Area Scan Machine Vision USB 3.0 Camera

User Manual

UD01715B

User Manual

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About this Manual

This Manual is applicable to Machine Vision USB 3.0 Camera.

The Manual includes instructions for using and managing the product. Pictures, charts, images and all other information hereinafter are for description and explanation only. The information contained in the Manual is subject to change, without notice, due to firmware updates or other reasons. Please find the latest version in the company website (http://overseas.hikvision.com/en/).

Please use this user manual under the guidance of professionals.

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FCC Information

FCC compliance: This equipment has been tested and found to comply with the limits for a digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Conditions

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.

2. This device must accept any interference received, including interference that may cause undesired operation.

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This product and - if applicable - the supplied accessories too are marked with "CE" and comply therefore with the applicable harmonized European standards listed under the EMC Directive 2014/30/EC, the RoHS Directive 2011/65/EU.

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Safety Instruction

These instructions are intended to ensure that the user can use the product correctly to avoid danger or property loss.

The precaution measure is divided into 'Warnings' and 'Cautions':

Warnings: Serious injury or death may be caused if any of these warnings are neglected.

Cautions: Injury or equipment damage may be caused if any of these cautions are neglected.

	
Warnings Follow these safeguards to prevent serious injury or death.	**Cautions** Follow these precautions to prevent potential injury or material damage.

 Warnings:

- Please adopt the power adapter which can meet the safety extra low voltage (SELV) standard. And source with 12 VDC (depending on models) according to the IEC60950-1 and Limited Power Source standard.
- To reduce the risk of fire or electrical shock, do not expose this product to rain or moisture.
- This installation should be made by a qualified service person and should conform to all the local codes.
- Please install blackouts equipment into the power supply circuit for convenient supply interruption.
- Please make sure that the ceiling can support more than 50 (N) Newton gravities if the camera is fixed to the ceiling.
- If the product does not work properly, please contact your dealer or the nearest service center. Never attempt to disassemble the camera yourself. (We shall not assume any responsibility for problems caused by unauthorized repair or maintenance.)

 Cautions:

- Make sure the power supply voltage is correct before using the camera.
- Do not drop the camera or subject it to physical shock.
- Do not touch sensor modules with fingers. If cleaning is necessary, use a clean cloth with a bit of ethanol and wipe it gently. If the camera will not be used for an extended period of time, put on the lens cap to protect the sensor from dirt.
- Do not aim the camera lens at the strong light such as sun or incandescent lamp. The strong light can cause fatal damage to the camera.
- The sensor may be burned out by a laser beam, so when any laser equipment is being used, make sure that the surface of the sensor not be exposed to the laser beam.
- Do not place the camera in extremely hot, cold temperatures (the operating temperature should be between -0 ° C to 50 ° C), dusty or damp environment, and do not expose it to high electromagnetic radiation.
- To avoid heat accumulation, ensure there is good ventilation to the device.
- Keep the camera away from water and any liquids.
- While shipping, pack the camera in its original, or equivalent, packing materials. Or packing the same texture.

Table of Contents

Chapter 1 Overview

1.1 Introduction

The Machine Vision Camera is an image capturing device and capable of real-time transmission of uncompressed image through a USB 3.0 interface. Remote image capturing and camera control, for example, the operating mode and the image parameters adjustment, are supported by client software.

1.2 Main Features

- The USB 3.0 interface provides the 3 Gbps bandwidth.
- Supports AEC (automatic exposure control), LUT, Gamma Correction, etc..
- Use hardware external trigger or software trigger to synchronize several cameras or cameras with external devices.
- Supports image capturing with different exposure modes.
- The color camera adopts the color interpolation algorithm to reproduce colors faithfully. It also supports automatic white balance (AWB).
- Compatible with USB 3.0 Vision Protocol (V1.0) and third-party software.

The functions in this manual are for reference only and may differ from the devices.

1.3 Specifications

1.3.1 MV-CA013-20UM/UC Specification

Table 1-1 MV-CA013-20UM/UC Specification

Model / Parameter	MV-CA013-20UM	MV-CA013-20UC
	1.3 MP 1/2" CMOS Machine Vision USB 3.0 Camera	
Camera		
Sensor Type	1/2" global shutter CMOS	
Resolution	1280 × 1024	
Pixel Size	4.8 μm × 4.8μm	
Frame Rate	170 fps@1280 × 1024	90 fps@1280 × 1024
Dynamic Range	> 60 dB	
SNR	> 40 dB	
Gain	0 to 15 dB	
Exposure Time	6 μs to 10 sec	
Shutter Mode	Global shutter, supporting Auto, Manual, One-Push, etc. exposture modes.	
Data Interfac	USB 3.0	
Digital I/O	Opto-isolated input × 1 Opto-isolated output × 1 Bi-directional non-isolated I/O × 1	
Data Format	Mono 8/10/10p/12/12p	Mono 8/10/12, RGB8, Bayer BG 8/10/10p/12/12p, YUV 422 8, YUV 422 8 UYVY
General		
Power Supply and Consumption	< 3 W@12V DC or USB power supply, voltage 5 to 15V, USB 3.0 Power Supply	
Temprature	Working Temprature 0 °C to 50 °C, Storage Temprature -30 °C to 70 °C	

Dimension	29 mm ×29 mm ×30 mm
Weight	Approx.56 g
Lens Mount	C-Mount
Control Client	MVS or the third-party client software which supports USB 3.0 Vision protocol
OS	Windows XP/7/8 32/64bits
Compatibility	USB 3.0 Vision V1.0
Certifications	CE, FCC, and RoHS

1.3.2 MV-CA013-20UM/UC Response Curve

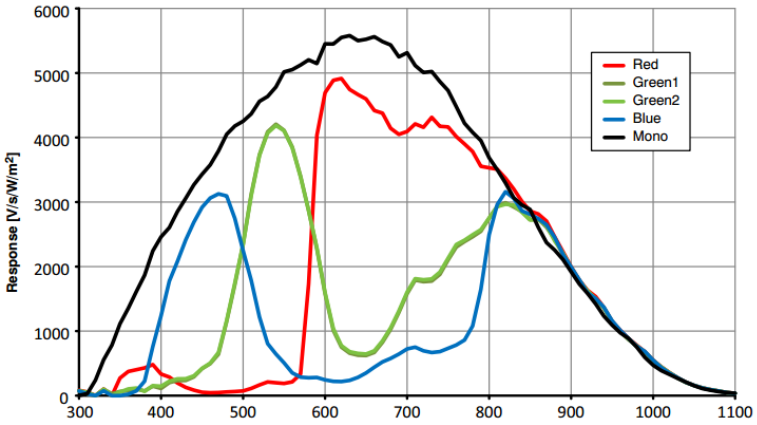

Figure 1-1 MV-CA013-20UM/UC Quantum Efficiency

NOTE

The response curve data is provided by the chip manufacture.

1.3.3 MV-CA050-20UM/UC Specification

Table 1-2 MV-CA050-20UM/UC Specification

Model / Parameter	MV-CA050-20UM	MV-CA050-20UC
	5 MP 1" CMOS Machine Vision USB 3.0 Camera	
Camera		
Sensor Type	1" global shutter CMOS	
Resolution	2592 ×2048	

Pixel Size	4.8 μm × 4.8 μm	
Frame Rate	60 fps @ 2592 × 2048	30 fps @ 2592 × 2048
Dynamic Range	> 60 dB	
SNR	> 40 dB	
Gain	0 to 15 dB	
Exposure Time	8 μs to 10 sec	
Shutter Mode	Global shutter, Auto-exposure, Manual exposure, and One-key exposure	
Data Interfac	USB 3.0	
Digital I/O	Opto-isolated input × 1 Opto-isolated output × 1 Bi-directional non-isolated I/O × 1	
Data Format	Mono 8/10/10p/12/12p	Mono 8/10/12, RGB8, Bayer BG 8/10/10p/12/12p, YUV 422 8, YUV 422 8 UYVY
General		
Power Supply and Consumption	< 3.5W@12V DC, Voltage 5 to15 V DC, USB 3.0 power supply	
Temprature	Working Temperature 0℃ to 50℃ (32° F to 122° F), Storage Temperature -30℃ to 70℃ (-22°F to 158°F)	
Dimension	29 mm × 29 mm × 30 mm	
Weight	≈ 56 g	
Lens Mount	C-Mount	
Control Client	MVS or the third-party client software which supports USB 3.0 Vision protocol	
OS	Windows XP/7/8 32/64bits	
Compatibility	USB 3.0 Vision V1.0	
Certifications	CE, FCC, and RoHS	

1.3.4 MV-CA050-20UM/UC Response Curve

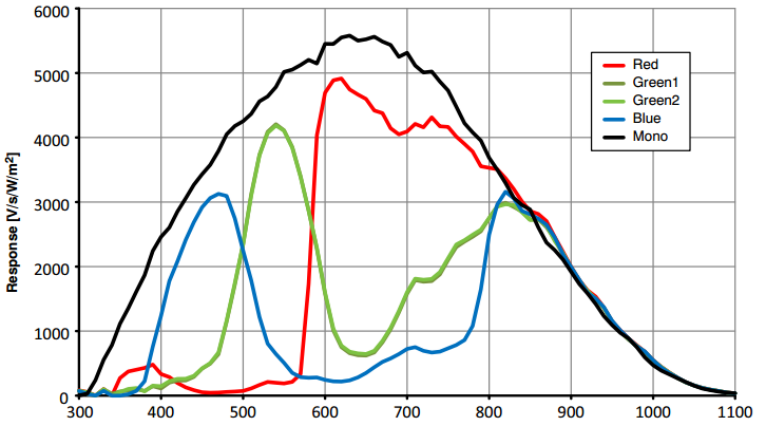

Figure 1-2 MV-CA050-20UM/UC Quantum Efficiency

NOTE

The response curve data is provided by the chip manufacture.

1.4 Camera Physical Interfaces

1.4.1 Camera Dimension

The dimension of the MV-CA013-20UM/UC and MV-CA050-20UM/UC is shown below. The camera should be installed with M3 ×3 or M2 ×3 screws.

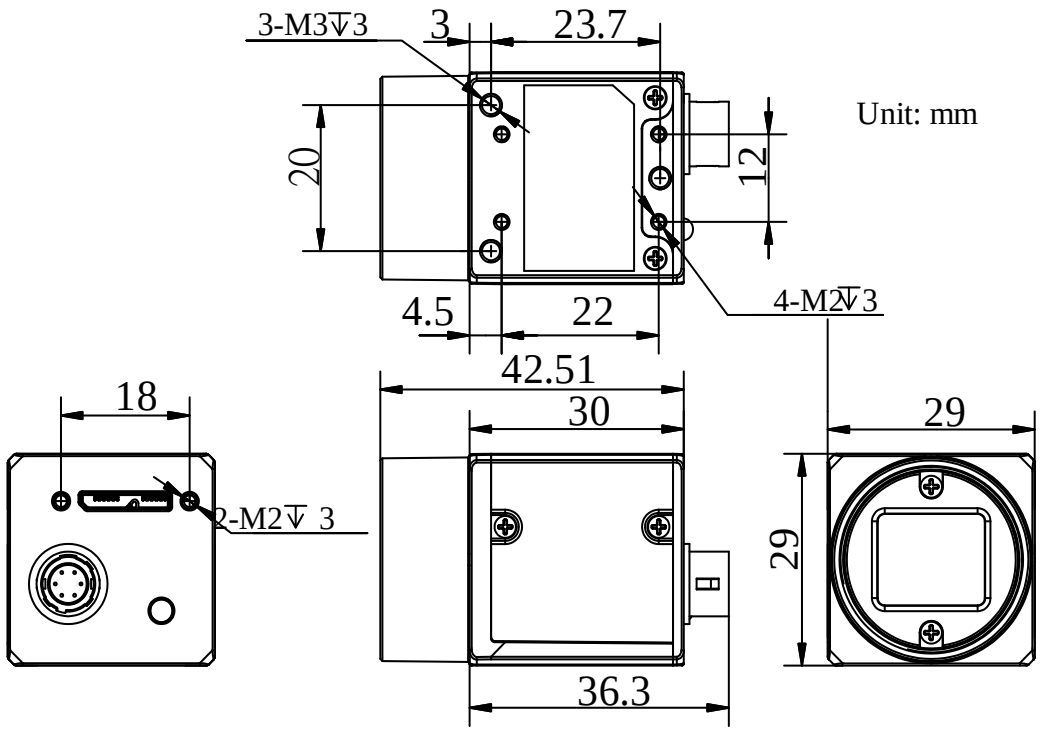

Figure 1-3 Dimension of MV-CA013-20UM/UC and MV-CA050-20UM/UC

NOTE

The camera adopts the C-Mount lens interface. The flange back length of lens is 17.5 mm ± 0.15 mm.

1.4.2 Rear Panel Introduction

The rear panel of the machine vision camera is shown in the figure below.

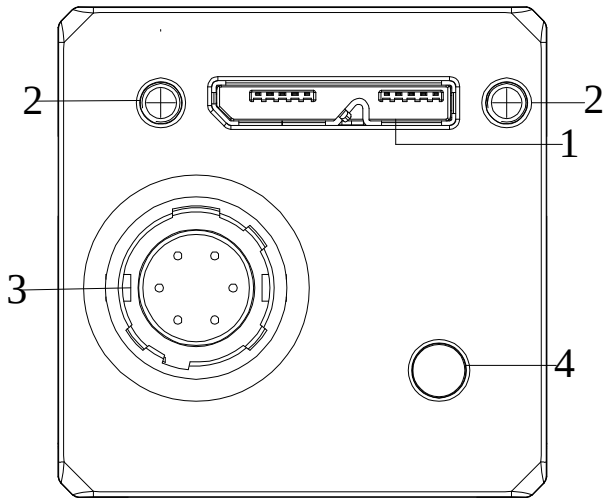

Figure 1-4 Rear Panel

Table 1-3 Description of the Rear Panel

No.	Description
1	USB 3.0 interface
2	M2 screw holes for USB 3.0 cable securing
3	6-pin power and I/O interface
4	Status indicator LED

1.4.3 Power and I/O Interface Introduction

The description of the 6-pin power and I/O connector is shown in the table below.

