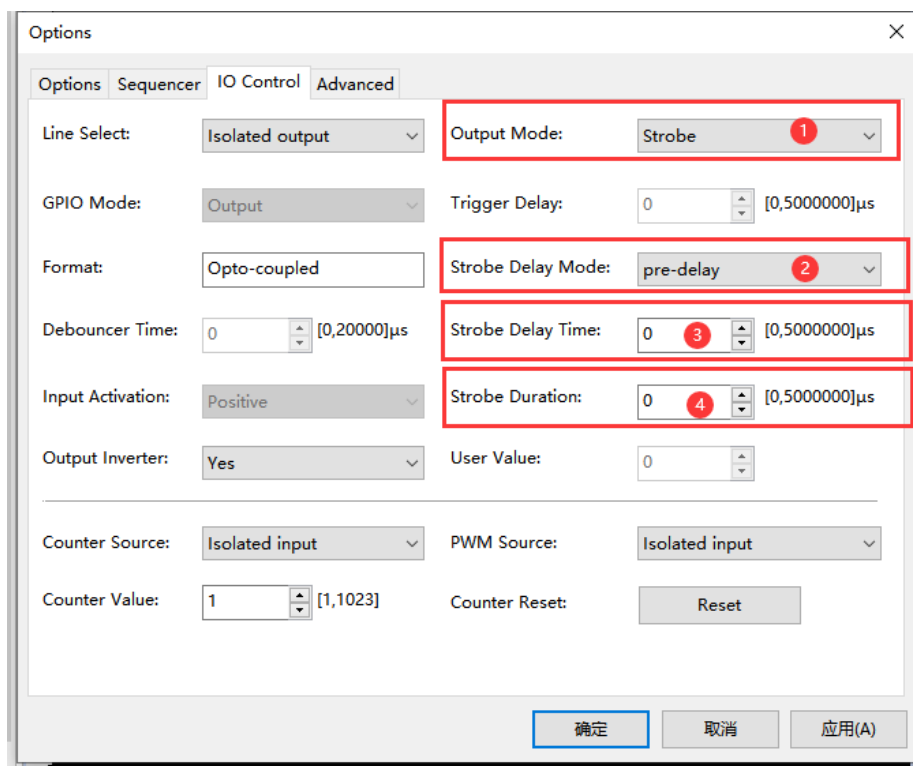


Figure 29 Flash signal setup

- Flash signal valid level duration

Figure 30, the flash signal is valid at high level, the camera outputs the flash signal immediately when exposure starts, and the high level duration of the flash signal is determined by the " flash pulse width " value: when the " flash pulse width " value is 0 When the flash signal high level duration is equal to the exposure time; if the " flash pulse width " value is not 0, the flash signal high level duration is equal to the " flash pulse width " value.

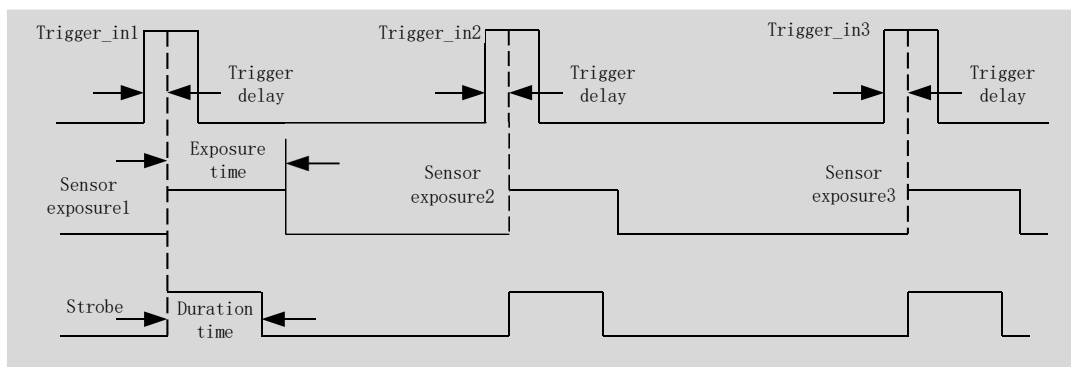


Figure 30 Flash signal valid level duration

- Strobe output delay

The camera provides the feature of output delaying the strobe signal to meet the user's special usage. When the exposure starts, the strobe signal output does not take effect immediately, and the output is delayed according to the value set by " Strobe Delay Time " . As shown in Figure 31.

