iRAYPLE CameraLink Line Scan Camera

User's Manual

V2.0.0

Foreword

This manual introduces the installation, functions, and configuration of the CameraLink line scan camera (hereinafter referred to as"the device", "the product", or"the camera"). Read carefully before you use the device, and keep the manual safe for future reference.

Models

L5047CK140, L5047MK140, L5082MK170, L5087CK670, L5087MK470, and L5162MK170

About the Device

The device described in the manual can only be sold and used in mainland China. After-sales service and maintenance service are only available in countries or regions where the device is purchased.

About the Manual

The manual is for reference only. Slight differences might be found between the manual and the Camera. iRAYPLE might update the manual due to device upgrade or other needs. You can obtain the latest manual from the official website of iRAYPLE https://www.irayple.com/cn/home. We recommended you use the manual under the guidance of professionals.

Disclaimer

To the fullest extent permitted by law, the manual and the device described (including its hardware, software, firmware, etc.) are provided "as is" with possible flaws or errors. iRAYPLE does not provide warranties of any kind, express or implied, including but not limited to warranties of merchantability, quality satisfaction, fitness for a particular purpose, etc. iRAYPLE shall not compensate for any special, incidental, incidental or indirect damages caused by the use of the manual or the use of iRAYPLE devices, including but not limited to loss of business profit, system failure, and data or document loss.

- When using the device, strictly follow applicable laws and regulations to avoid infringing on the rights of third parties.
- If the data in the manual is different due to environmental and other factors, iRAYPLE shall not assume the consequences arising therefrom.
- For any conflict between the contents defined in this Manual and applicable laws, the laws shall prevail.

Safety Instructions

The following signal words might appear in the manual.

Signal Words	Meaning
	Indicates a high potential hazard which, if not avoided, will result in death or serious injury.
	Indicates a medium or low potential hazard which, if not avoided, could result in slight or moderate injury.
	Indicates a potential risk which, if not avoided, could result in property damage, data loss, lower performance, or unpredictable results.
	Provides methods to help you solve a problem or save time.
	Provides additional information as a supplement to the text.

Revision History

Version	Revision Content	Release Time
V2.0.0	Updated the manual.	January 2023
V1.0.0	First release.	April 2022

Important Safeguards and Warnings

This chapter introduces how to use the product in a proper manner. To prevent hazards and property damage, read the following requirements before you use the product and comply with the requirements when you use the product.

Transportation Requirements

- Pack the device with packaging provided by its manufacturer or packaging of the same quality before transporting it.
- Do not place heavy stress on the device, violently vibrate or immerse it in liquid during transportation.
- Transport the device under allowed humidity and temperature conditions. Refer to the technical parameters for requirements on the temperature and humidity that is suitable for transporting the device.

Storage Requirements

- Store the device under allowed humidity and temperature conditions. Refer to the technical parameters for requirements on the temperature and humidity that is suitable for storing the device.
- Do not place heavy stress on the device, violently vibrate or immerse it in liquid during transportation.

Requirements

DANGER

- Make sure that the power is off when you connect the cables, install or disassemble the device.
- For devices with earthing systems, make sure they are grounded to avoid their being damaged by static electricity or induced voltage, and the risk of electrocution.
- All installation and operations must conform to the local electrical safety code and standards.
- The device must be installed by professionals using accessories suggested by the manufacturer.
- Install the device in a well-ventilated place, and do not block its ventilation.
- Do not place the device in a place exposed to sunlight or near heat sources, such as a radiator, heater, stove or other heating equipment. This is to avoid the risk of fire.
- Do not place the device in an explosive, humid, dusty, extremely hot or cold site that has corrosive gas, strong electromagnetic radiation or unstable illumination.
- Do not place heavy stress on the device, violently vibrate or immerse it in liquid during transportation.

DANGER

Safe and stable power supply is a prerequisite for the proper operation of the device.

- Make sure the ambient voltage is stable and meets the power supply requirements of the device.
- Protect the power cord and wires from being walked on or squeezed particularly at plugs, power sockets, and the point where they exit from the device.
- Do not connect the device to two or more kinds of power supplies, to avoid safety risks and damage to the device.
- Refer to you's manual for the power requirements of the device.

We recommend you use the device with a lightning protector for better lightning-proof effect.

Operation Requirements

A suitable operating environment is necessary for the device to work properly. Make sure that the following requirements are met before use.

- Use the device under allowed humidity and temperature conditions. Refer to the device label for information on the operating temperature and humidity of the device.
- Use the device on a stable surface.
- Do not allow liquid to get into the device to avoid damage to the internal components. If any liquid flows into the device, immediately disconnect the power supply, unplug all the cables connected to the device, and contact after-sales service.
- Do not plug in or unplug RS-232, RS-485 and other ports while the power is on to avoid damage to the ports.
- Back up data in time during deployment and use, in an effort to avoid data loss caused by abnormal operation. We are not liable for data security. We are not responsible for data security issues.
- Do not expose the lens to strong light, such as strong illumination, sun light or laser beams. Otherwise, the imaging sensor will be damaged.
- We are not responsible for any damage incurred to the device due to the excessive or improper use of the device.

Maintenance Requirements

- Contact professionals for regular inspection and maintenance of the device. Do not disassemble or dismantle by yourself.
- Use the accessories suggested by the manufacturer. Maintenance must be performed by qualified professionals.

Table of Contents

1 Overview

1.1 Introduction

The device is a highly reliable and cost-effective camera for industrial use.

The CameraLink line scan camera uses a high-performance photosensitive chip and transmits image data through the CameraLink data interface. It can be compatible with any tools that meets the CameraLink protocol and GenICam standards. The max. theoretical transmission rate can reach 6.8 GB/s, meeting the transmission rate requirements in most industrial scenarios. It can work stably in various harsh environments, and are highly reliable and cost-effective.