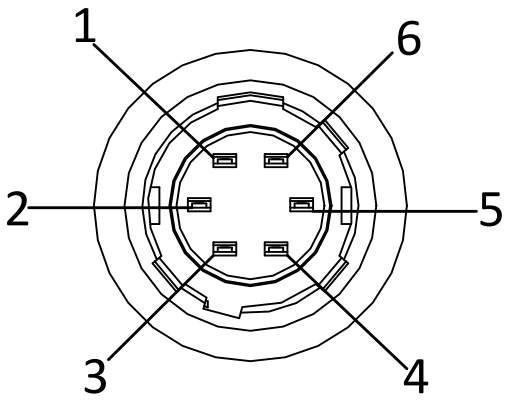

Figure 1-5 Power and I/O Interface

Table 1-4 Description

No.	Signal	I/O Type	Description
1	12 V	Input	12 V DC
2	Opt-Iso In	Input	Opto-isolated input
3	GPIO	Input/output	Can be configured as input or output
4	Opt-Iso Out	Output	Opto-isolated output
5	I/O Ground	Input	Ground for opt- isolated I/O, not connected to camera ground
6	GND	Input	Power ground

1.4.4 Installation Accessories

Prepare the installation accessories listed below before installing the machine vision camera.

Table 1-5 Accessory List

No.	Accessory Name	Number	Description
1	Camera	1	The machine vision camera.
2	Power I/O cable	1	The 6-pin cable (included) or extension cable (not included).
3	Power adapter	1	12 V DC power adapter (Min. 1A)
4	USB 3.0 Cable	1	Micro USB 3.0 (model B) cable (need to be ordered separately)
5	Lens (Optional)	1	C-Mount Lens
6	Mounting Bracket (Optional)	1	The mounting bracket has four M2 holes and one 1/4-32UNF interface.

Chapter 2 Camera Installation and Configuration

2.1 Installing the Camera

Steps:

1. Unpack the camera package and install the lens (optional) to the camera body by rotating the lens clockwise.
2. Fix the camera to the desired position.
3. Use Micro USB 3.0 (B model) cable to connect the camera with a PC or any other transmission devices..
4. Choose a power supply method.

- Direct supply: Use the supplied cord with a 6-pin power and I/O interface to connect the camera to a power adapter (12 V DC for the camera).
- USB (Power over USB cable: Use a USB cable to connect the camera to a USB 3.0 interface).

The machine vision camera adopts a USB 3.0 interface. To guarantee the bandwidth for real-time image transmission, you need to use a USB 3.0 cable.

2.2 Checking the Drive

Purpose:

Before using the camera, you should make sure that the drive is installed on your computer. Otherwise, the client is unable to find the camera.

Steps:

1. Enter the Device Manager Interface of your computer, and you are able to find Hikvision USB 3.0 Machine Vision Camera on the interface.
2. Right click Hikvision USB 3.0 Machine Vision Camera, to check the device property. And the following figure shows that the dive is installed successfully.

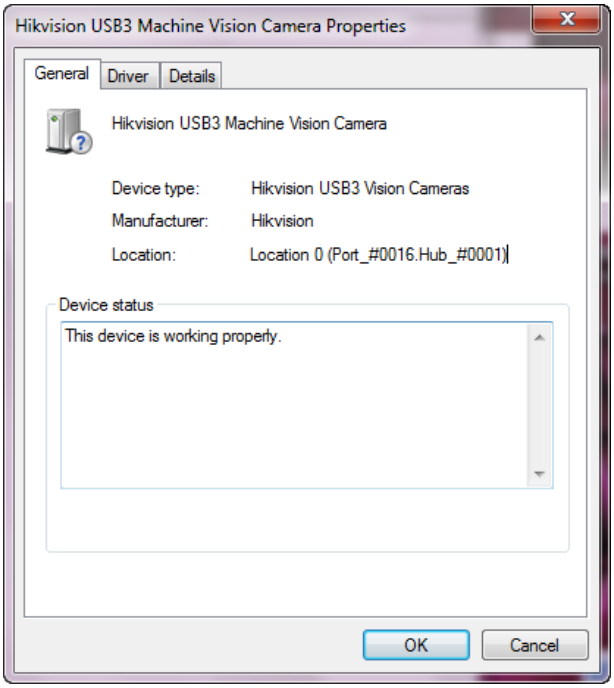

Figure 2-1 Drive Status Checking

2.3 Camera Configuration

NOTE

You can configure the camera via the control client. There are two methods available: setting via the attribute tree or via the menu bar.

2.3.1 Setting via Attribute Tree

The software can read the XML file of camera attributes and display it in tree format.

Steps:

1. Double click the MVS icon to enter the client software. The main user interface and the description of the client software are shown in Figure 2-2 and Table 2-1.

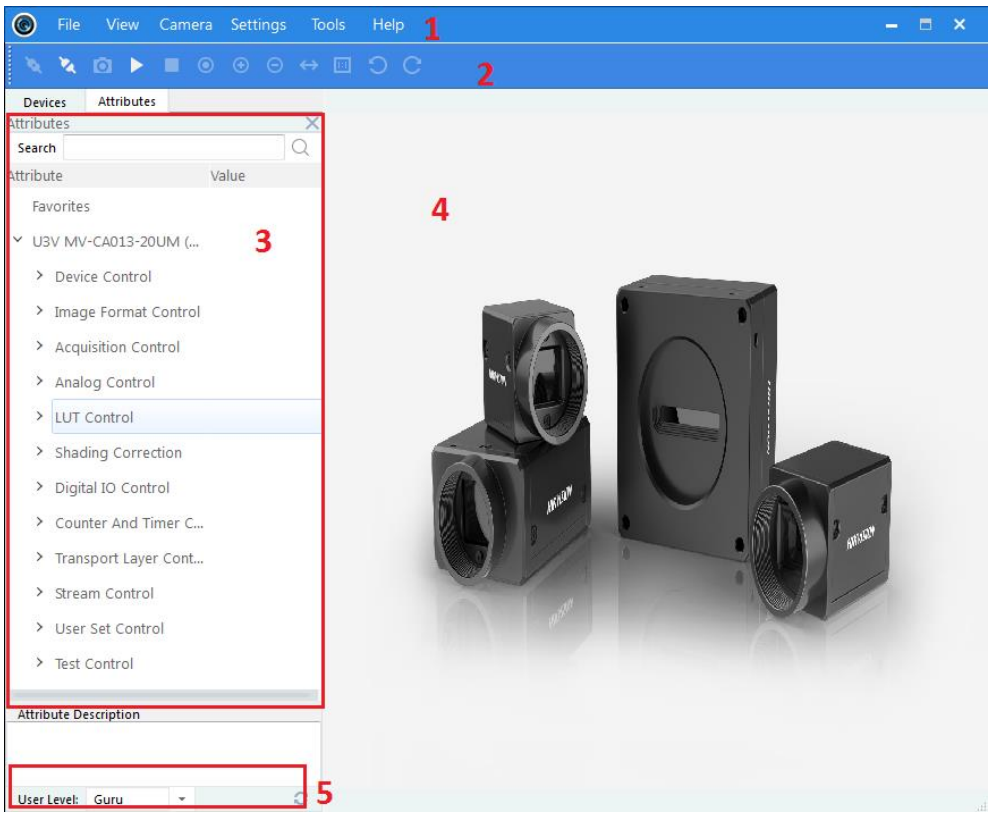

Figure 2-2 Main User Interface of the Client Software

Table 2-1 Description of the Main User Interface

No.	Area Name	Description
1	Menu Bar	Function modules includes File, View, Camera, Settings, Tools, and Help
2	Control Toolbar	Contorls the image of live view including starting/stopping live view, zooming in/out, recording, capturing, etc.
3	Device and Attribute Tree	Displays the machine vision cameras and the device attributes
4	Live View Area	Views the live video of the selected machine vision camera
5	User Level Area	Switches the user level quickly as beginner, expert, or guru.

For details, refer to the *User Manual of MVS Control Client*.

2. Double click the camera on the device list in Devices and Attributes Tree area.
3. Click the **Attributes** tab to enter the camera attribute page.

NOTE

You can switch the user level as Beginner, Expert or Guru which displays different camera attributes. For Guru Level, it provides the most comprehensive camera attributes for professional use. Here we take Guru Level as an example.

4. Click the ⊡ icon before each attribute to view and edit the details.

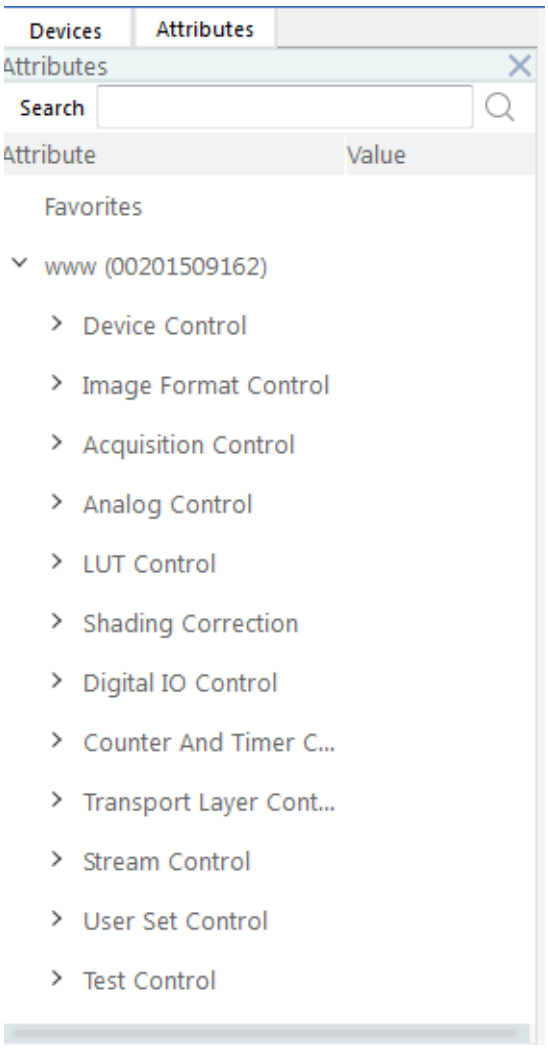

Figure 2-3 Attribute Page

- Device Control: In the Device Control attribute, you can view the camera details include device type, version, manufacturer details, device ID, device alias,

device temperature, etc. You can modify the alias and reset the device.

- Image Format Control: In the Image Format Control attribute, you can view the live view image width and height, pixel size, etc. You can modify the image reverse status, test pattern and the embedded information, etc.
- Acquisition Control: In the Acquisition Control attribute, you can set the trigger mode, trigger source, exposure details, etc.
- Analog Control: In the Analog Control attribute, you can adjust analog gain, black level, brightness, gamma, sharpness, AOI, etc.
- LUT Control: In the LUT Control attribute, you can view the user lookup table and set the LUT index and value.
- Shading Correction: In the Shading Correction attribute, you can correct the inconsistency among pixels.
- Digital IO Control: In the Digital IO Control attribute, you can manage the digital input and output.
- Counter and Timer Control: In the Counter and Timer Control attribute, you can set the counter and timer function. It can count the triggering signal and control the exposure according to the user needs.
- Transport Layer Control: In the Transport Layer Control attribute, you can set the parameters of transport layer of the camera.
- Stream Control: In the Stream Control, you can see the data on data header, effective load, and data tail.
- User Set Control: In the User Set Control attribute, you can save or load the parameter configuration set by users. You can set the default parameter when running the software.

2.3.2 Setting via Menu Bar

You can set the camera attribute via the menu bar which classifies the camera attributes.

Click **Settings > Attributes** to enter the attributes setting interface.

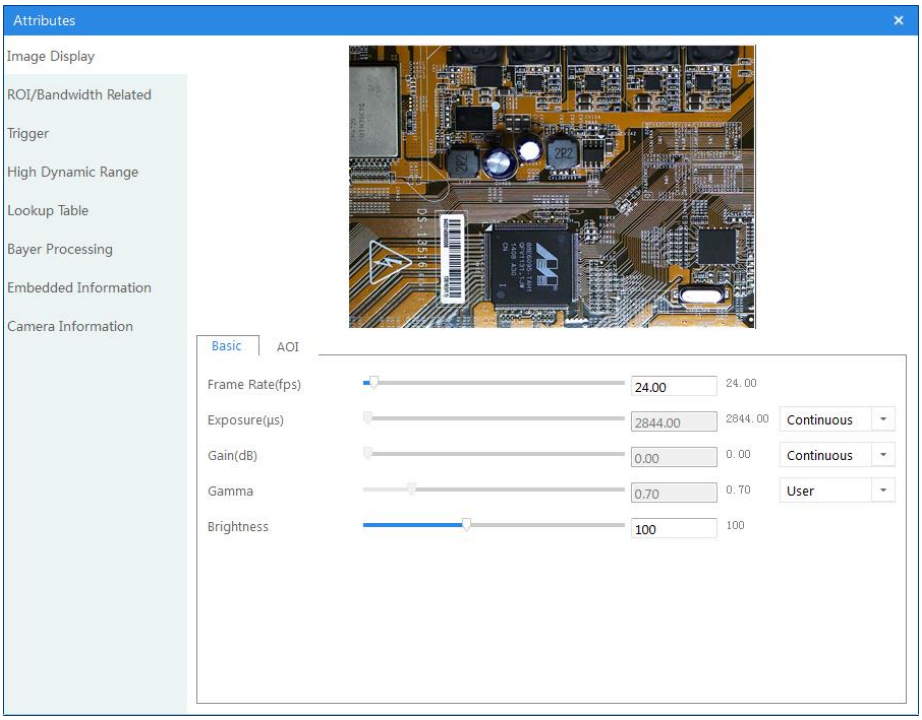

Figure 2-4 Setting via Menu Bar

You can set the image display, ROI, bandwidth, trigger mode, high dynamic range, lookup table, embedded information and camera information.

Functions and Attributes of machine vision cameras may be different among different camera models. Refer to the actual user interface and the user manual of the camera for detail information.

Chapter 3 Functions

3.1 Device Control

3.1.1 Name Modification

Run the client software and click Device Control. You will see the device type, the version information, the device serial number, and so on. Input the device name in Device User ID as shown in Figure 3-1.