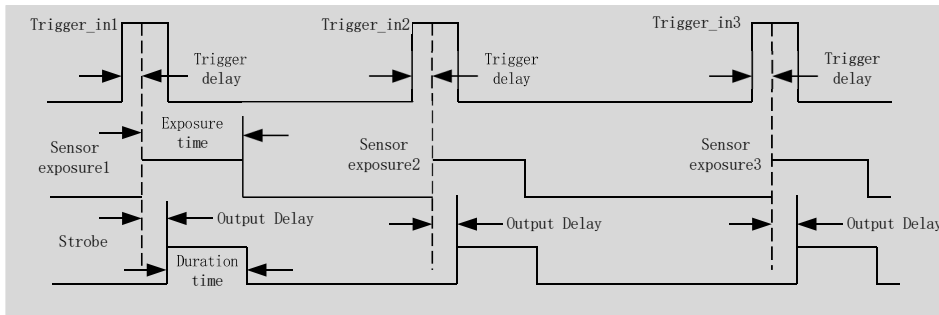


Figure 31 Flash output delay

- Strobe pre-output

The camera also provides a pre-output feature for the strobe signal, that is, the strobe signal takes effect earlier than the exposure start time. This feature can be applied to flash lamps with slow response. The pre-output time is set by " Strobe Delay Time ". The timing is shown in Figure 32.

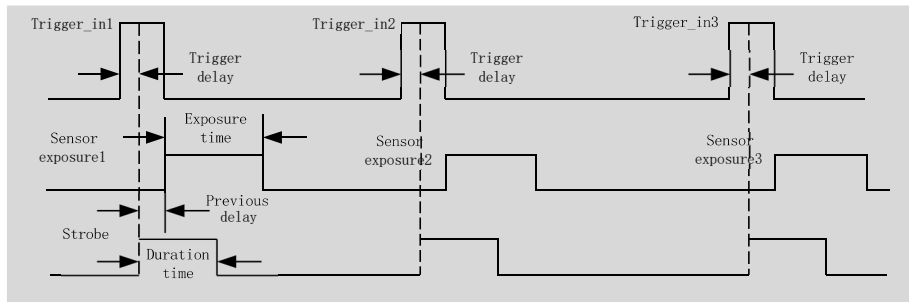


Figure 32 Flash pre-output

5.5.2 Exposure Active

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 being exposed. The timing diagram of the exposure valid signal is shown in Figure 33.

When the relative position of the camera and the object to be photographed changes, you can refer to this signal to prevent the captured image from being affected by movement and focus adjustment during the exposure process.

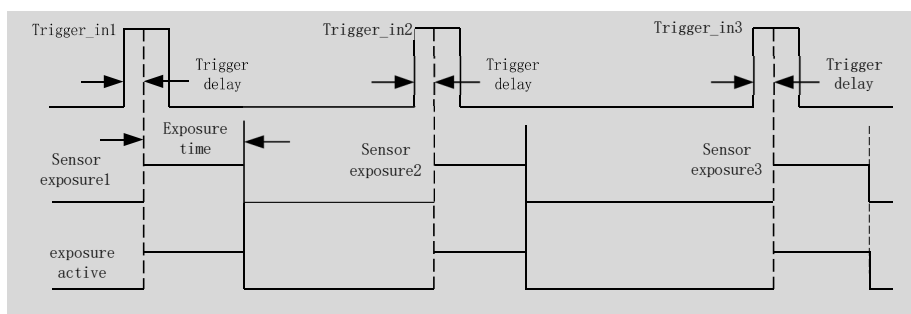


Figure 33 Exposure effective signal

5.5.3 Frame Trigger Wait

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 inputted by the user should be in the valid period of the signal. 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, shown in Figure 34.