Figure 1-1 L5047MK140

1.2 Product Features

- Simple installation and easy operations
- Supports Deca, Full, Medium, and Base. Theoretically, it can provide up to 6.8 GB/s bandwidth.
- Multiple trigger modes such as external trigger, free-run, multi-frame trigger, and more.
- Multiple image data formats.
- Compatible with CameraLink protocol and GenICam standards
- 12-24 VDC wide range voltage
- Complies with CE and FCC certification standards
- Bright field uniformity correction and multiple ISP functions

1.3 CameraLink Camera and Capture Card

Camera Link interface has been continuously upgraded and transformed since its birth to adapt to the increasingly high data throughput requirements. Therefore, we can find various versions, including Base, Medium, Full, and Deca, on the market. They can transfer data at different rates, and some interfaces can use 2 cables for transmission as required.

- Base: Transmits signals through a single connector or cable. The cable used is the MDR (Mini D Ribbon) 26-pin male plug connector, optimized by 3M for LVDS signals. In addition to 5 LVDS pairs (24 bits of data and 4 framing/enabling bits) for transmitting serial video data, the connector comes with 4 LVDS discrete control signals and 2 LVDS asynchronous serial communication channels for communicating with the camera. At the maximum chipset operating frequency (85 MHz), basic settings produce a video data throughput of 2.04 Gbit/s (255 MB/s).

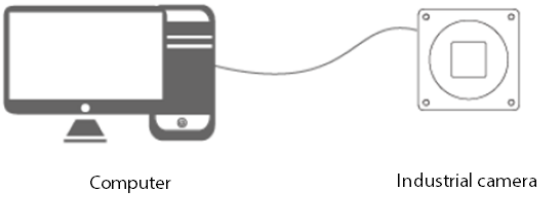
- Medium and Full: Camera Link specifications include higher bandwidth configurations that provide additional video data paths through a second connector or a second cable. The "Medium" configuration doubles the video bandwidth, and 24 bits of data and 4 identical framing/enabling bits are added to the "Base" configuration. This results in a 48-bit wide video data path with a throughput of up to 4.08 Gbit/s (510 MB/s). The "Full" configuration adds another 16 bits to the data path, resulting in a 64-bit wide video path that supports 5.44 Gbit/s (680 MB/s).

  If Base=Channel Link, Medium=Base+Channel Link and Full=Base+2Channel Link.
- Deca: With the development of camera technologies, the original Camera Link Full standard has been unable to meet the image capture requirements of some ultra-high resolution cameras. Therefore, the 8 unused bits in the Camera Link Full standard are re-allocated and used. This creates the new standard DecaCamera Link. The Deca standard can use 2 connectors or a second cable to generate an 80-bit data path width, greatly expanding the data bandwidth to 5.44 Gbit/s (850 MB/s).

  The term "Camera Link Deca" is used by major camera manufacturers to describe compatible cameras and image capture cards. However, some manufacturers use "Extended Full" to refer to the Deca configuration, and some still use "Camera Link Full" to refer to the Deca mode. This might confuse you when you choose which cameras to purchase.

  Networking of CameraLink line scan camera: Install a capture card on the host, and then connect the host to the camera through a CameraLink cable. After connection, the MV Viewer and capture card installed on the host can detect online industrial cameras and allow you to configure and use these cameras.

Figure 1-2 Networking



1.4 Working Environment

- Temperature and humidity
  - ◇ Operating temperature: –30 °C to +50 °C (–22 °F to +122 °F).
  - ◇ Operating humidity: 20%–80% (non-condensing).
  - ◇ Storage temperature: –30 °C to +80 °C (–22 °F to +176 °F).
  - ◇ Storage humidity: 20%–80% (non-condensing).
- Install the device indoors on a stable surface, and leave enough space for heat dissipation.
- Ensure air circulation.

1.5 Product and Accessories

1. Camera: The CameraLink line scan camera described in the manual.
2. Lens: Select a lens based on your needs.
3. Adapter ring: Purchase an adapter ring if the lens cannot be directly connected to the device.
4. Purchase power I/O cables (12-pin/6-pin cables or extension cords).
5. Power adapter or switched-mode power supply (12 V-24 V).
6. Cat-6 network cable with an appropriate length.
7. Capture card with a CameraLink interface.
The cable to the capture card must be matched with the type of the capture card. In general, 1 or 2 cables are required. If the CL interface of the capture card is the big part,

you must purchase the CameraLink cable used for converting a large port to a small port.

1.6 Status Indicator

Table 1-1 Description of status indicators

Status	Indicator		Description
Normal	Red	Flashes quickly	The device is starting.
	Blue	Low light	The address has been allocated, but the application API is not connected to the device.
		Bright	The application API is connected to the device and the device is in free-run mode, but there is no image transmission.
		Flashes quickly	The application API is connected to the device, the device is in free-run mode, and there is image transmission.
		Flashes slowly	The device is in trigger mode.
	Red Blue	Flashes alternately	The firmware is being upgraded.
Abnormal	Red	Solid on	The device is abnormal, such as no bit stream, firmware upgrade failure.
		Flashes slowly	The network is disconnected.

2 MV Viewer Installation and Camera Connection

2.1 Download Method

Step 1 Visit http://download.huaraytech.com/pub/sdk/Ver2.2.5/Windows/CL_support_ver/.

You can select a version as needed. For details, contact technical support.

Step 2 Confirm the version and system information. Download the package, and then install the package on your computer. If you use a Cameralink camera, select MV of CL_support version.