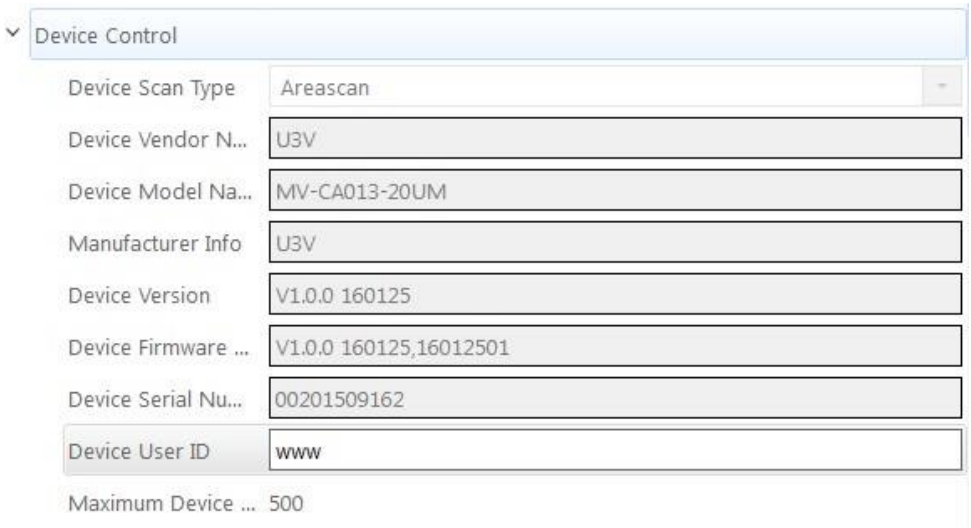

Figure 3-1 Device Name Modification

You can reset the device, and view the device temperature in Device Control, as shown in Figure 3-2.

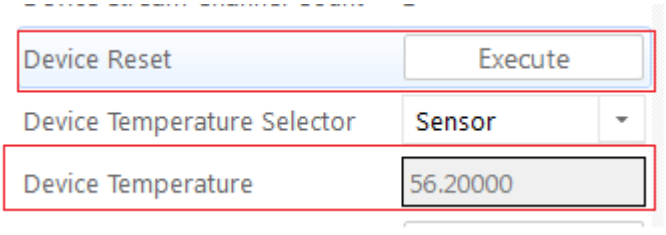

Figure 3-2 Device Information

3.2 Image Format and Frame Rate

Support different image formats and customized ROI settings. The specified ROI will increase the image frame rate in some models.

NOTE

The following figures are for reference only. The actual format depends on the camera's supported formats.

3.2.1 Camera Data Format

The supporting pixel formats of MV-CA camera are shown in Table 3-1.

Table 3-1 Data Format Table

Format	Mono8	Mono 10/10p	Mono12/ 12p	RGB8	Bayer 8	Bayer 10/10p	Bayer 12/12p	YUV 422	YUV 422 (UYVY)
MV-CA013-20UM	Y	Y	---	---	---	---	---	---	---
MV-CA013-20UC	Y	---	---	Y	BG	BG	BG	Y	Y
MV-CA050-20UM	Y	Y	---	---	---	---	---	---	---
MV-CA050-20UC	Y	---	---	Y	GR	GR	GR	Y	Y

NOTE

YUV 422 8 is the default output data format for color camera. Mono8 is the default output format for black and white camera. "Y" means support and "---" means not support.

Color camera changes from the original data to RGB8 by color interpolation algorithm. Bayer GB, Bayer GR and any other patterns are shown in the following four figures.

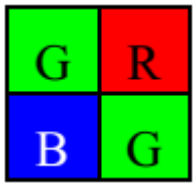

Figure 3-3 Bayer GR Pixel Pattern

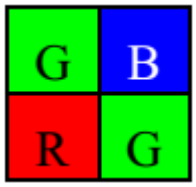

Figure 3-4 Bayer GB Pixel Pattern

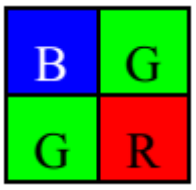

Figure 3-5 Bayer BG Pixel Pattern

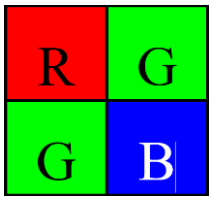

Figure 3-6 Bayer RG Pixel Pattern

The camera uses 12 bit ADC (some only support 10 bit ADC)， and supports 8 bit data output according to your data processing capacity.

The camera will capture 8 bit from Most Significant Bits just as MSB8 output, in order to maintain the grey level output of the image data.

The bytes number corresponding to different formats are shown in Table 3-2.

Table 3-2 Pixel Format

Pixel Format	**Byte Number**
Mono 8, Bayer GB/GR/BG/RG 8	1
Bayer GR/GB/RG 12 Packed, Bayer BG/GR/RG 10 Packed, Mono10 Packed, Mono12 packed	1.5
Bayer GR/GB/RG 12, Bayer BG/GR/RG 10, YUV 4:2:2 (YUYV), YUV4:2:2 (YUYV) Packed	2
RGB 8	3

Click Image Format Control in the attribute list and select Pixel Format. You will find the supported pixel format. Choose the appropriate data output format as shown in

Figure 3-7 and finish setting.

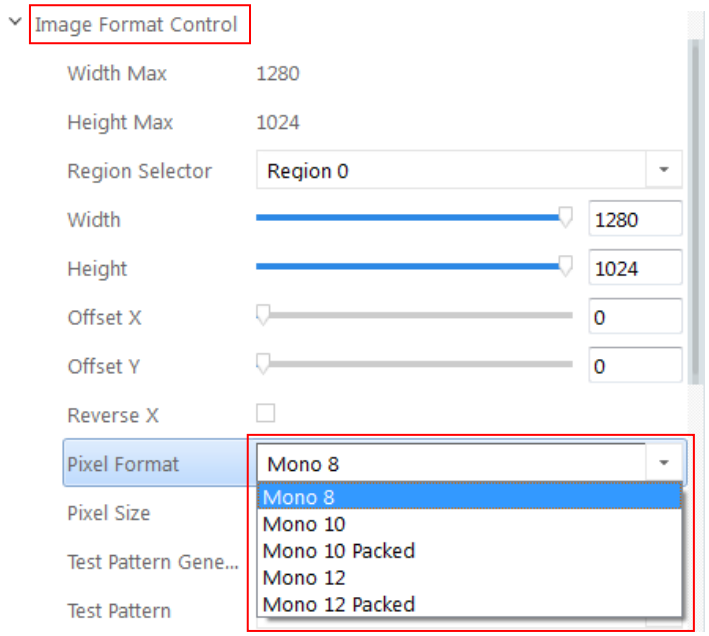

Figure 3-7 Frame Rate Setting

3.2.2 Frame Rate

The transmission bandwidth, pixel format and output ROI resolution decides the maximum camera frame rate. Please refer to the frame rate formula when setting ROI. Click Acquisition Control in the attribute list and select Acquisition Frame Rate. Input available frame rate as shown in Figure 3-8 and finish setting.

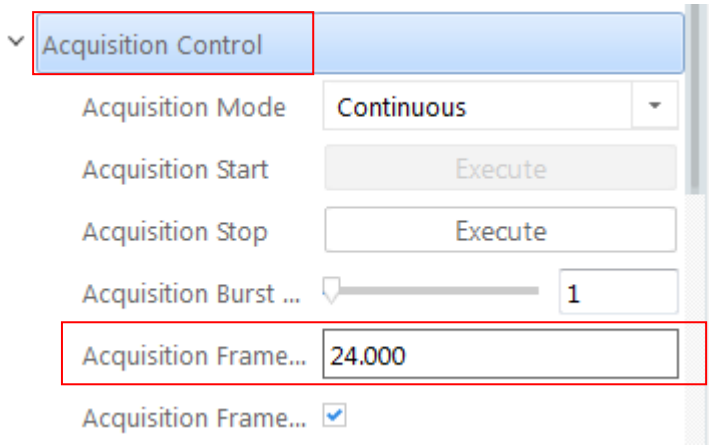

Figure 3-8 Frame Rate Setting

3.2.3 ROI Setting

The following three factors decide the maximum camera frame rate:

- Frame Readout time: the shorter the image height, the less the readout time and the higher the frame rate.
- Exposure time: the less the exposure time, the higher the frame rate.
- Bandwidth: the wider the bandwidth, the higher the frame rate.

The camera can output ROI images depending on your needs. ROI setting can decrease the data transmission bandwidth, and increase the camera frame rate. The following formulas show the frame rate corresponding to the ROI:

Fps1 = 1/(ROI height * T1 + ROI OffsetY * T2 + T3);

Fps2 = 1/Exp Time;

Fps3 = Bandwidth / PayloadSize;

Table 3-3 ROI and Frame Rate Parameter Table

Value / Model	T1(us)	T2(us)	T3(us)
MV-CA013-20UM/UC	10.38	0	375.89
MV-CA050-20UM/UC	17.13	0	10370.97

The lowest frame rate within the three formulas is Resulting Frame Rate.

Click Image Format Control and move. Select Width and Height. Adjust the ROI on the right side. The value in the Offset X and the Offset Y refer to the ROI starting point at the top left corner. The following figure shows the ROI setting.

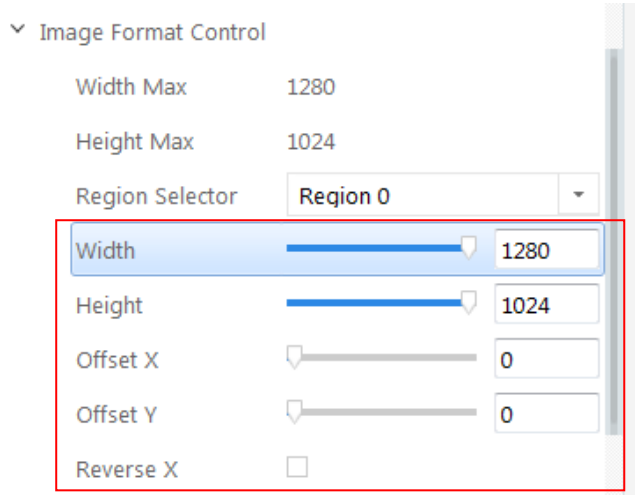

Figure 3-9 ROI Setting

3.3 Global Shutter and Rolling Shutter

3.3.1 Global Shutter

Support global shutter camera. Exposure starts and ends in each line simultaneously. Data readout is after the exposure. The time for the sensor collecting exposure and for the data readout are the same, but as shown in Figure 3-10, different in the actual readout time.

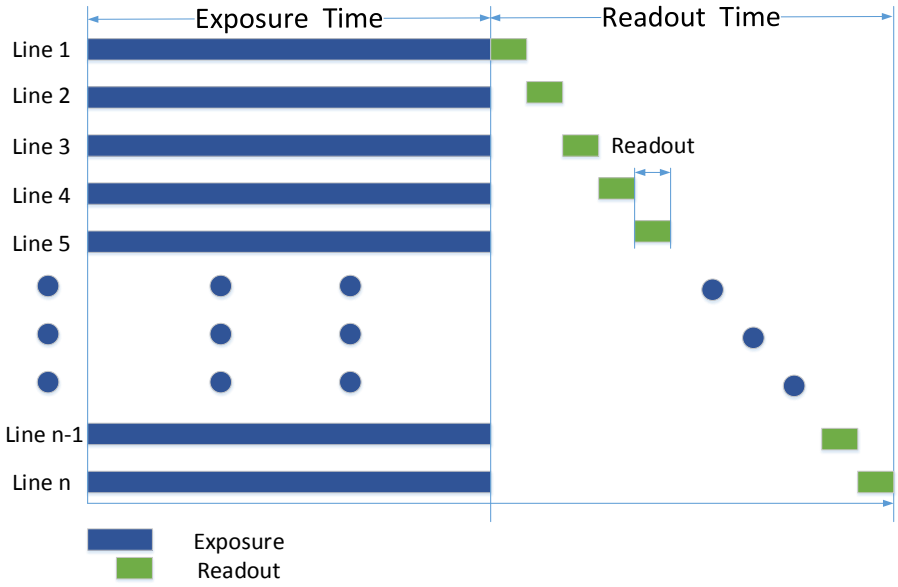

Figure 3-10 Global Shutter

3.3.2 Rolling Shutter

Support rolling shutter camera. The exposure starts in the first row, and the data will read out simultaneously. After the whole action, the rest of rows start to expose and read out one by one. The time for the sensor collecting exposure and for the data readout are the same, but as shown in Figure 3-11, different in the exposure starting time.