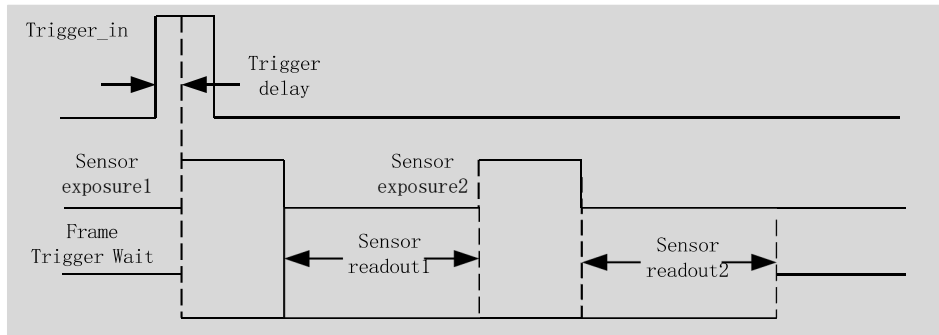


Figure 34 Trigger wait signal timing

5.5.4 User Output

When the output mode is selected as "User Output", the user can input a value at "User Value" to control the corresponding line output 0 or 1. The value here is only valid for the lower three bits of binary. For example, when line 1 and line3 are set to "user output mode", and "User Value" is set to 4 ('b100), then line3 outputs 1, and line1 outputs 0, as shown in Figure 35. The settings in EHDView are shown in Figure 36.

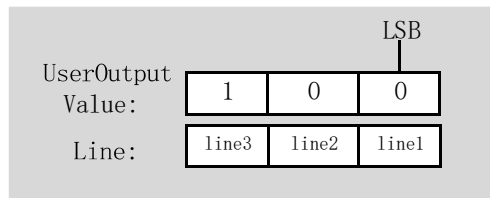


Figure 35 Schematic diagram of user-defined output

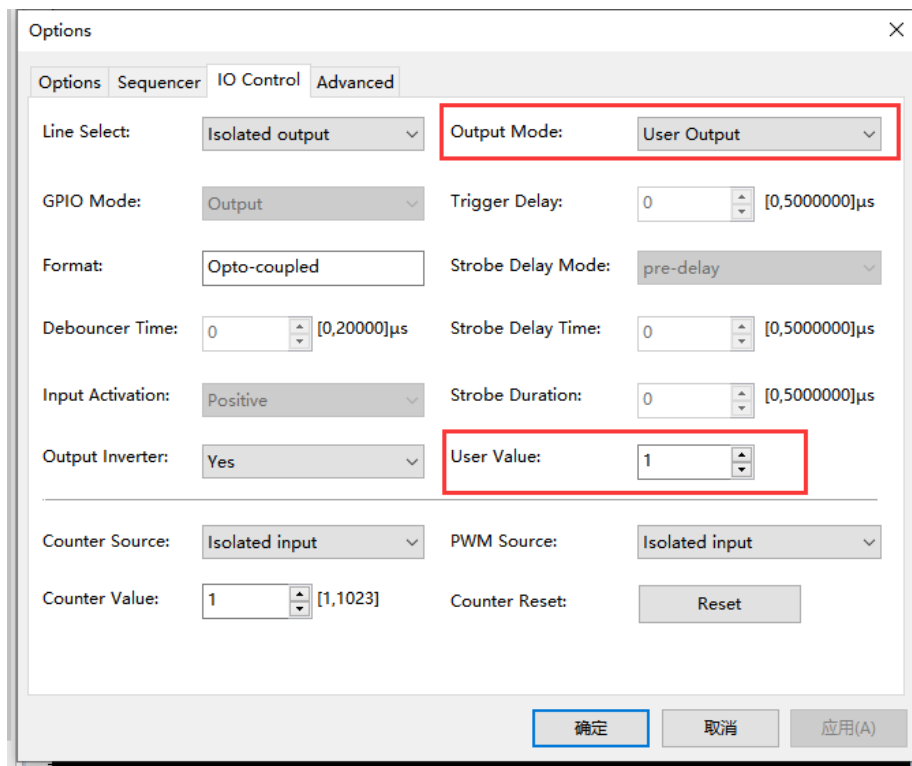


Figure 36 User output signal settings

5.6 Advanced trigger function

5.6.1 Plan trigger

Plan trigger only supports "soft trigger" as the trigger source. After entering trigger mode, click "Options", click "Sequence" in the pop-up interface to enter the sequence interface, select "Plan" in "Mode", and set the number of plans (the range is 0-255). As shown in Figure 37, the number is set to 5, and then the 5 groups of planned exposure time and gain are set to user-defined values. If a delay of 5s is set for the first group of sequences, after the trigger signal is given, the delay will be 5s. Expose.