Path to development manual (default)

C:\Program Files\HuarayTech\MV Viewer\Documentations

Path to driver file (default)

C:\Program Files\HuarayTech\MV Viewer\Drivers

Path to samples

C:\Program Files\HuarayTech\MV Viewer\Development\Samples

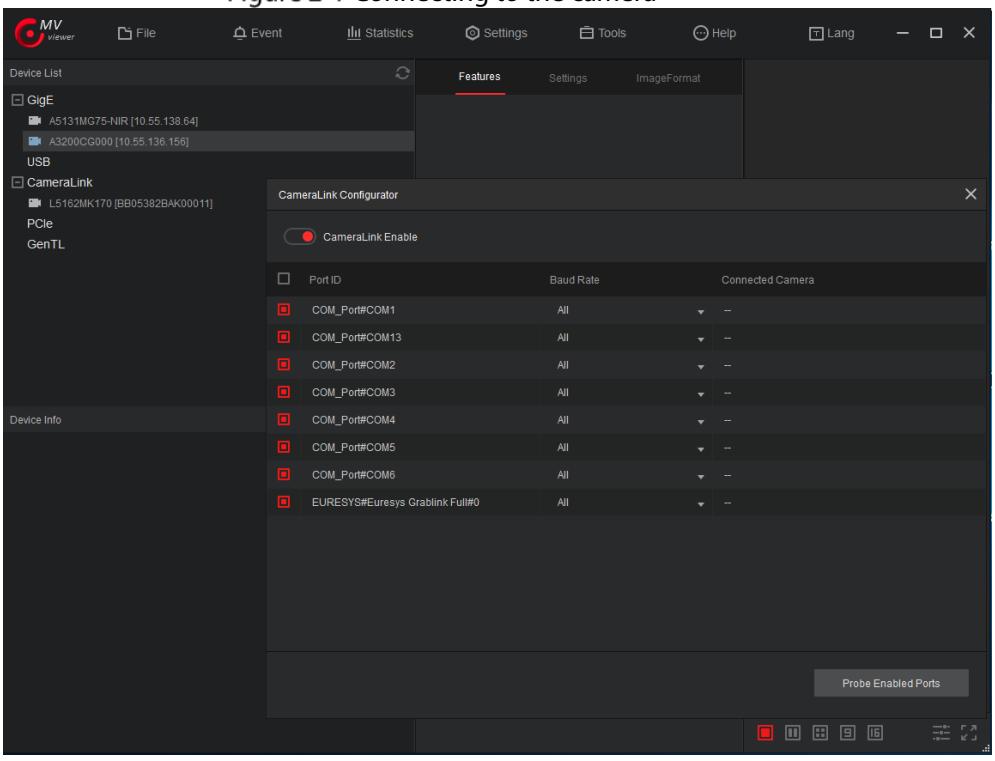
2.2 Camera Connection

Step 1 Connect the capture card to the camera, and then open MV Viewer to configure and use the camera. Image and trigger related settings needs to configured in the software of the capture card.

After you install the capture card, you need to check the configuration tool of CameraLink in the device manager or MV. Check whether the port of the capture card has been correctly configured. Otherwise, after the camera is inserted with the capture card, if MV still cannot detect the camera, you need to open the capture card software to check whether the port needs to be manually configured or whether some steps are missing when installing the capture card software.

Port on capture card	Port on camera	Capture mode
CL1	CL1	Base
CL2	CL2	Medium, full, deca

Figure 2-1 Connecting to the camera

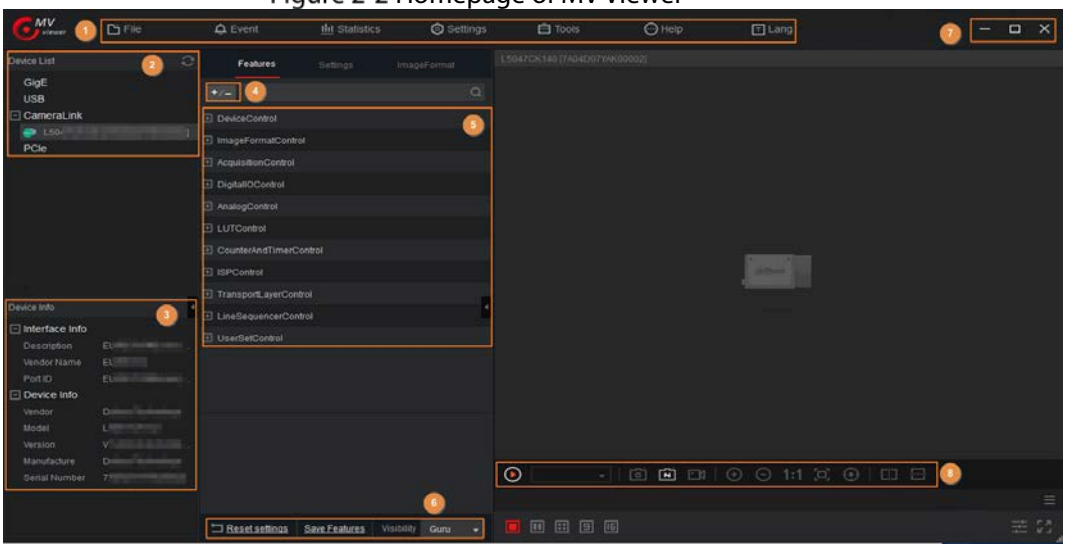


2.2.2 Configurations of Capture Card and Camera

After the camera is installed and the capture card is connected using proper cables, you need to set the basic parameters of the capture card. If the settings are not set or are incorrect, the camera cannot generate images or images are incorrectly generated.

The basic parameter names of capture cards from different manufacturers might vary. You need to set the parameters based on actual conditions and the user manual of the capture card. Contact the technical support of the capture card or our company for help.

Figure 2-2 Homepage of MV Viewer



Configure the camera.

Table 2-1 Description of MV Viewer parameters

No.	Parameter	Description
1	Menu	For details, see Table 2-2.
2	Device list	Includes GigE, USB, CameraLink and PCLe cameras. : Click the icon to refresh online devices.
		: Device to be connected.
		: Device is connected. One camera can only be connected to one MV Viewer at a time.
3	Device information	The port and device information on connected cameras.
4	Parameter information	/: Display or hide the parameter information.
5	Function	Select and configure function parameters.
6	Operation level	• Reset settings: Click to restore all parameters to default values. • Save Features: Click to save the current change on a parameter. • Visibility: Click to select **Beginner**, **Expert** or **Guru** from the drop-down list. Each character corresponds to different sets of parameters.
7	Window menu	/: Maximize/restore/minimize the image window. : Close MV Viewer.
8	Tool bar (For CameraLink cameras, functions related to	Continuous /: Start/stop playback. Click and select play mode among continuous, single frame and multiple frames as needed. You can only select play mode when the video is paused.
		: Save single or multiple frames of images.
		/: Zoom in or out the image.