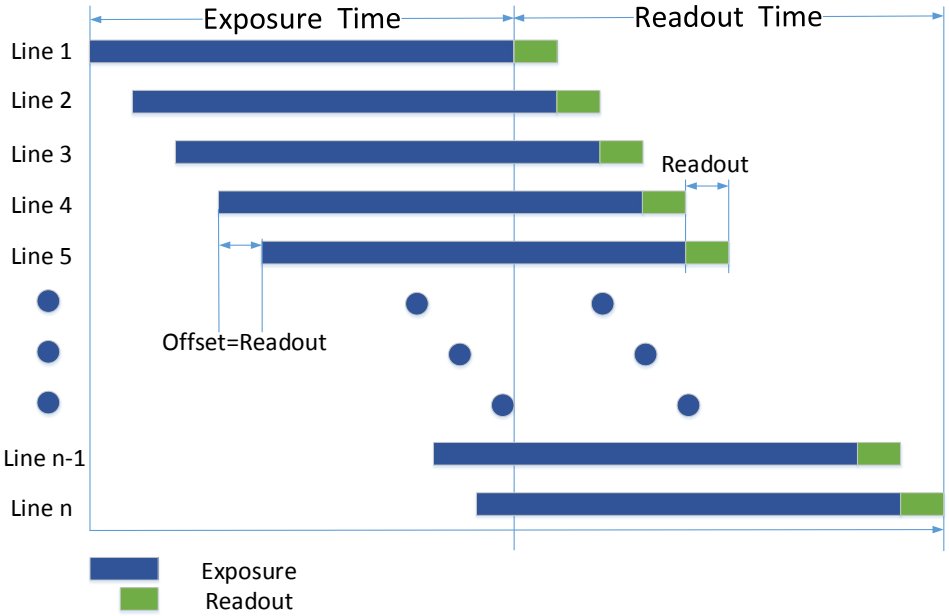

Figure 3-11 Rolling Shutter

- The figure of rolling shutter's signal readout under internal trigger mode

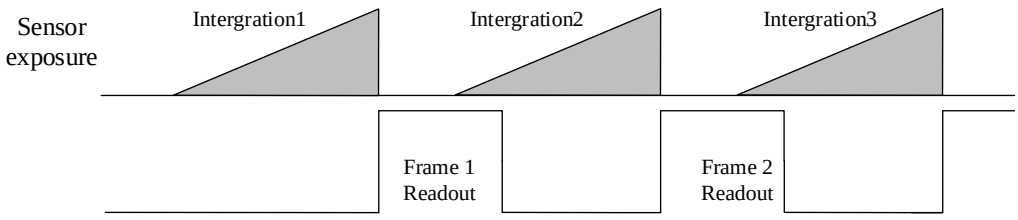

Figure 3-12 Internal Trigger Mode

- The figure of rolling shutter's signal readout under the external trigger mode

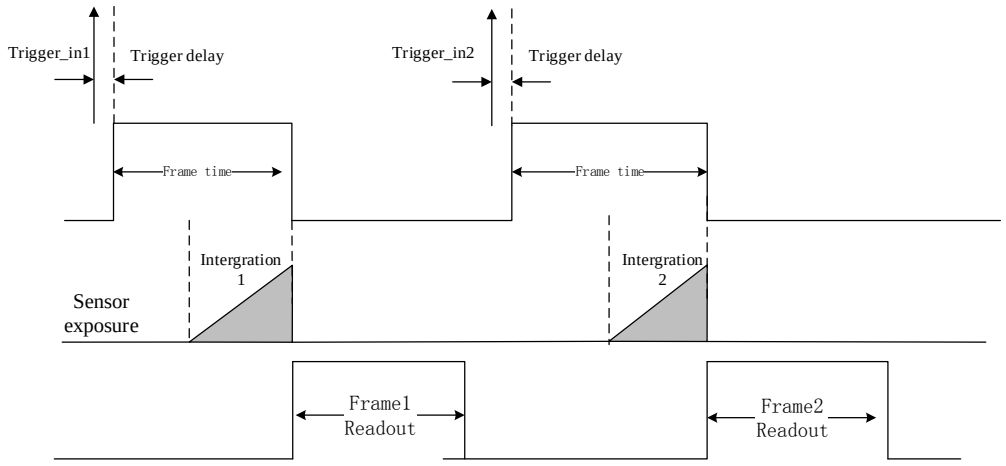

Figure 3-13 External Trigger Mode

3.4 Image Acquisition and Transmission

Purpose:

Image acquisition mode is divided into internal trigger mode and external trigger mode. Internal trigger mode includes continuous acquisition mode and single frame acquisition mode. External trigger mode includes software trigger mode and hardware external trigger mode.

Select On or Off in Trigger Mode to select either internal trigger mode or external trigger mode. (Off refers to the internal trigger mode and On refers to the external trigger mode.)

3.4.1 Internal Trigger Mode

Purpose:

The Camera can output one image or several images continuously in the internal trigger mode.

Click Acquisition Control in the attribute list. Select Acquisition Mode and you will see elements of Continuous and SingleFrame. Continuous refers to outputting images

continuously based on the configured frame rate. SingleFrame refers to outputting only one image, as shown in Figure 3-14.

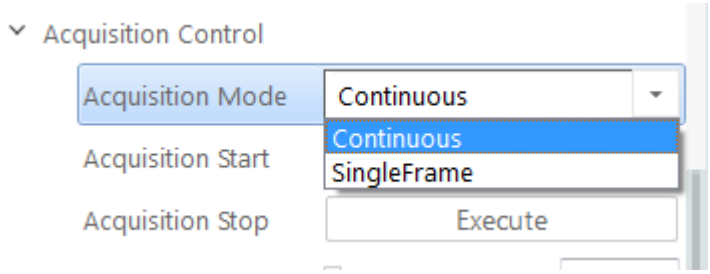

Figure 3-14 Internal Trigger Mode

3.4.2 External Trigger Signal and Working Mode

Purpose:

The signal for the camera to acquire external trigger signal includes the software trigger signal and the signal from external level.

Under the external trigger signal mode, the camera can output images according to single frame mode, burst mode, PWM mode and any other working modes.

- Software trigger mode

Support software trigger mode. When setting software trigger mode, the client software will send command to the camera to capture and transfer images.

Click Acquisition Control in the attribute list and select Trigger Mode. Choose On to open trigger mode. Select Trigger Source and choose Software to switch to the software external trigger status. Click Execute in Trigger Software to trigger image acquisition, as shown in Figure 3-15.

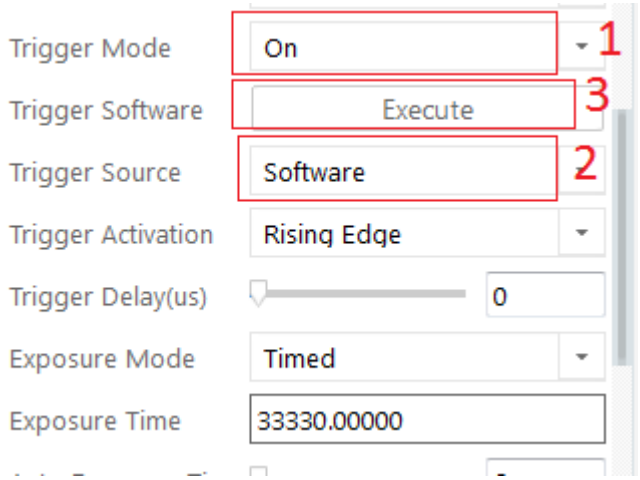

Figure 3-15 Software Trigger Mode Setting

- Hardware external trigger mode

Select Trigger Source and Choose Hardware to switch to the hardware external trigger status.

Available parameter setting of input signal from hardware external trigger:

(1) Trigger edge selection

Selecting Rising Edge/Falling Edge under the external signal is available.

(2) Trigger delay

As shown in Figure 3-16, in order to integrate later, the camera can set delay time when receiving the trigger signal. As shown in Figure 3-17, the delay time can be set through Trigger Delay. The range is from 0 to 32000000 and the unit is μs.

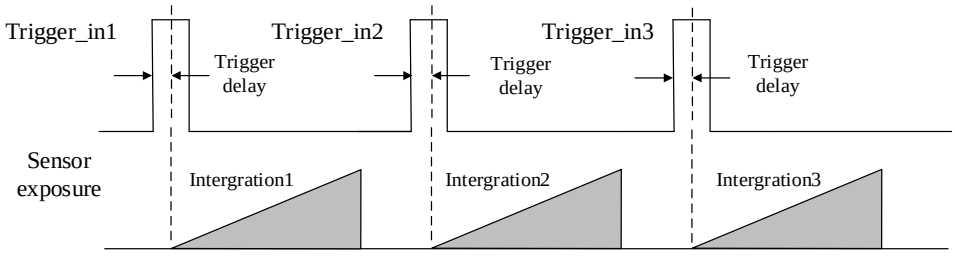

Figure 3-16 Signal Delay Principle

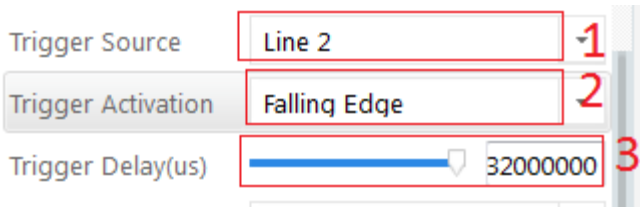

Figure 3-17 Delay Time Setting

(3) Triggering Anti-jitter

The noise may exist in external trigger's input signal and it may cause spurious triggering status if it goes into the camera. Thus the debounce is necessary.

The debounce parameter can be set through Line Debouncer Time in the client software. The unit is μs. The timing sequence map is shown in Figure 3-18. The camera will ignore the trigger signal if the debouncer time is longer than the triggering signal time.

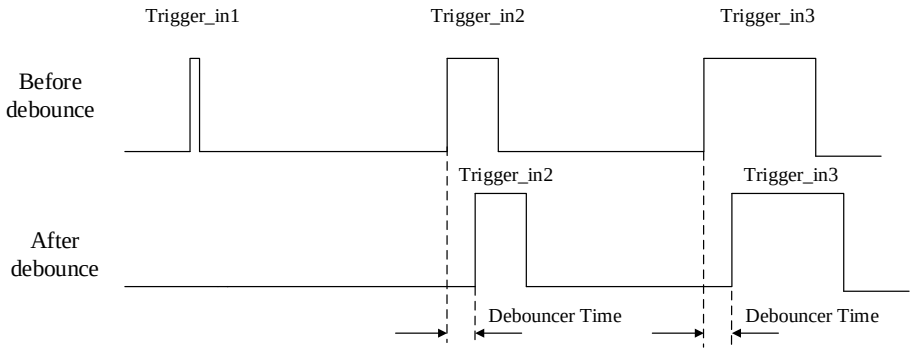

Figure 3-18 The Debounce of Triggering Input Signal Sequence Map

3.5 Strobe Output

Purpose:

Strobe is external trigger output signal and is used for controlling external devices such as flashing light and so on. You can set the Strobe polarity, duration, output delay and pre-trigger through the client software.

As shown in Figure 3-19, click Digital IO Control. Select Line Selector and choose output pin. Check Strobe Enabled and finish settings.

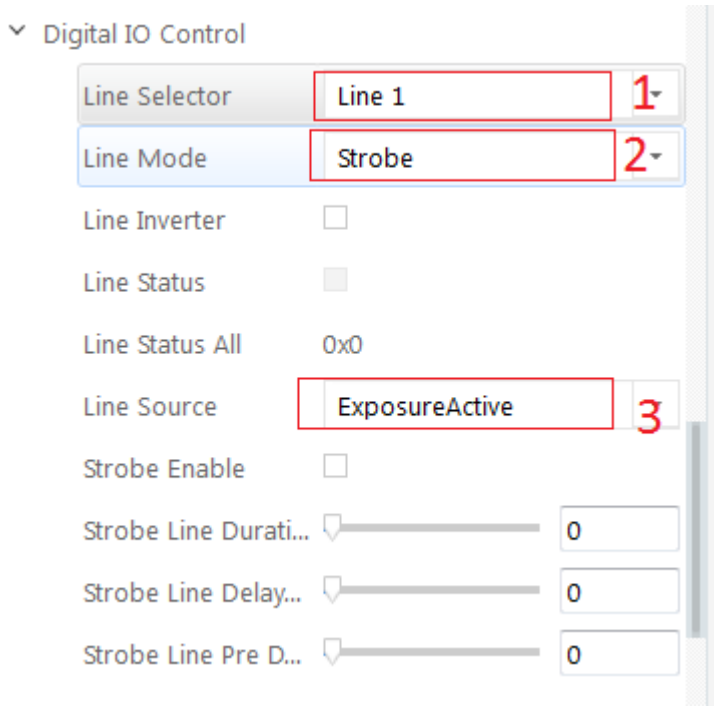

Figure 3-19 Strobe Output Mode

Available Strobe parameter setting:

(1) Polarity setting

Tick Line Inverter to set polarity external trigger's output signal, as shown in Figure 3-20.

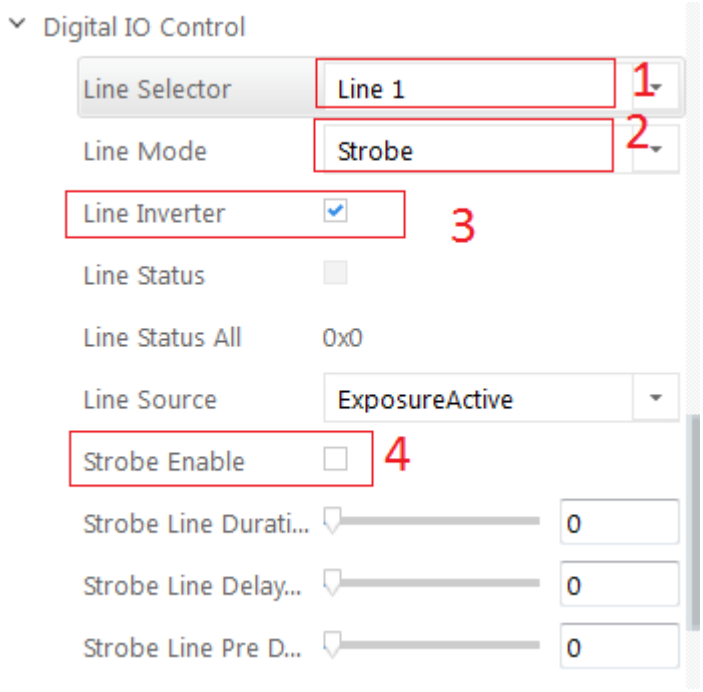

Figure 3-20 Modifying Strobe Polarity

(2) Strobe valid time

As shown in Figure 3-21, Strobe is set to high level. When exposure starts, Strobe will output immediately. Strobe Line Duration value decides the Strobe duration: when the Strobe Line Duration value is 0, the Strobe duration is equal to the exposure time; when the Strobe Line Duration value is not 0, the Strobe duration is equal to Strobe Line Duration value.

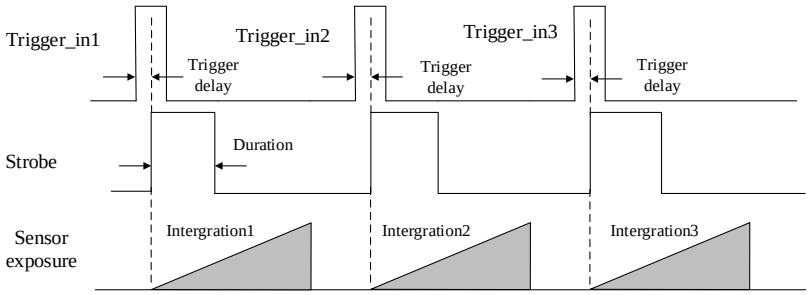

Figure 3-21 Strobe Valid Electrical Level Duration

(3) Strobe output delay

The camera supports the function of Strobe signal output delay to satisfy special application: as shown in Figure 3-22, when exposure starts, the Strobe output is not valid immediately. Instead, the Strobe output will delay according to the setting in Strobe Line Delay.