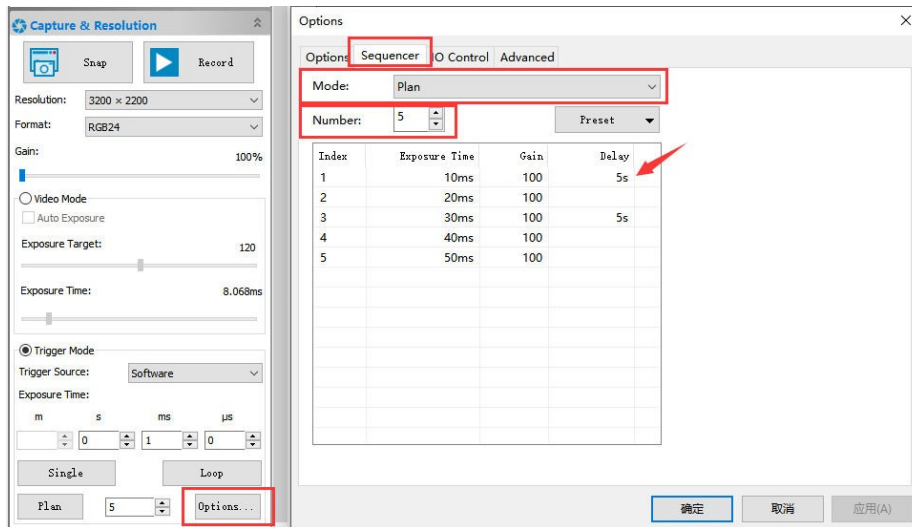


Figure 37 Schedule Trigger Settings

After setting the plan trigger parameters, the original "multiple pictures" will automatically become "plan". After clicking "plan", the camera will start to trigger the acquisition of the set number of pictures according to the set exposure time, gain and delay time. image, as shown in Figure 38 .

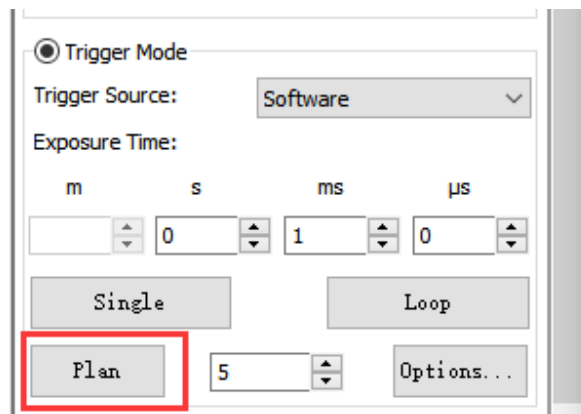


Figure 38 Scheduled trigger

5.6.2 Sequence trigger

The sequence trigger supports "soft trigger" and "external trigger". After entering the trigger mode, click "Option" and click "Sequence" in the pop-up interface to enter the sequence interface, select "Sequence" in "Mode", and set the number of sequences (range 0-255). As shown in Figure 39, if the number is set to 5, there are 5 groups of sequences, and then the exposure time and gain of the 5 groups of sequences are respectively customized. The set sequence parameters can be saved and loaded. After a trigger signal is given, the camera will perform exposure sequentially according to the set 5 exposure time values and gain values.