No.	Parameter	Description
	image display are unavailable in MV Viewer. You can configure the parameters in the capture card.)	1:1/: Displays the image in 1:1 ratio or as the window size. When the image is zoomed in or out, click can restore the image to windows size.
		/: The mirror of image in the vertical or horizontal direction.

You can only operate on the images during pause or the image stops.

Table 2-2 Menu parameter description

Menu		Description
File	Open File	Select **File > Open File**, select a file in the pop-up window, and click **Open**.
	Open Recent	Select **File > Recent**, and then the software displays 10 files that you have recently opened in MV Viewer. Click a file to open it.
	Save	Save the changes of the current file.
	Save as	Save the current file to a different path with a different name.
Event		Notifications for events such as device parameter change, event message channel and stream cache.
Statistics		Collect data such as capture frame rate, bandwidth, number of received images, frame loss rate, and number of wrong images.
Settings (For CameraLink cameras, functions related to image display are unavailable in MV Viewer. You can configure the parameters in the capture card.)	General Settings	You can configure camera operation level and basic parameters on the client.
	Image saving	Set the storage path and format of images.
	Video recording	Set the storage path and format of recorded videos.
	Video saving	Set cache parameters of video streams.
	Transmission control	Set parameters such as command response timeout, heartbeat interval, and stream packet timeout.
Tool	Camera tool	Upgrade the firmware of cameras, configure camera IP addresses, and more.
	Driver management tool	Install or uninstall the basic driver of MV Viewer.
	Network adapter configuration tool	The tool can be used to switch network adapters and configure parameters of network adapters.
Help		About: View the version information on the software.
Audio	Configure language	Select Chinese or English.

3 Production Introduction

3.1 Models and Parameters

CameraLink line scan cameras can be classified into 3 categories. You can distinguish them distinguished based on the resolution and sensor manufacturers. The naming rules are as follows:

For example: L5047MK140, L5082MK170.

- L stands for Line.
- 5 means the camera belongs to the 5000 series of iRAYPLE cameras. The third number 4 in 5047 means 4 k, and the camera sensor width is 4096. The fourth number 2 in 5047 means that the sensor manufacturer is CMOSIS. If it is 7, the sensor is made by Gpixel.
- The sixth digit C or M represents color or mono. The seventh digit G represents the Ethernet port. If it is K, it represents the CameraLink port.
- The last 3 numbers are for internal use.

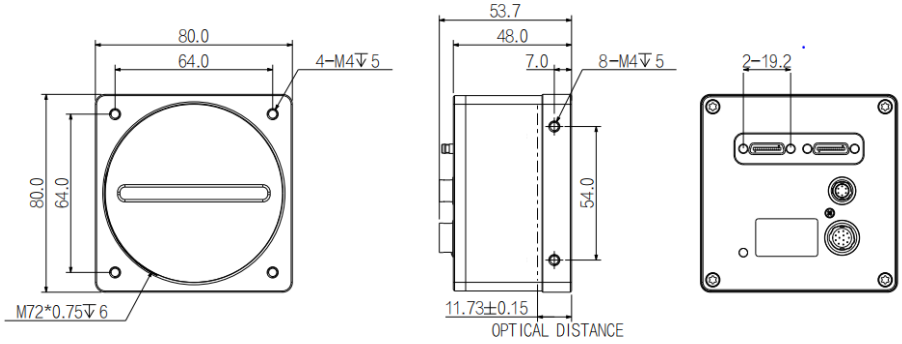
Table 3-1 Description of CameraLink line scan camera

Model	Sensor type	Resolution	Line frequency	Bit depth (bit)	Port	Color	Pixel pitch (μm^2)
L5047CK140/ 141	CMOS	4096x2	62 KHz/ 92 KHz	12	CameraLink	Color	7 × 7
L5047MK140/ 141		4096x1	120 KHz/ 180 KHz			Mono	7 × 7
L5082MK170		8192x1	80 KHz			Black and white	7 × 7
L5087MK470		8192x4	100 KHz	10			5 × 5
L5087CK670		8192x6	34KHz			Color	5 × 5
L5162MK170		16384x1	50KHz	12		Black and white	3.5 × 3.5

3.2 Dimensions

L5082MK170

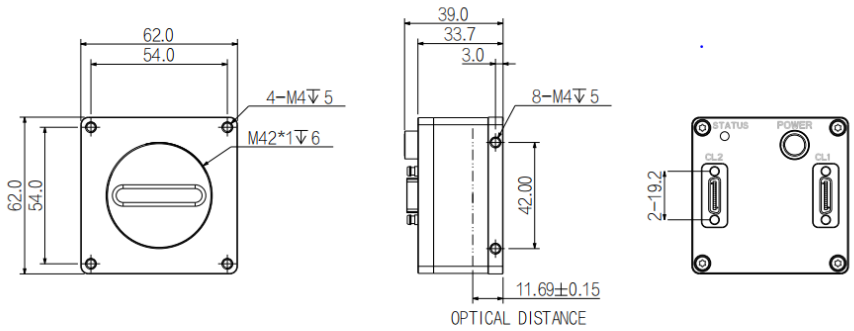
Figure 3-1 L5082MK170 (Unit: mm)