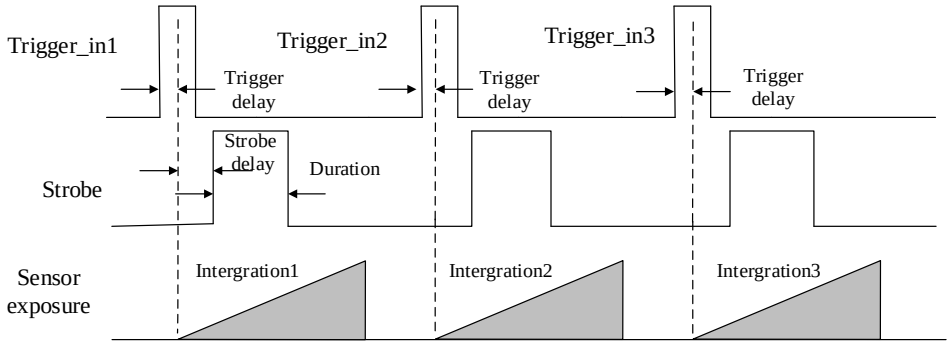

Figure 3-22 Strobe Output Delay Sequence Map

(4) Strobe pre-trigger

Support Strobe pre-trigger. Strobe signal is valid before the sensor exposure. This function can apply to the LED light that takes time to be stable after starting. It is necessary for a stable light source when capturing images. Pre-trigger time can be set

through Strobe Line Pre Delay in the client as shown in Figure 3-23.

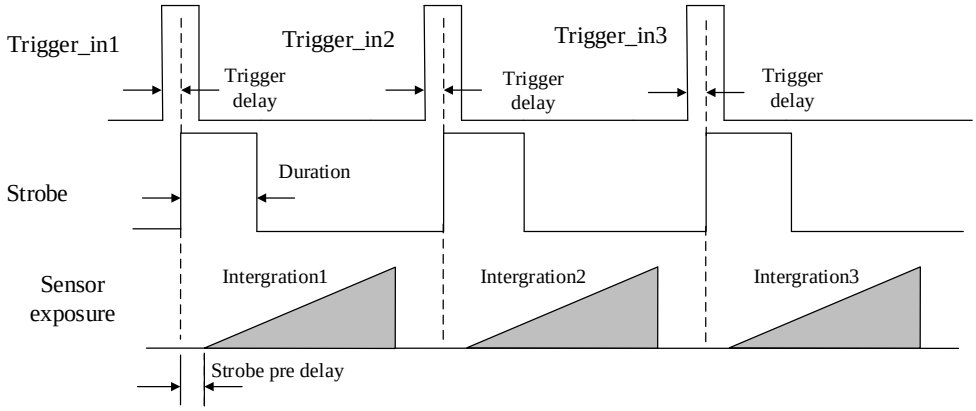

Figure 3-23 Strobe Pre-trigger Sequence Map

3.6 Acquisition Mode under External Trigger

The acquisition mode under external trigger includes single frame mode, burst mode and PWM mode. The relationship among the input trigger signal, the Strobe output signal, the exposure time and readout time under different modes is as follows:

(1) Single frame mode

Expose only once when inputting one trigger signal.

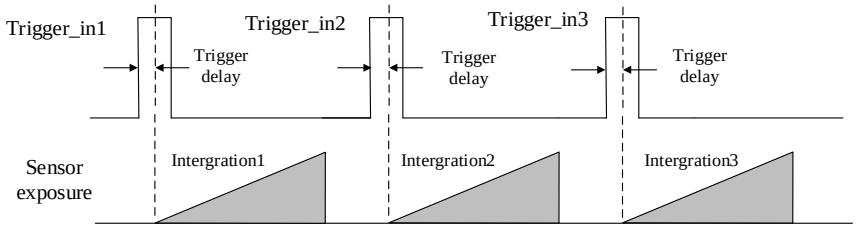

Figure 3-24 Single Frame Mode

The frame rate and exposure time decide to trigger the next frame or not when reading out camera data. If exposure is in progress, the camera will ignore another external trigger signal. You can set a longer exposure time to achieve Bulb Shutter.

(2) Burst mode

The camera supports burst mode: receiving one trigger signal and outputting multiply frames images. You can set the burst number by Acquisition Burst Frame Count in the client software. The range is from 0 to 1023. The sequence map is shown in Figure

3-25. If Burst Frame Count = 3, one trigger signal will output three frames images and at the same time output three strobe signals.

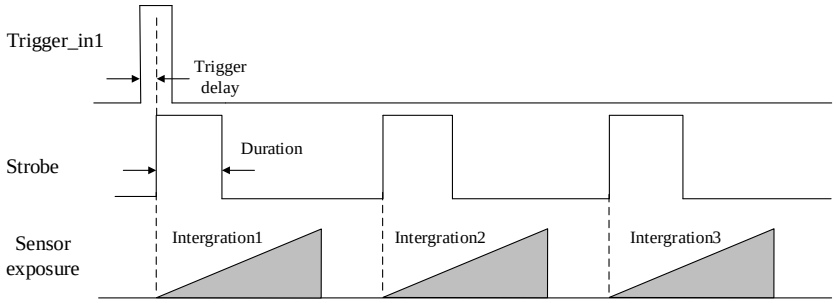

Figure 3-25 Burst Mode Sequence Map

(3) PWM mode

Support PWM mode. The difference in the sensor's exposure time is the main difference between the PWM mode and the single frame mode. In the PWM mode, the duration of trigger source decides the sensor's exposure time of each frame. The sequence map is shown in Figure 3-26.

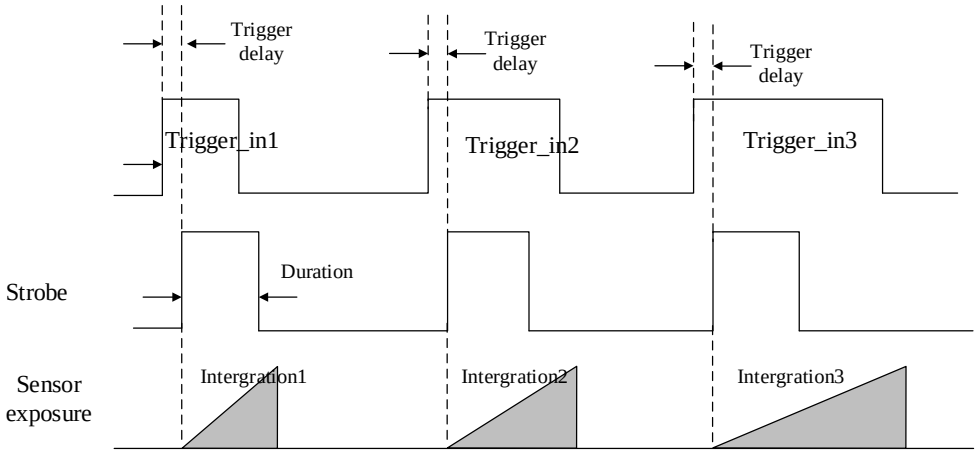

Figure 3-26 PWM Mode Sequence Map

3.7 Counter Control

The counter can divide frequencies that from external inputting trigger signal. You can control the exposure depends on your expectations. Operation steps are as follows:

As shown in Figure 3-27, click Acquisition Burst Frame Count and select Trigger Source. Choose Counter 0.

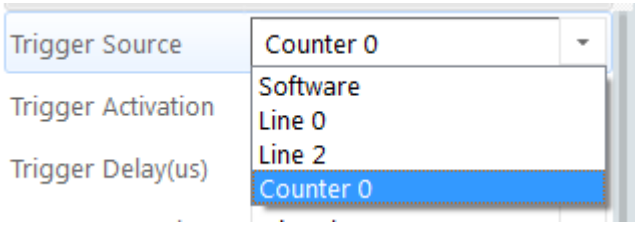

Figure 3-27 Trigger Source Configuration

As shown in Figure 3-28, click Counter And Timer Control and select external trigger source which needs frequency division.

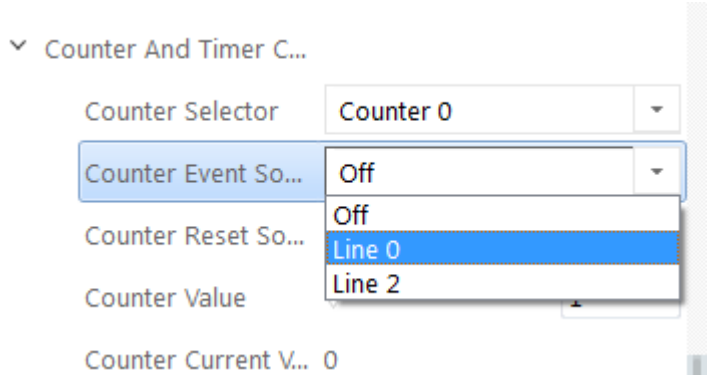

Figure 3-28 Counter Frequency Division Configuration

NOTE

By default, Line 0 is signal input pin. Line 2 is configurable input and output pin. Configure Line 2 to input pin in Digital IO Control, as shown in Figure 3-29, in order to do frequency division for Line 2.

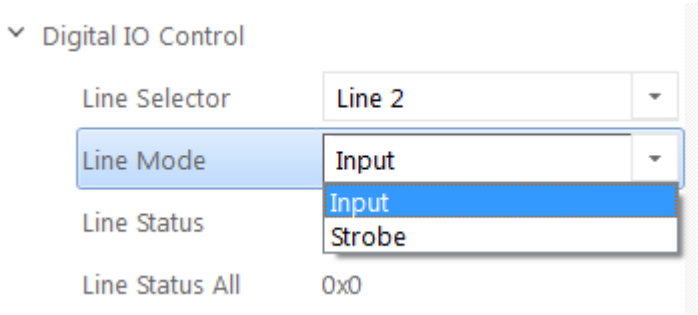

Figure 3-29 Configuring Line 2 Pin to Input

In Counter And Timer Control, you should set Counter Value. Parameter value range

is from 1 to 1023. Please see the red 2 in Figure 3-30.

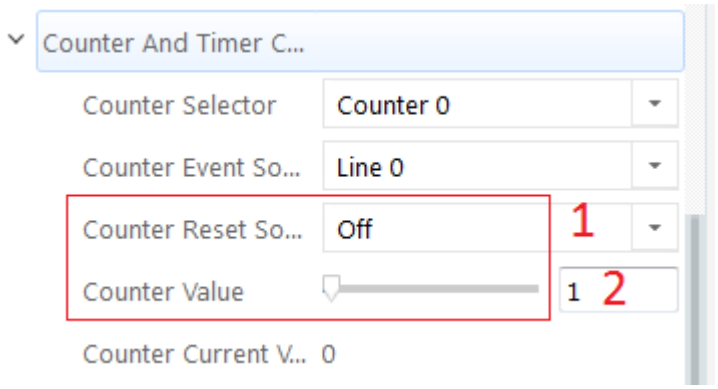

Figure 3-30 Counter Parameter Setting

By default, Counter Reset Source is OFF as shown in the red 1 in Figure 3-30. Click Counter And Timer Control and select Counter Reset Source. Choose Software and click Execute to reset the counter, as shown in Figure 3-31.

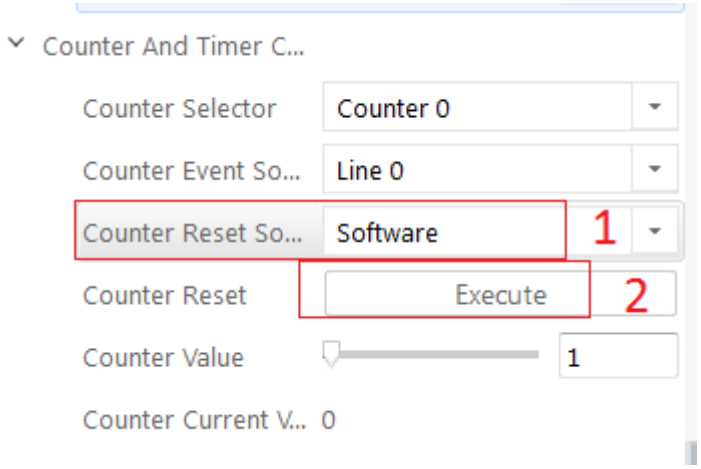

Figure 3-31 Resetting The Counter

3.8 Imaging Parameter Setting

3.8.1 Exposure Time

Purpose:

Refer to the camera technical index to acquire the supported exposure time. The exposure control supports manual mode, single mode and continuous mode. When

setting trigger mode, the single mode and continuous mode are invalid. When setting single mode or continuous mode, the exposure time will be limited by Auto Exposure Time Lower Limit and Auto Exposure Time Upper Limit. The time range should only be set between Auto Exposure Time Lower Limit and Auto Exposure Time Upper Limit.

Click Acquisition Control in the attribute list. Select Auto Exposure Time Lower Limit and Auto Exposure Time Upper Limit. Input available parameter to the numeric field. Set the running parameter range of the auto exposure time, as shown in Figure 3-32.

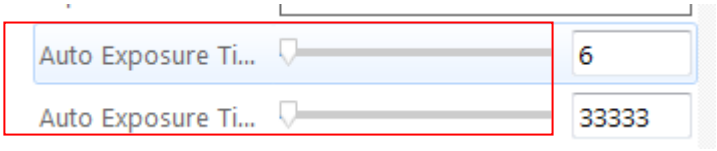

Figure 3-32 Exposure Control

3.8.2 Gain Control

Please refer to the camera technical index to acquire the supported Gain Value. Gain Control supports manual mode, single mode and continuous mode. Gain Control under these three modes can be shown as follows:

Manual mode: Set Gain according to the user's setting value.

Single mode: Set Gain value automatically according to the target image brightness. Set once only.

Continuous mode: Adjusting Gain continuously according to the target image brightness.

When setting single mode or continuous mode, Gain is limited by Auto Gain Lower Limit and Auto Gain Upper Limit. Gain Range should only be set between Auto Gain Lower Limit and Auto Gain Upper Limit.

Click Analog Control in the attribute list. Click Gain Auto. Select Gain Mode. Input available parameter in the numeric field and finish setting, as shown in Figure 3-33.