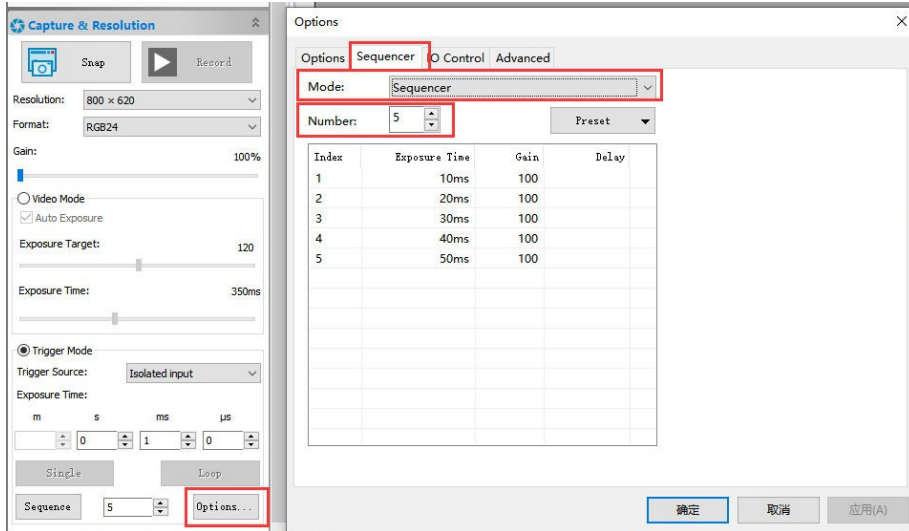


Figure 39 Sequence trigger setup

5.6.3 Always enable software triggering

After entering the trigger mode, click "Options" and click "Advanced" in the pop-up interface to enter the advanced interface, as shown in Figure 40, after checking "Always enable software triggering", you can use "Software" and "External IO signal " at the same time. "

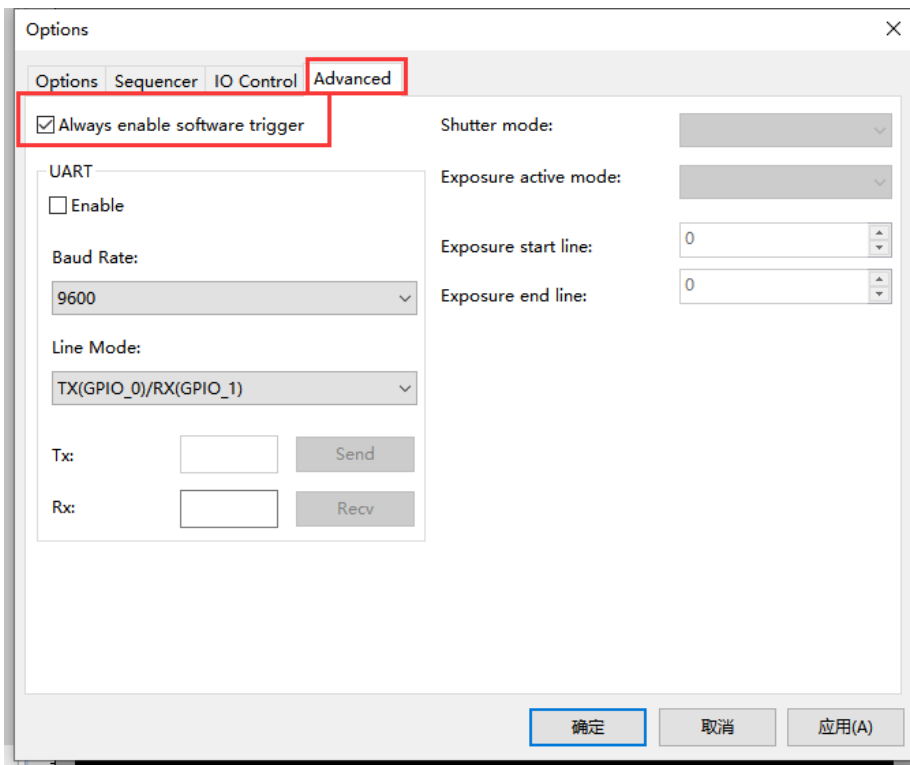


Figure 40 Advanced Triggering

5.6.4 UART function

There is a serial port function in the advanced interface, which can communicate with external devices via serial port. Check "Enable" to enable this function. As shown in Figure 41, when enabled, GPIO_0 and GPIO_1 will only be used as UART transfers. The baud rate supports 9 600-115200 . "Cable Select" can configure GPIO_0 and GPIO_1,

which can be configured as TX or RX respectively. Set a value at "TX", click send to send the set value; click accept at "RX" to receive the value from the external device.