L5047CK140, L5047MK140

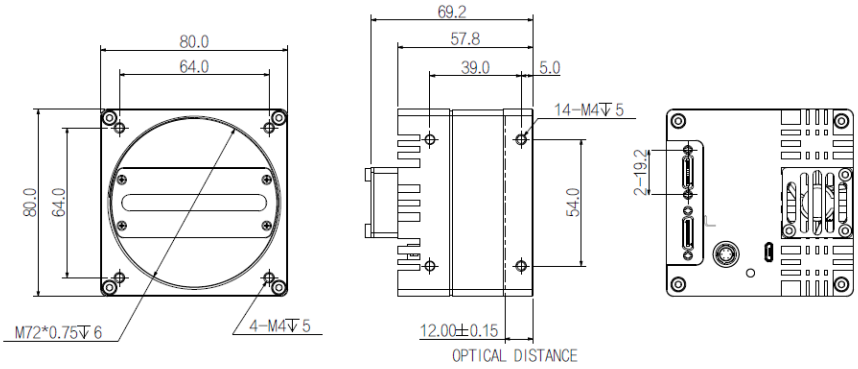
The dimensions and structure of the 2 models are the same

Figure 3-2 L5047CK140, L5047MK140 (Unit: mm)



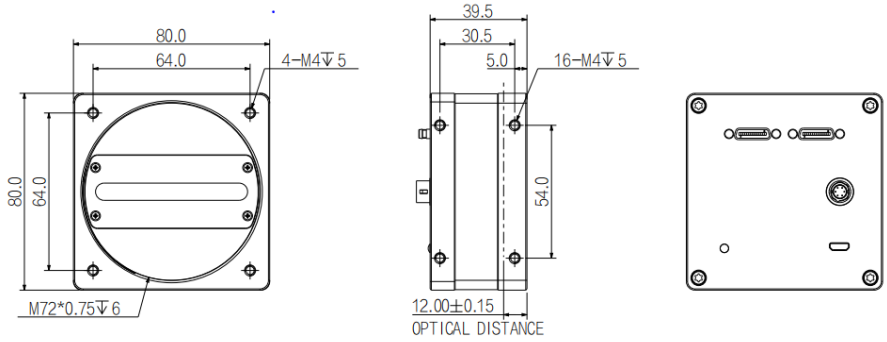
L5087MK470, L5087CK670

Figure 3-3 L5087MK470, L5087CK670 (Unit: mm)



L5162MK170

Figure 3-4 5162MK170 (Unit: mm)



3.3 IO Electrical Specifications

Except L5082MK170, CameraLink line scan cameras only have the capture card port and 6-pin power ports. Their signal trigger is provided by the capture card. For the definition of IO trigger connection of capture card, see the user manual of the capture card.

The L5082MK170 has a capture card port, a 6-pin power supply, and a 12-pin trigger port. The trigger signal can be provided by the capture card or the 12-pin trigger port of the camera.

Figure 3-5 IO port on L5082MK170

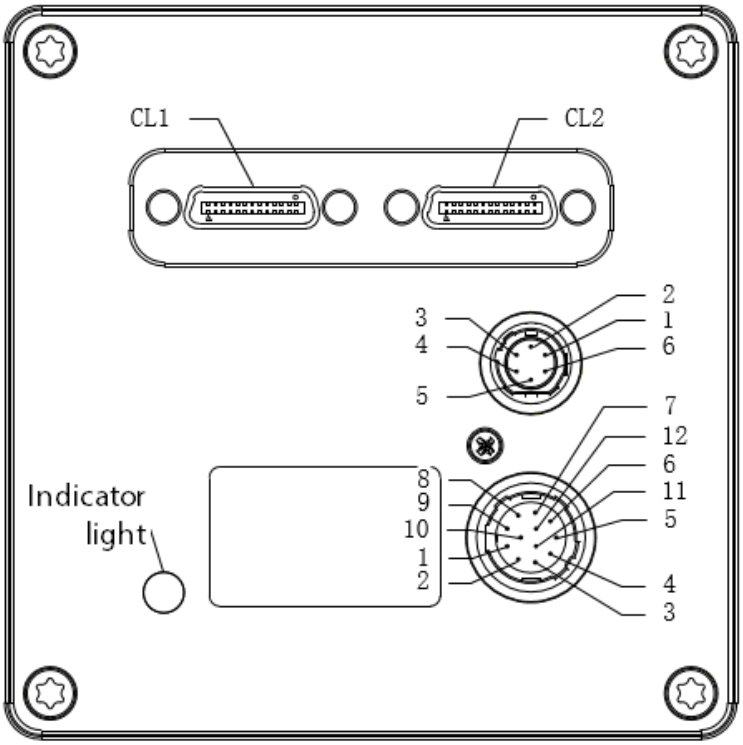


Table 3-2 Electrical specifications of L5082MK170

No.	Signal name	Function	Suggestion
1	Line1_in–	RS422 input -	Connects the encoder (line trigger)
2	Line1_in+	RS422 input +/single-end input	
3	Line3_inout–	RS422 input/output	—
4	Line3_inout+	RS422 input/output +/single-end input/output	
5	Signal ground	Signal ground (SGND)	Encoder power ground (0 V)
6	Line5_out–	RS422 output -	—
7	Line5_out+	RS422 output+/single-end output	
8	Line2_in–	RS422 input	Connects the encoder (line trigger)
9	Line2_in+	RS422 input +/single-end input	
10	Line4_GPIO	single-end input/output	Connects the photoelectric switch (frame trigger)
11	Line6_out–	RS422 output	—
12	Line6_out+	RS422 output+/single-end output	

Table 3-3 Description of 6-pin power ports on line scane camera

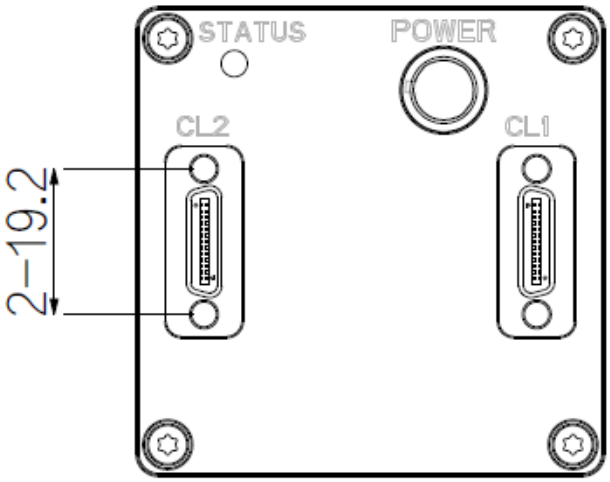
Color	Pin	Signal	Function
Blue	1	Power	6-24 VDC power supply of the camera
Red	2	–	
Gray	3		

Color	Pin	Signal	Function
Mono	4		
Green	5		
Brown	6	GND	DC power grounding

The color coding given in the table is the definition of the I/O cables of iRAYPLE cameras.