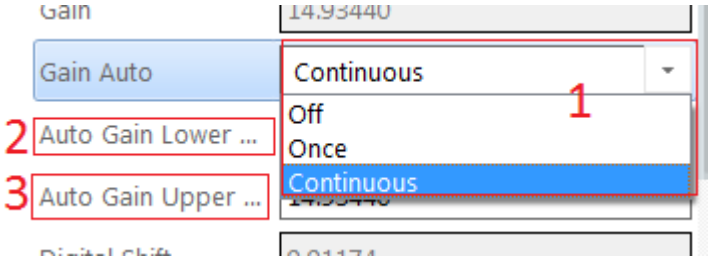

Figure 3-33 Gain Control

The noise increases when Gain increases. Auto exposure and Auto Gain are mutually restricted. When the image is dark, the camera will firstly increase the exposure time. Secondly, the camera starts to adjust Gain Value when the exposure time turns to the maximum. When the image is bright, the camera will firstly decrease Gain Value. Secondly, it starts to adjust the exposure time when Gain Value turns to the minimum.

3.8.3 White balance

The camera supports the white balance. The white balance refers to the camera color adjustment depending on different light sources. Adjust the Gain Value of the image's R channel and B channel to keep white regions white under different color temperatures. Ideally, the proportion of R channel, G channel and B channel in the white region is 1:1:1.

Table 3-4 White Balance Status Introduction

Status	Description
OFF	MBW mode: You can adjust the R, G, and B gain value manully. The adjustable range is 1 to 4095, 1024 means the ratio is 1.0 .
ONCE	Adjust the white balance value according to the current scene and the adjustment stops automatically after a while. The adjustment adopts a algrithm that looks for the gray blocks in the Bayer data.

NOTE

The white balance adjustment is only available in color models.

Click Analog Control in the attribute list. Click Balance White Auto and Balance

Ratio Selector. Select available white balance status parameter and finish setting, as shown in Figure 3-34.

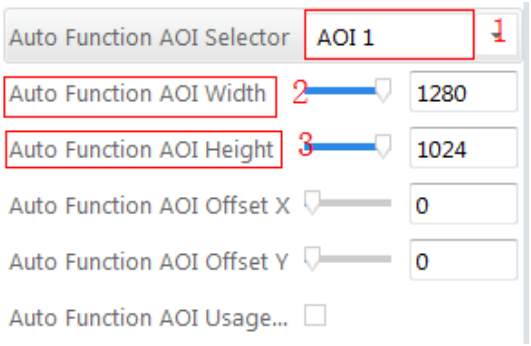

Figure 3-34 White Balance Setting

3.8.4 Region Setting of Auto Functions

The camera can adjust exposure time and white balance automatically to achieve your expectations. By default, the camera will adjust the brightness and the white balance of the whole image. In addition, you can also set an area of interest, which is called AOI. The camera will adjust the AOI in the image. And the area outside the selected region will also be changed.

Regional exposure and regional white balance are generally used in the back light scene and the scene with the great difference of regional brightness. You can also select rectangle region. The camera will adjust the region's exposure and white balance to achieve the best image quality.

Click Analog Control in the attribute list. Select Auto Function AOI Selector. Choose AOI1 or AOI2. Adjust Auto Function AOI Width value and Auto Function AOI Height value and finish setting, as shown in Figure 3-35.

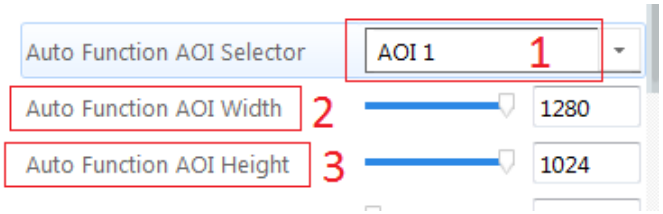

Figure 3-35 AOI Setting

The available exposure region and the white balance region are the overlapped part of the setting region and the image region. If there is no overlap, the available region refers to the whole image.

3.8.5 Look Up Table (LUT)

Purpose:

LUT is the grey level mapping table. You can change the grey level in your interested regions. The operation can be linearity curve or custom mapping curve. LUT and Gamma are mutually exclusive.

Set the user mode to Guru Mode. Click LUT Enable and adjust the parameters, as shown in Figure 3-36.

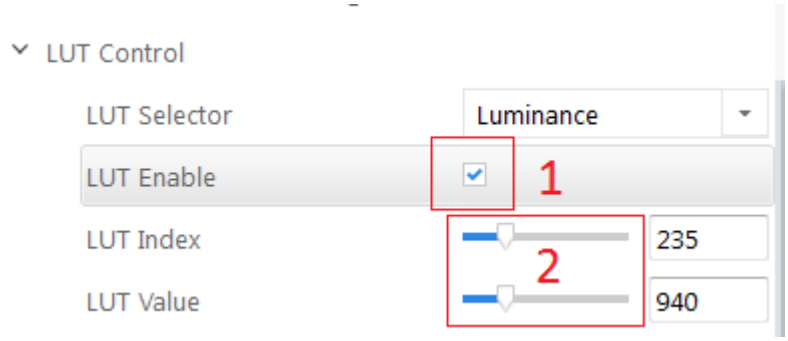

Figure 3-36 LUT Setting

3.8.6 Gamma Correction

Purpose:

The camera supports Gamma Correction. Normally, the output of the camera chip and the number of photon that the sensor (on the chip) received are linear. And Gamma Correction provides a non-linear output. If the Gamma value is between 0.5 and 1, the image brightness decreases while the brightness of the dark area increases. If the Gamma value is between 1 and 4, the image brightness increases while the brightness of the dark area decreases.

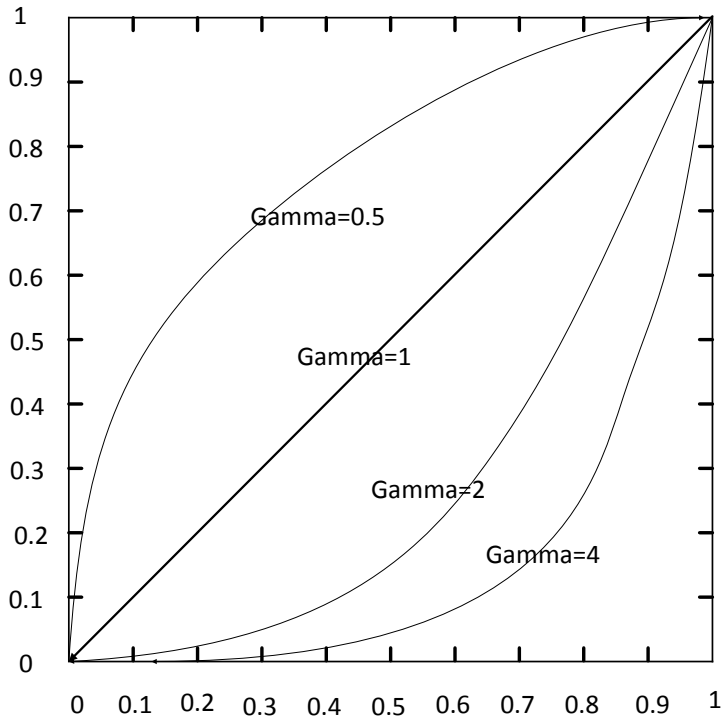

Figure 3-37 Gamma Curve

Click Analog Control in the attribute list. Select Gamma and Gamma Selector and set the parameter as shown in Figure 3-38.

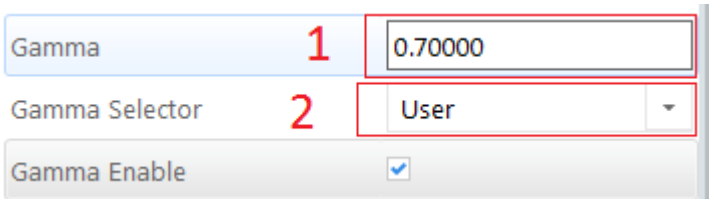

Figure 3-38 Gamma Setting

Different cameras versions have different default function parameters. The figures shown above are only for reference.

3.8.7 Brightness, Hue and Saturation

- Brightness

You can adjust the brightness of the exposure target. The default value is 64. The larger the value, the brighter is the image.

- Hue

You can adjust the hue value in HSV. The default value is 128.

- Saturation

You can adjust the saturation value in HSV. The default value is 128. The larger the value, the higher is the saturation and the stronger is the color.

The hue and the saturation are only for the color camera.

3.8.8 Image Reverse

Purpose:

The camera supports image horizontal mirroring. Open the mirroring function to gain the horizontal mirroring image. Click Image Format Control. Tick Reverse X (horizontal) or Reverse Y (vertical) according to your preference, as shown in Figure 3-39.

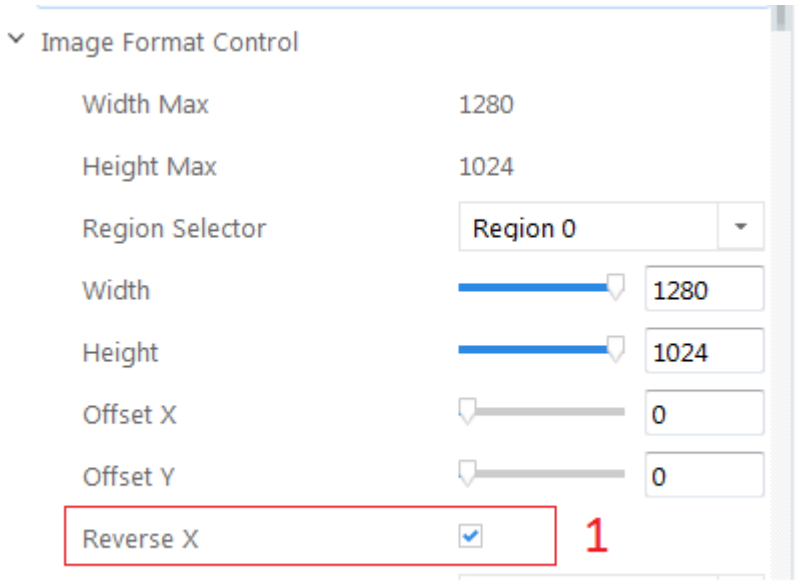

Figure 3-39 Tick Mirroring Function

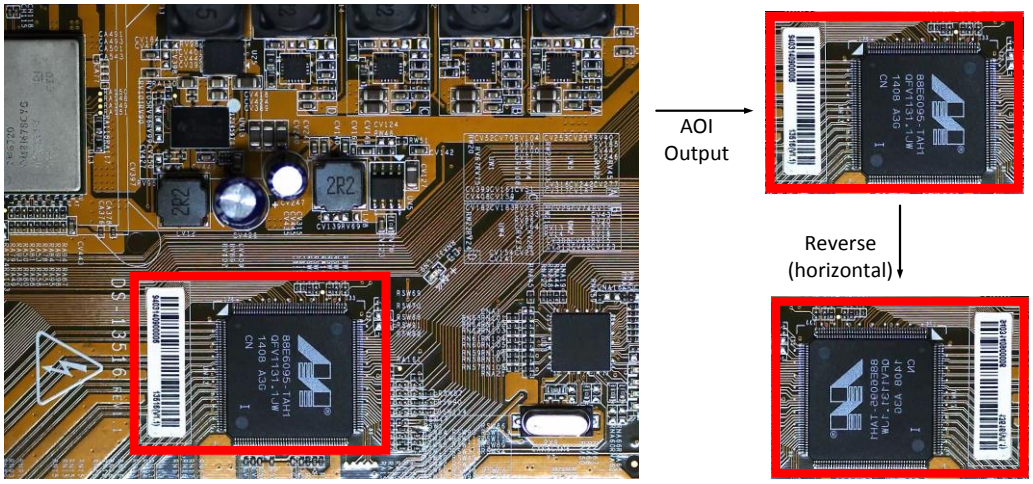

Figure 3-40 The Comparison of ROI Output Before And After Mirroring

3.8.9 HDR Cycling Mode

Purpose:

The camera supports HDR cycling mode: the camera can capture images in cycling mode depending on four groups of parameters. You can configure exposure time and Gain independently by setting parameters in each group.

Click Acquisition Control and choose Selector. Set parameters in each group. Set available parameter in HDR Shutter and HDR Gain. Tick HDR Enable and finish setting, as shown in Figure 3-41.

Figure 3-41 Four Groups of Parameters' HDR Cycling.

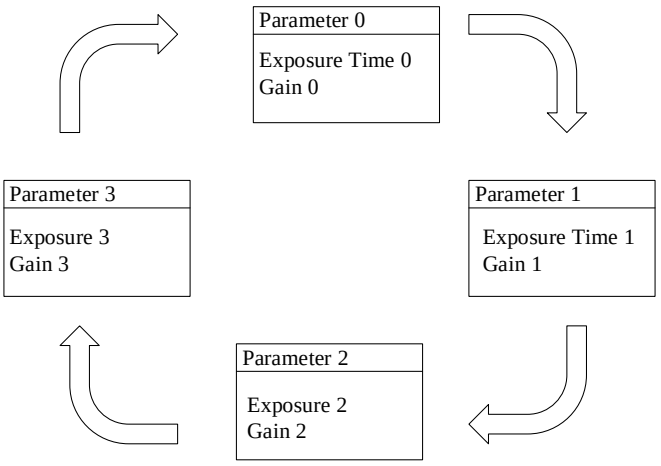

Figure 3-42 HDR Cycling Map

3.8.10 Test Pattern

Click Image Format Control in the attribute list. Select Test Pattern and set the parameter. The default test pattern is OFF, as shown in Figure 3-43.

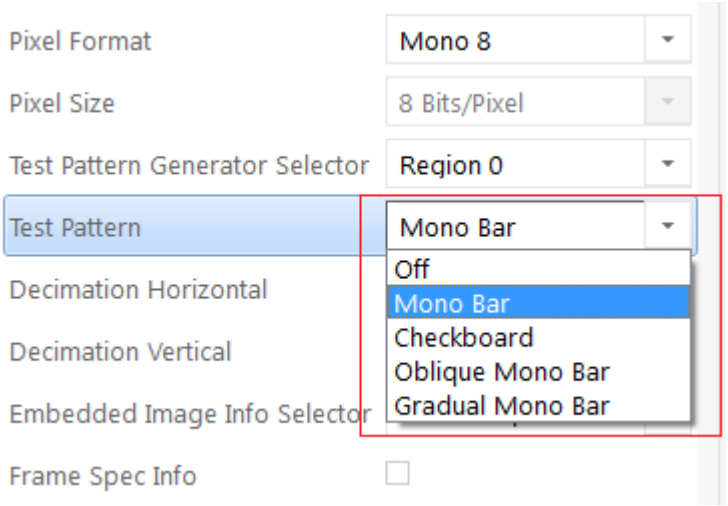

Figure 3-43 Test Pattern

The camera provides four test patterns, including Mono Bar, Vertical Color Bar, Horizontal Color Bar and Checkboard as shown in the following four figures.