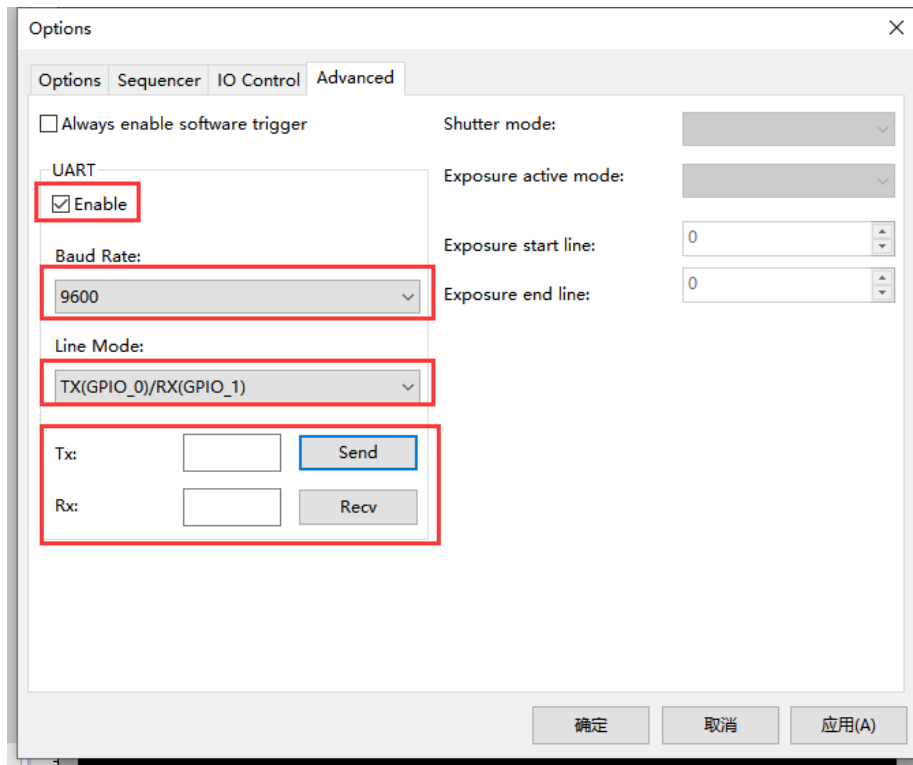


Figure 41 UART settings

6 Refrigeration and heating

6.1 Refrigeration

There is a cooling function module on the left sidebar of EHDView. To enable the cooling function, an external 19V power supply is required. By default, the TEC is turned on. You can set the target temperature. After entering the value, click "Apply", and the sensor temperature will gradually approach the target temperature. At the same time, the camera can display the current temperature in real time. power, the cooling effect can reach about 35 degrees lower than the ambient temperature ,as shown in Figure 42 .

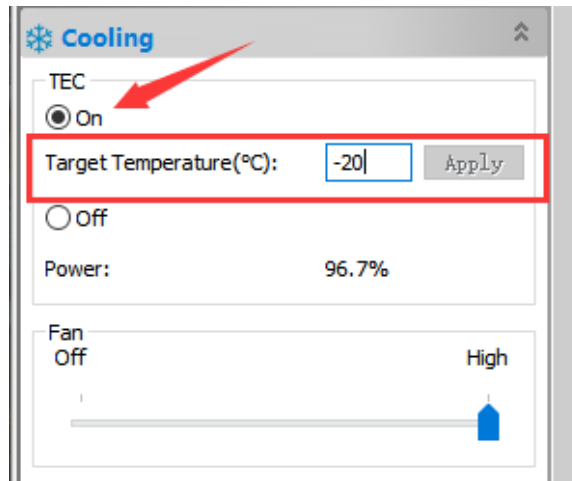


Figure 42 TEC setup

The fan has five gears from off to high. When high, the fan speed reaches the highest. When off, the fan is turned off, and the TEC is also turned off, and the power is 0, as shown in Figure 43.