A signal pin not in use must be hanged. Do not connect it to the power supply or GND to avoid camera damage.

Figure 3-6 Ports on the back of L5047CK140 and L5047MK140



L5087CK670, L5087MK470 and L5162MK170 have a reserved Android development port for upgrading and importing FPN coefficient. In addition, L5087CK670 and L5087MK470 have a fan for heat dissipation.

Figure 3-7 Ports on the back of L5087CK670 and L5087MK470

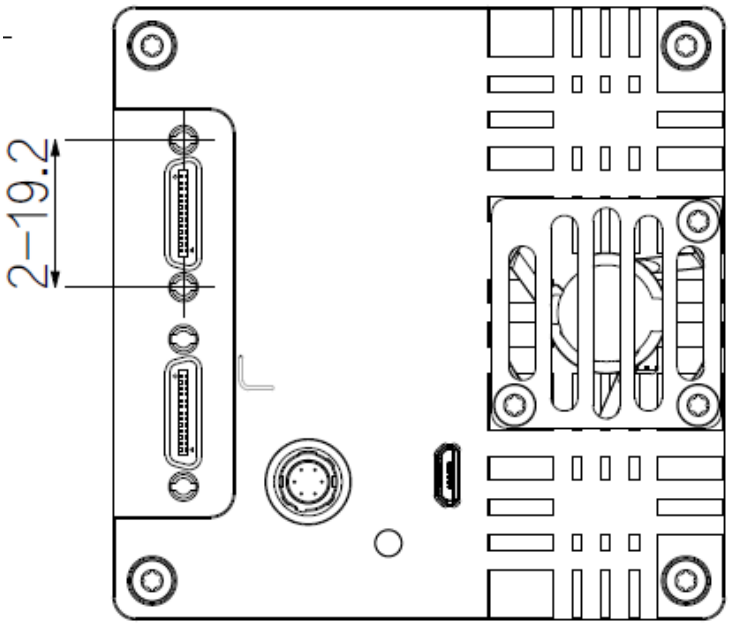
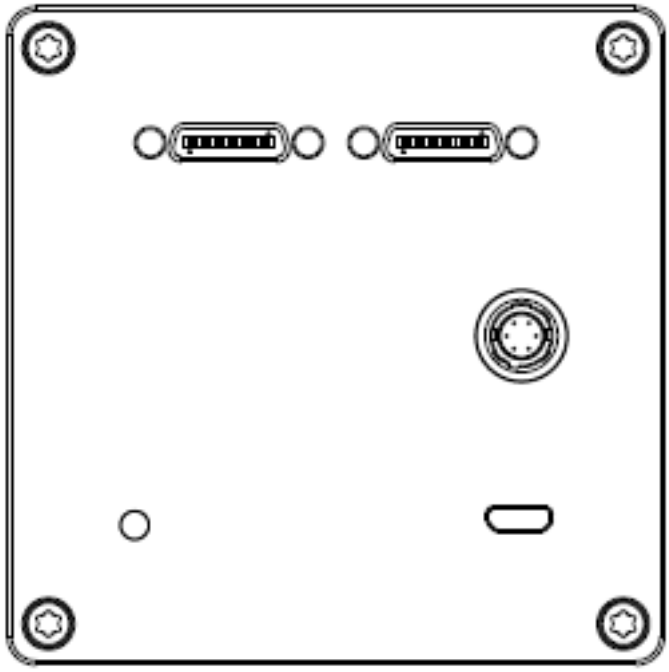


Figure 3-8 Ports on the back of L5162MK170



3.4 Notes for IO Electrical Specifications

During the use of the camera, improper electrical operations can easily lead to damage to the camera. An unused output signal pin must be hanged. Connect an input pin not in use to GND (recommended) or leave it hanging, instead of connecting it to the power supply to avoid camera damage. The safe voltage and instantaneous voltage must not exceed 24 V.

You might not be familiar with the operating principle encoders. Therefore, the following chapter describes knowledge of encoders and methods to avoid EMI and ESD.

3.4.1 Avoiding EMI and ESD

Cameras are installed in industrial sites where equipment that generates EMI (electromagnetic interference) may exist, and are themselves susceptible to ESD (electrostatic discharge). Serious EMI and ESD can lead to false triggering or sudden stop of current sampling. EMI and ESD can also adversely affect image quality of cameras and the reliability of data transmission between camera and PC.

In order to avoid the problems mentioned above caused by EMI and ESD, customers are recommended to take the following precautions:

- Use high quality shielded cables, which can play a good effect on shielding EMI and ESD;
- Use a cable with an appropriate length. If the cable is excessively long, bend it back and forth instead of making it a coil.
- Make the power cord of the camera in parallel with the data cable.
- Do not make camera cables in parallel with cables with heavy current or cables connected to high-power switch devices (such as stepper motor drive and solenoid valve). Do not make camera cables close to the preceding devices.