NOTE

Color camera and black and white camera have different test patterns. The specific test pattern is decided by the camera function.

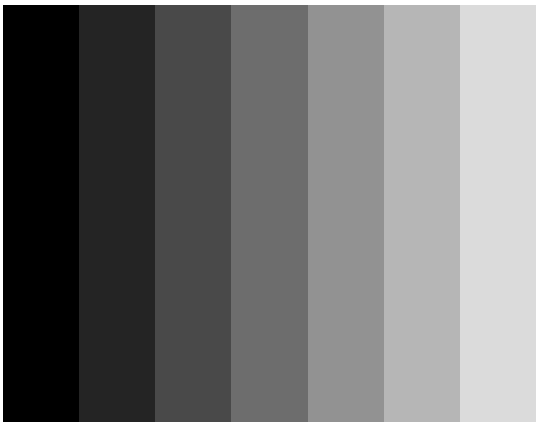

Figure 3-44 Mono Bar Test Pattern

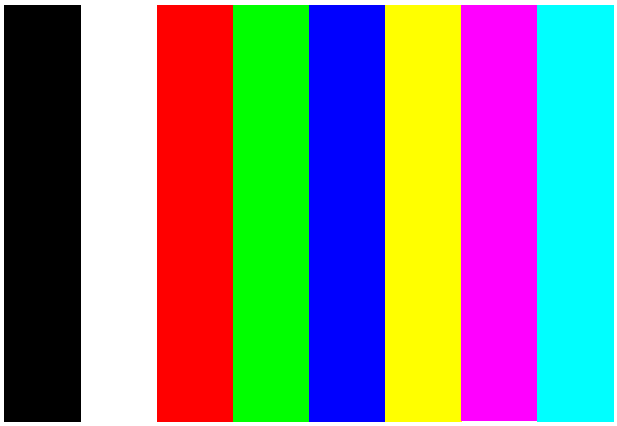

Figure 3-45 Vertical Color Bar Test Pattern

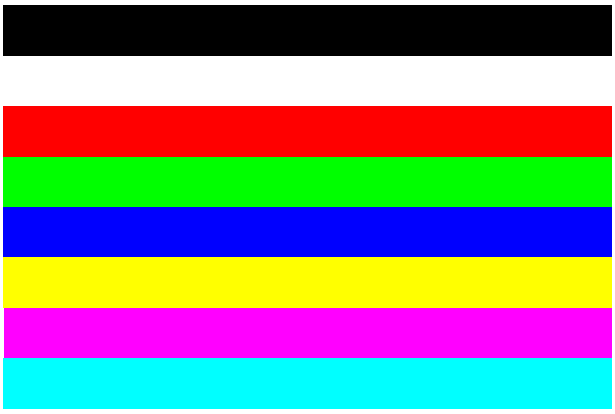

Figure 3-46 Horizontal Color Bar Test Pattern

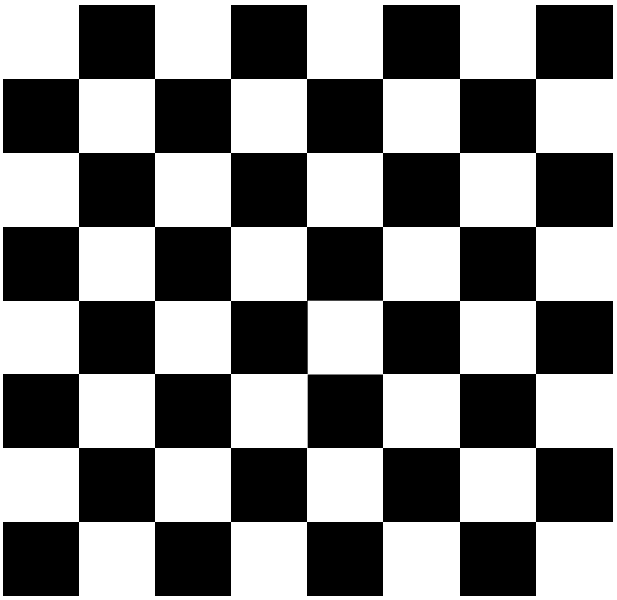

Figure 3-47 Checkboard Test Pattern

3.9 I/O Electric Feature

3.9.1 Line0 Opto-isolated Input Circuit

In controlling camera I/O, Line0 input circuit can be shown in Figure 3-48.

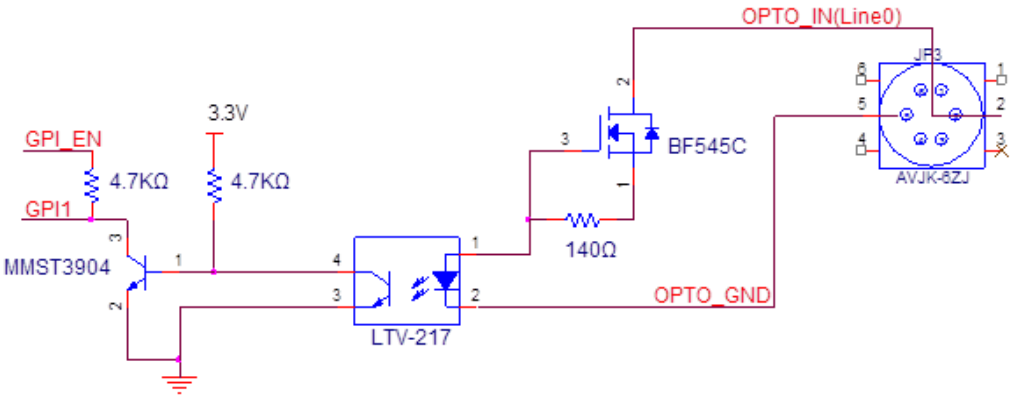

Figure 3-48 Input Circuit

Logic 0 input level: 0~1VDC (OPTO_IN pin)

Logic 1 input level: 1.5~24VDC (OPTO_IN pin)

Maximum input current: 25 mA

Please make sure the input voltage is not from 1V to 1.5V as the electric status among the two values is not stable.

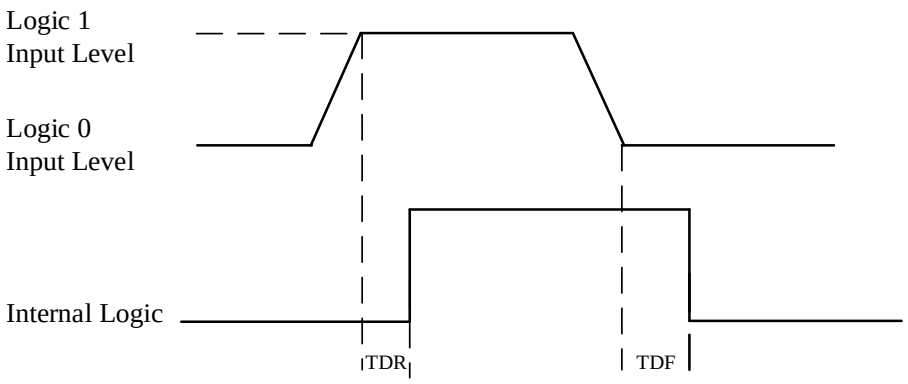

Figure 3-49 Input Logic Level

Input rising delay (TDR): 2.6μs

Input falling delay (TDR): 19.2μs

3.9.2 Line1 Opto-isolated Output Circuit

In controlling I/O, Line1 output circuit can be shown in Figure 3-50.

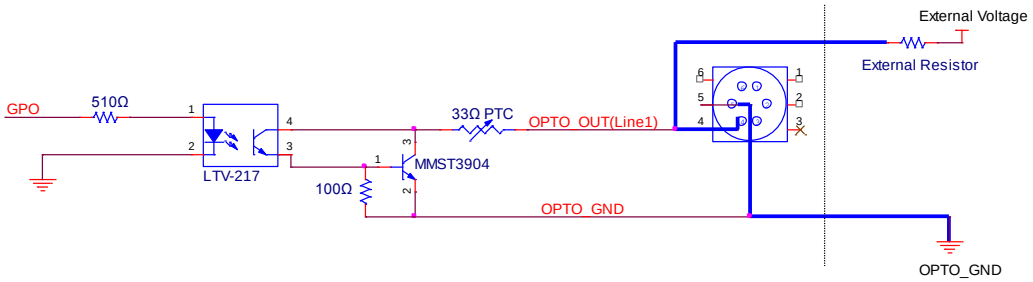

Figure 3-50 Output Circuit

Maximum Line1 output current: 25 mA

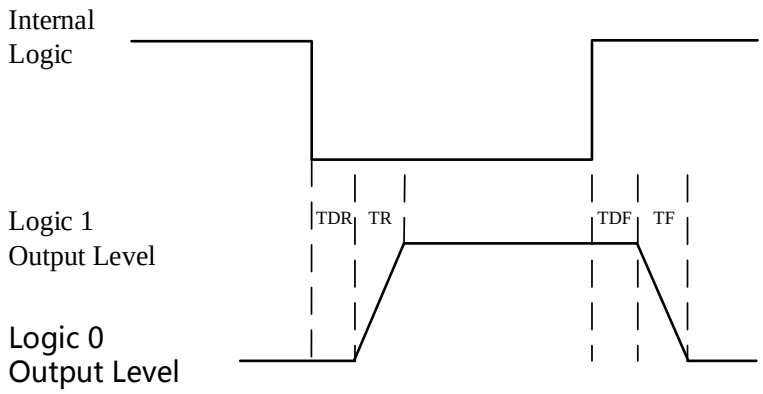

Figure 3-51 Output Logic Level

Opto-isolated output electric feature can be shown in Table 3-5 (The external voltage is 3.3 V and the external resistance is 1 K.)

Table 3-5 Output Electric Feature

Parameter	Symbol	Value
Output Logic Low Level	VL	575mV
Output Logic High Level	VH	3.3V
Output Rising Time	TR	8.4us
Output Falling Time	TF	1.9us
Output Rising Delay	TDR	16.6us
Output Falling Delay	TDF	3.6us

Table 3-6 shows the corresponding current and the parameter of output logic low level when the opto-isolated outputs the different external voltage and resistance.

Table 3-6 The Parameter of Output Logic Low Level

External Voltage	External Resistor	VL	Output Current
3.3V	1KΩ	575mV	2.7mA
5V	1KΩ	840mV	4.1mA
12V	2.4KΩ	915mV	4.6mA
24V	4.7KΩ	975mV	4.9mA

3.9.3 Line2 Configurable Bi-direction I/O Circuit

In controlling I/O, the configurable bi-direction non-isolated IO circuit of Line2 can be shown in Figure 3-52.

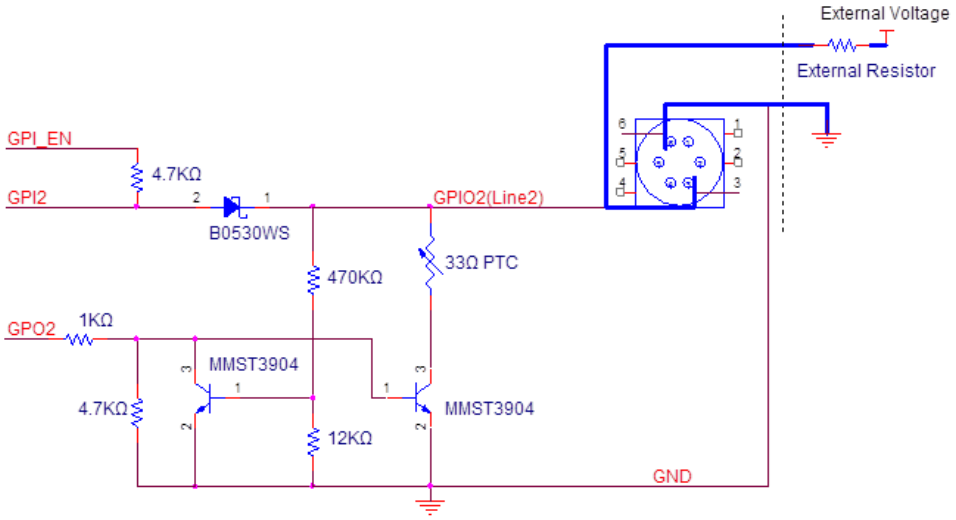

Figure 3-52 Line2 Bi-direction I/O Circuit

NOTE The camera of MV-CA030-10GM/GC has no such function.

1. Configure Line2 to input pin

Logic 0 input level: 0 to 0.5V DC (GPIO2 pin)

Logic 1 input level: 1.5 to 30V DC (GPIO2 pin)

Please make sure the input voltage is not from 0.5V to 1.5V as the electric status among the two values is not stable.

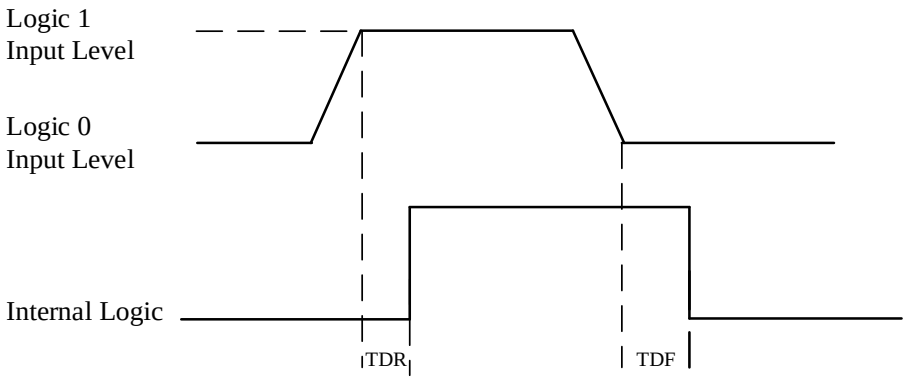

Figure 3-53 Inputting Logic Level

Please connect to GND pin first to protect GPIO pin and then input voltage to Line2 pin.