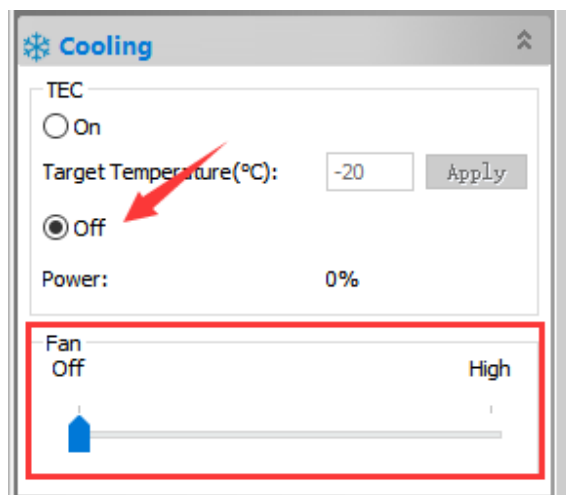


Figure 43 Fan Settings

When the TEC is turned on, the fan will automatically turn on; when the fan is turned off, the TEC will automatically turn off. Prevent the abnormal situation that the case temperature is too high if the fan stops running when the TEC is working.

6.2 Heating

In the left sidebar of EHDView, there is a heating function designed for the common low-temperature fogging phenomenon on the sensor surface to ensure that the sensor surface will not fogging at low temperature . There are also five gear positions from close to high,as shown in Figure 44.



Figure 44 Heating

7 Application

7.1 Application installation

In terms of software, customers are welcome to visit our software website : <https://www.ehd.de> to download the latest EHDView. Maxcam2020e-TE can also be used with ASCOM , DirectShow SDK . If the third-party software is compatible with these SDKs, customers can also download software drivers from our website and install them into the third-party software.

7.2 Introduction to EHDView

EHDView is a professional software that integrates camera control, image acquisition and processing, image browsing and analysis functions. EHDView 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 Maxcam cameras

7.2.1 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

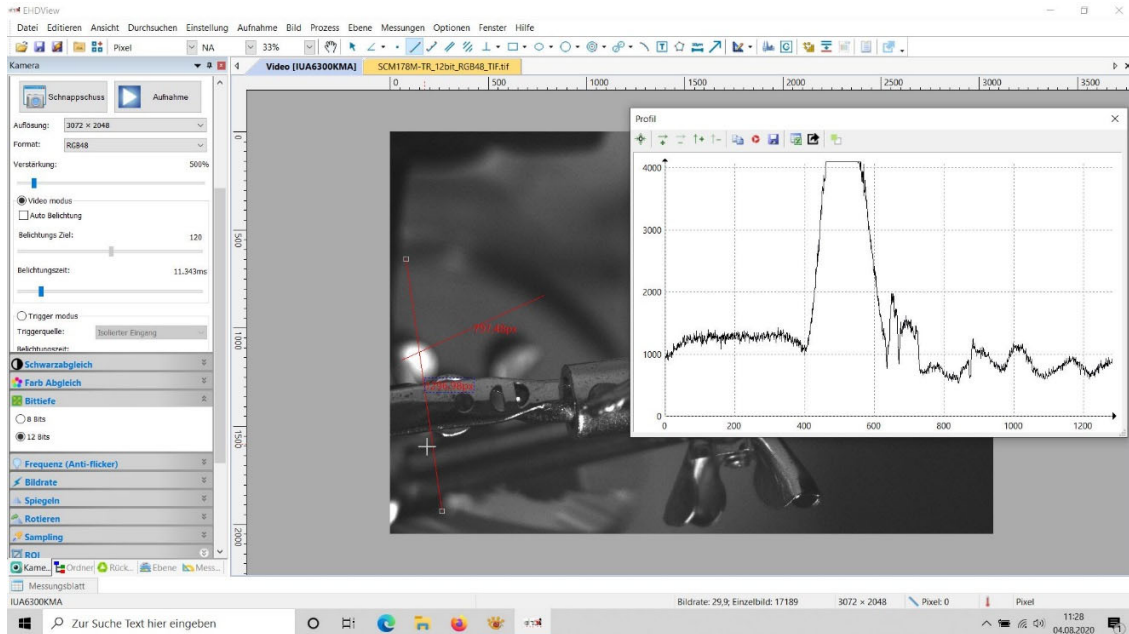


Figure 45 EHDView Video Window

7.2.2 Professional camera control panel

capture and resolution	Set up live and still capture, snap images, or record video
Exposure and 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
refrigeration	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.)