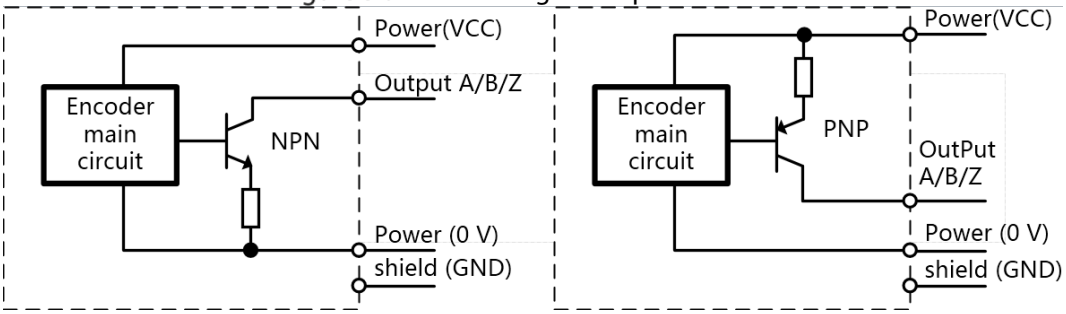
- Connect all grounding (GND) wires to a single point. For example, you can use a distribution board to connect the grounding wires of the whole system to a single point. This is done to avoid plenty of ground circuits (which are a major cause of EMI problems).
- Use a line filter for the main power supply of the camera, or use a separate power supply.
- Install the camera and cables far away from devices generating spark, such as brush motors and relays. If necessary, you can use a metal shield.
- The following measures can be taken to reduce the risk of ESD:
  - ◇ Use conductive material for the mounting surface.
  - ◇ Ensure appropriate humidity in the environment. Dry air easily leads to ESD.

3.4.2 FAQ Related to Rotary Encoder Hardware

What is the difference between voltage output, collector signal output, and differential output of the encoder?

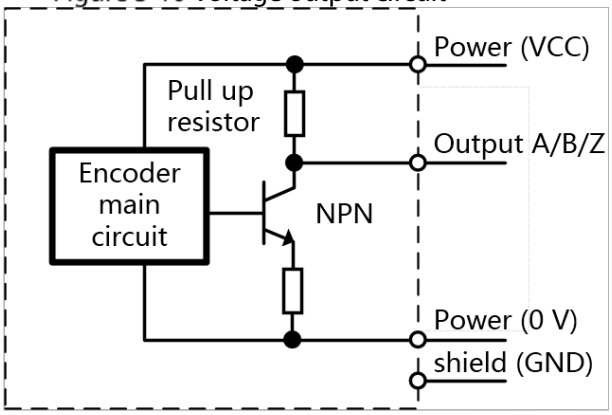
- The collector signal output uses the transistor emitter of the output circuit as the common end, and the collector is suspended in the output circuit. Generally, the collector signal output is divided into NPN open collector output and PNP open collector output.

Figure 3-9 Collector signal output



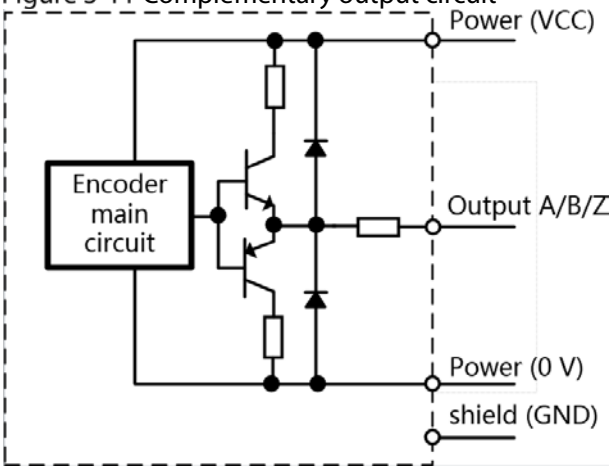
- Voltage output is based on an open-collector output circuit. A pull-up resistor is connected between the power supply and the collector, so that stable voltage can be provided between the collector and the power supply.

Figure 3-10 Voltage output circuit



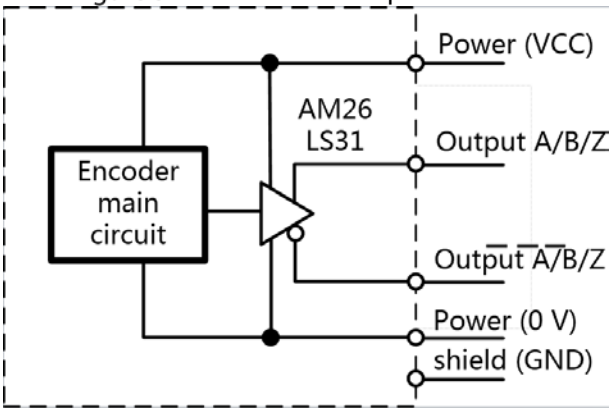
- Output circuit with NPN and PNP transistors for complementary output. According to the strength of the output signal, the 2 output transistors switch alternately. This allows longer transmission distance than the open-collector output circuit.

Figure 3-11 Complementary output circuit



- Differential output is a data transmission method by using dedicated IC output and based on RS422-A specifications. The signal outputs as a differential 2 signal, so it has strong anti-interference ability, suitable for long-distance and high-speed transmission. The camera side uses a dedicated IC (called RS422 transceiver) to receive the signal sent by the encoder.

Figure 3-12 Differential output



What is the difference between an incremental encoder and an absolute encoder?

After power failure, the incremental encoder does not record the angle that it has rotated before the power failure. Absolute encoders can save the previously rotated angle after power-off, and record up to 360°. Huaray line scan cameras only support incremental encoders.

What causes missing pulses of rotary encoder?

Possible causes:

- The encoder rotated too fast, exceeded the response frequency of the encoder or subsequent device.
- The wire is extended too long and the signal is attenuated.
- There is hardware failure of encoders.
- There is jitter or interference on site, such as jitter of mechanical transmission devices and electrical cable interference.
- The encoder and the motor shaft are not fixed tightly, and there is eccentric angle.