2. Configure Line2 to output pin

The available maximum current is 25mA and the output impedance is 40Ω.

When the environment temperature is 25 degree centigrade, the relationship among external voltage, impedance and the output low level can be shown in Table 3-7.

Table 3-7 The Parameter of Output Logic Low Level

External Voltage	External Resistor	VL（GPIO2）
3.3V	1KΩ	160mV
5V	1KΩ	220mV
12V	1KΩ	460mV
24V	1KΩ	860mV
30V	1KΩ	970mV

When the external voltage of 1KΩ external resistance turns to 5V, features of output logic level and electric feature in GPIO2 configuration can be shown in Figure 3-54 and Table 3-8.

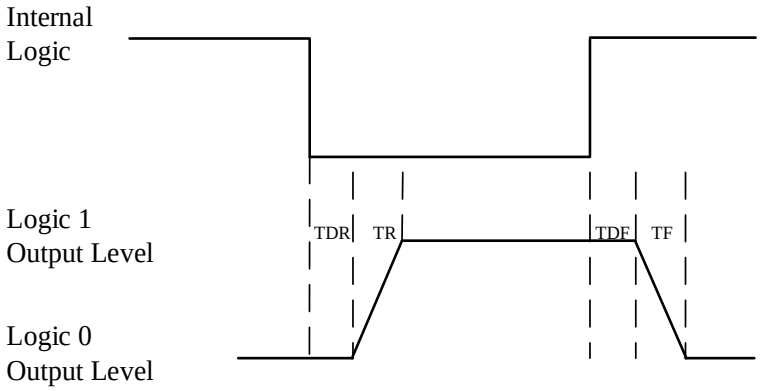

Figure 3-54 Output Logic Level

Table 3-8 Output Electric Feature

Parameter	Symbol	Value
Output Logic Low Level	TR	0.06us
Output Logic High Level	TF	0.016us
Output Rising Time	TDR	0.03us
Output Falling Time	TDF	0.28us

3.10 User Parameter and Preference Setting

3.10.1 Parameters Saving and Loading

The camera can save four groups of parameters, including one group of factory parameter and three groups of configurable parameters. You can save currently configured parameter and set corresponded default parameter when logging in at next time in User Set Control in the attribute list.

Configuration method: Select one of the parameter names in the drop-down box in User Set Selector. Save current parameter setting. In the drop-down box of User Set Default, select one of the parameters when the client runs, as shown in Figure 3-55. Click Execute in both User Set Save and User Set Load.

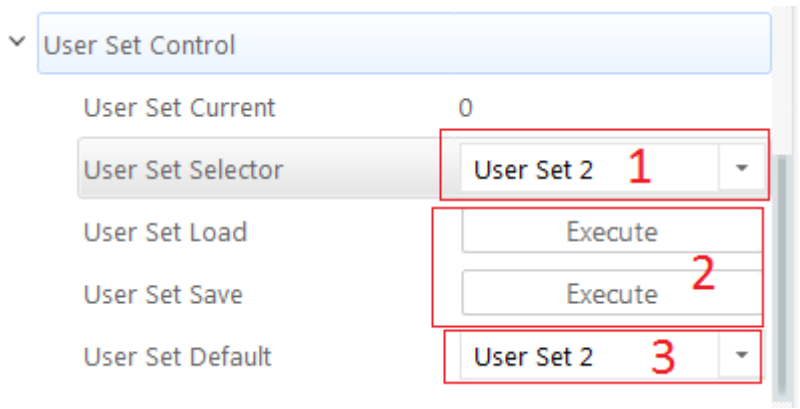

Figure 3-55 Parameters Saving And Loading

Figure 3-56 shows the relationship among four groups of parameters.

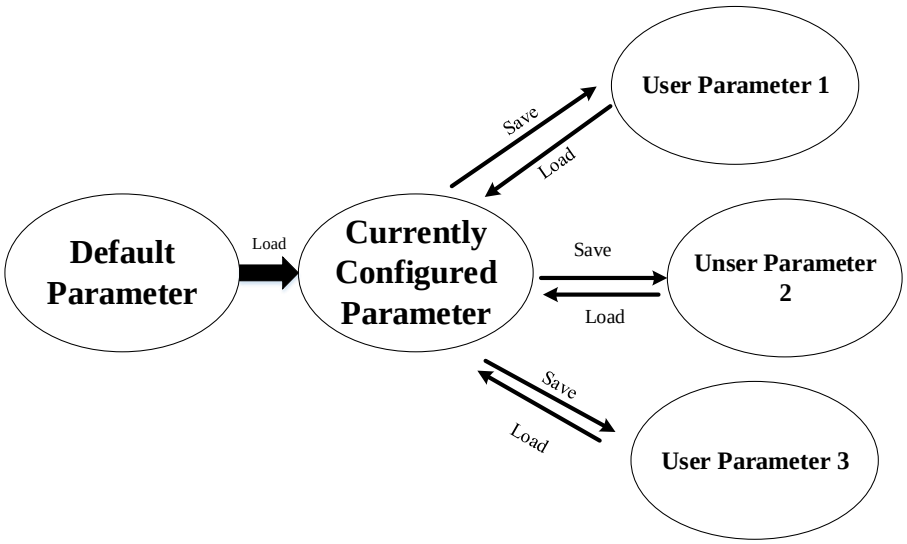

Figure 3-56 The Relationship Among Four Groups of Parameters

3.10.2 Embedded Information

The camera supports embedding information into the image data. The current supporting embedded information is:

- Timestamp
- Analog gain
- Exposure time
- Average brightness
- White balance gain
- Frame number
- Trigger counter
- ROI

The above eight information will be embedded in the image data one by one according to the client. If the information is not available, it will not be embedded.

The AOI will not affect the embedding. If the region of AOI is small, the first line of the image data is not enough for embedding. Then the information will be embedded in the second line.

Each embedded information of the available data will be put in the least 8 significant bits (No matter in MONO8 or RGB24).

The Embedded information is as following:

Timestamp: Take four bytes: transmission with four available data.

Data format: The data format of the timestamp is shown in Figure 3-57.

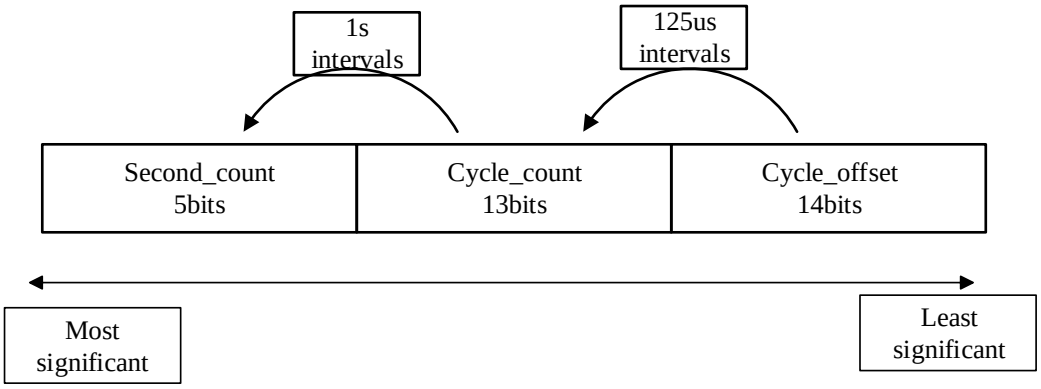

Figure 3-57 Timestamp Format

Analog gain: Take four bytes: transmission with four available data. Connect the least significant 8 bit of the four data together.

The data format of analog gain: Show the connected data directly. The range is form 0 to 1023. The Most Significant Bits will complement 0 automatically.

Exposure time: Take four bytes: transmission with four available data. Connect the least significant 8 bit of the four data together.

The data format of the exposure time: The connected least significant 8 bit of the four data is the number of the exposure line. Multiply the line number to 25.8μs. The result is the exposure time. The unit is μs.

Average Brightness: Take four bytes: transmission with four available data. Connect the least significant 8 bit of the four data together.

The data format of the average brightness: Show the connected data directly. The range is form 0 to 4095. The Most Significant Bits will complement 0 automatically.

White balance gain: Contains three components of gain. It consumes 8 bytes in total, including two bytes for R channel of Gain, two bytes for G channel of Gain and four bytes for B channel of Gain. In other words, the transmission uses eight available image data.

Data format of white balance gain: Each channel consumes 2 bytes. The range is form 0 to 4095.

Frame number: Take four bytes.

Frame number format: Connect four bytes directly. The range is form 0 to 2^32.

Trigger counter: Take 4 bytes. The range is from 0 to 2^32.

ROI: Take three bytes in the initial position. The length and the width consume three bytes.

The data format of ROI:

(1) The initial position of ROI takes three bytes. The length and the width consume three bytes.

(2) The initial coordinate of ROI' column takes one and a half bytes. The initial coordinate of ROI's row takes one and a half bytes. The column coordinate is in the front of the row coordinate. The coordinate of the length and the width also consume one and a half bytes respectively.

Click Image Format Control in the attribute list. Select Embedded Image Info Selector. Choose the parameter in the drop-down box and finish setting, as shown in Figure 3-58.

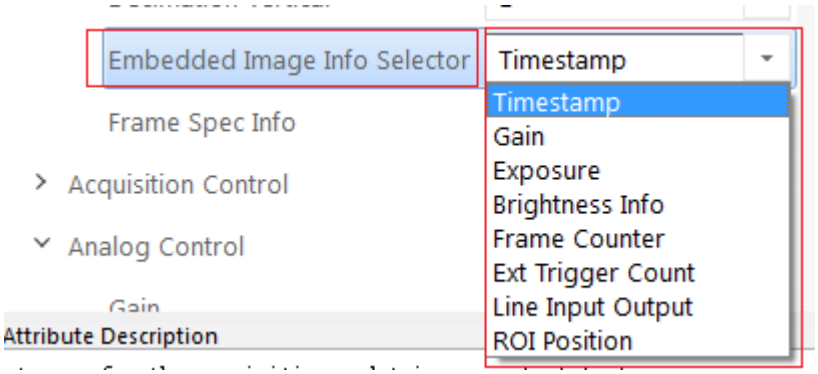

Figure 3-58 Embedded Information

3.11 Firmware Updating

Support firmware updating via USB 3.0. After selecting available device in the device list, open **Tools > Firmware Updating Tool** in the Menu. Select available firmware updating kit, as shown in Figure 3-59.

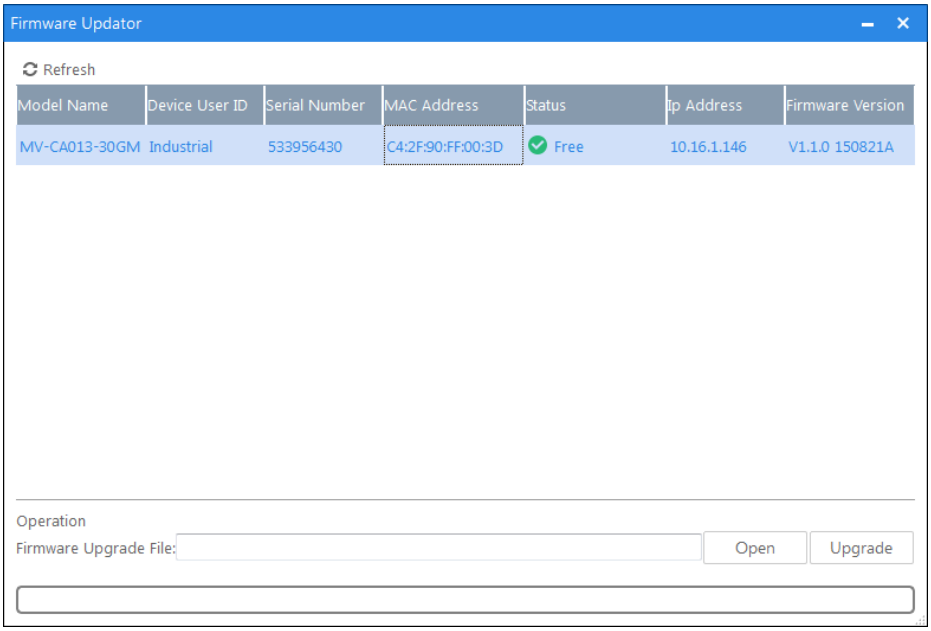

Figure 3-59 Firmware Update

Chapter 4 Troubleshooting

4.1 Indicator Status Definition

Table 4-1 LED Indicator Status

LED Status	**Definition**
Steady On	The LED indicator keeps lights on all the time
Unlit	The LED indicator keeps unlit all the time
Fast Flicker	The LED indicator flickers every 200ms to 300ms
Slow Flicker	The LED indicator flickers every 1000ms.
Extreme Slow Flicker	The LED indicator flickers every 2000ms.

4.2 Indicator Status Description

Table 4-2 LED Status Description

Indicator Status		**Camera Status**
Indicator in Red	**Indicator in Blue**	
-	-	The camera is off or hardware damaged.
Extreme Slow Flicker	-	Connection failed.
-	Steady On	The camera is starting up.
-	Slow Flicker	Transmitting image while the camera is in the internal trigger mode with the transmission speed of USB 2.0.
-	Fast Flicker	Transmitting image while the camera is in the internal trigger mode with the transmission speed of USB 3.0.
	Extreme Slow Flicker	Transmitting image while the camera is in the external trigger mode.
The indicator flickers red and blue alternately evey 1 second.		Upgrading the firmware.
Steady on	-	Upgrading the firmware failed. Contact the technical support.

4.3 FAQ

Table 4-3 FAQ

No	Problem Description	Possible Reasons	Solutions
1	1. The camera cannot be detected by the client software. 2. The camera is detected by the client software but connecting failed.	1. The camera does not work properly. 2. MVS installation error or failed to install the USB 3.0 drive.	1. Confirm that the power supply of camera is well connected (via LED indicator), and the USB 3.0 connects properly. 2. Check the drive installation status. 3. Reinstall MVS client or drive.
2	The live view of camera is black.	1. The iris is closed. 2. Camera error	1. Open the iris. 2. Reboot the camera.
3	Camera cannot be triggered	1. Incorrect cable connection. 2. The camera works in the internal trigger mode	Make sure the trigger mode is correct and the external trigger is well connected.
4	The live view and image are normal, while the image saved could not be displayed properly.	The mismatched image format.	Make sure the image format what you saved is supported.