7.2.3 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 EHDView 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
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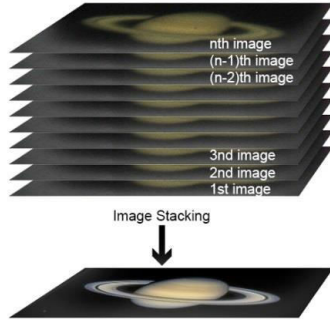


Figure 46 Image overlay denoising

7.2.4 Super Compatibility

camera video interface	Provide Twain, DirectShow, Labview, SDK installation package (native C++, C#)
Supported operating systems	Compatible with Microsoft® Windows® XP / Vista / 7 / 8 /10 (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

7.2.5 Basic hardware requirements

PC basic configuration requirements	CPU: Intel Core 2 2.8GHz or higher
	RAM: 2GB or more
	USB Interface: USB3.0 / USB 2.0 interface
	Monitor: 17" or higher
	CD-ROM

8 Software Development Instructions

8.1 SDK description

The download link of the SDK is as follows:

<https://www.ehd.de/products/driver/driver.htm>

8.1.1 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.

8.1.2 Introduction to SDK Content

MaxCam 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 :
 - nncam.h, the C/C++ header file.
- win: Microsoft Windows platform file
- ◆ dotnet:
 - nncam.cs, supports C#. nncam.cs uses P/Invoke to call nncam.dll. Please copy nncam.cs to your C# project for use.
 - nncam.vb, supports VB.NET . nncam.vb uses P/Invoke to call nncam.dll. Please copy nncam.vb to your VB.NET project for use.
- ◆ x86:
 - nncam.lib, x86 lib file.
 - nncam.dll, x86 dynamic library file.
 - democpp.exe, x86 C++ demo execute the procedure.

-
- x64:
ccam.lib, x64 lib file.
nncam.dll, x64 dynamic library file.
democpp.exe, x64 C++ demo execute the procedure.

- arm:
nncam.lib, arm lib file.
nncam.dll, arm dynamic library file.

- arm64:
nncam.lib, arm64 lib file.
nncam.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 nncam.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) demouwpc.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 nncam.cat, nncam.inf and nncam.sys. The x64 folder contains the x64 kernel-mode driver files, including nncam.cat, nncam.inf and nncam.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 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-nncam.rules , udev rule file .
Please refer to : http://reactivated.net/writing_udev_rules.html .
- c# : nncam.cs , Support. Net Core C# . nncam.cs uses P/Invoke to call libnncam.so . Please copy nncam.cs to your C# project for use .
- x86 : libnncam.so , x86 version so file .
- x64 : libnncam.so , x64 version so file .
- armel : libnncam.so , armel version so file , toolchain is arm-linux-gnueabi .
- armhf : libnncam.so , armhf version so file , toolchain is arm-linux-gnueabihf .
- arm64 : libnncam.so , arm64 version so file , toolchain is aarch64-linux-gnu .
- android : libnncam.so for four architectures of Android platform arm , arm64 , x86 , x64 .
- mac : macOS platform files.
- python : nncam.py and example code .
- java : nncam.java and example code (console and Swing).
- doc : SDK usage documentation , Simplified Chinese , English.
- sample :
- demosimplest , the simplest example , is about 60 lines of code.
- demoraw , RAW data and still shots , about 120 lines of code.

8.2 Third-party interfaces and software

- directshow : DirectShow SDK and demo program .
- twain : TWAIN SDK .
- labview : Labview SDK and demo program .
- matlab : MatLab demo program .
- Micromanager.

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