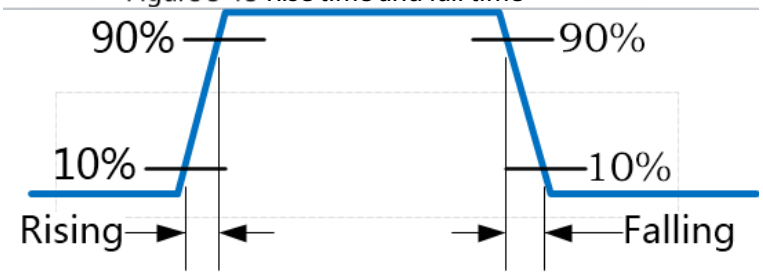
How to know the quality of a rotary encoder?

- Check whether the number of pulses is correct when connecting the camera.
- Connect the oscilloscope to view the waveform.
- Use a multimeter to test whether the output is normal.
  - ◇ When the encoder is NPN output: Test the positive pole of the power supply and the signal output cable. When the transistor is turned on (ON), the output voltage is close to the encoder supply voltage, and when the transistor is turned off (OFF), the output voltage is close to 0 V.
  - ◇ When the encoder is PNP output: Test the negative pole of the power supply and the signal output cable. When the transistor is turned on (ON), the output voltage is close to the encoder supply voltage, and when the transistor is turned off (OFF), the output voltage is close to 0 V.

What are rise time and fall time?

- Rise time: The time for the output pulse to rise from 10% to 90%.
- Fall time: The time for the output pulse to fall from 90% to 10%.

Figure 3-13 Rise time and fall time



What are maximum response frequency and maximum allowed speed?

- The maximum response frequency is the maximum electrical response frequency of the encoder. The unit is Hz. If the encoder is used not exceeding this parameter, its internal circuit will not be able to respond, resulting in pulse leakage of the encoder.
- The maximum allowed speed refers to the highest speed that the shaft of the encoder can withstand during rotation. The unit is r/min. If the encoder is used when max. allowed speed is exceeded, the shaft of the encoder will be damaged.

How far can the signal output of the rotary encoder be transmitted?

It depends on the encoder output type.

- Open collector NPN/PNP output: 10 m.
- Voltage output: 2 m.
- Complementary output: 30 m.
- Differential output (or cable drive output): 100 m.

- We recommend using a differential output (linear drive output) encoder for long-distance transmission.
- If you want to extend the wire of the encoder, you must use a shielded twisted pair.

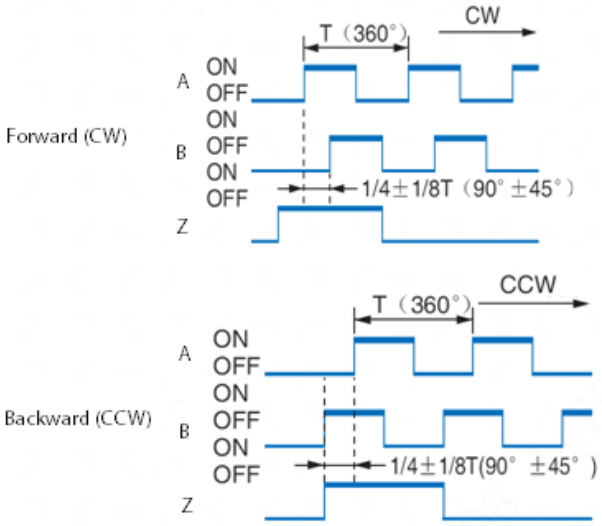
How to avoid encoder interference?

- Use shielded cables for signal cables, and connect them reliably.
- The signal wires are routed separately from high-current power cables (such as motor wiring).
- Install the device separately from high-power or high-frequency device.

What do the phase A, phase B and phase Z output of the incremental encoder mean?

Each time the encoder rotates, phase A and phase B send out the same number of pulses, but there is a 90° phase difference between phase A and phase B (one rotation is 360°), and you can learn whether the encoder is rotating forward or reverse according to the phase difference. During forward rotation, phase A leads B phase 90° for phase output, and for reverse rotation, phase B leads phase A by 90° for phase output (as shown in the figure below). Each time the encoder rotates, phase Z only sends out a pulse at a fixed position, so it can be used as a reset phase or a zero phase.

Figure 3-14 Phase difference



What is encoder resolution?

Resolution is also called the number of pulses. For an incremental encoder, resolution is the number of pulses output by the encoder after the shaft rotates one circle.

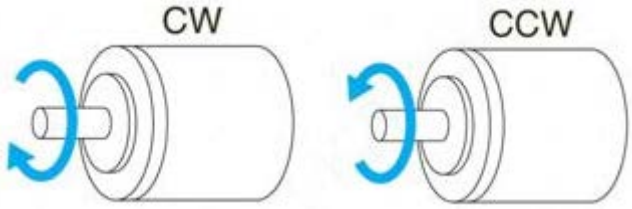
What is the output phase?

For incremental encoders, it refers to the number of output signals. It includes 1-phase type (phase A), 2-phase type (phase A, phase B), 3-phase type (phase A phase, phase B, and phase Z).

What are CW and CCW?

CW means clockwise rotation. For this rotation direction and an incremental encoder, phase A outputs before phase B. The opposite of the CW rotation direction is CCW (counter clockwise). In such rotation direction, phase B of an incremental encoder outputs before phase A.

CW and CCW



How do I convert the signal output by NPN into the signal output by PNP?

Connect a pull-up resistor between the NPN output pin and the encoder power supply, output a low level when the transistor is turned on, and output a high level when the transistor is turned off. The pull-up resistor value depends on the camera's minimum turn-on voltage and the internal resistance of the input terminal, generally 4.7 K–10 K.

4 Functions

This chapter mainly introduces the functional parameters related to industrial cameras.

- Industrial cameras support 3 user levels, including **Beginner**, **Expert** and **Guru**. Each corresponds to slightly different sets of parameters.
- Grayed out parameters cannot be changed under the current running mode.
- The software pages in this manual are for reference only, and might be different from actual product.
- The properties of different models of cameras are different, and the specific property parameters can be viewed in MV Viewer.

4.1 DeviceControl

Figure 4-1 DeviceControl

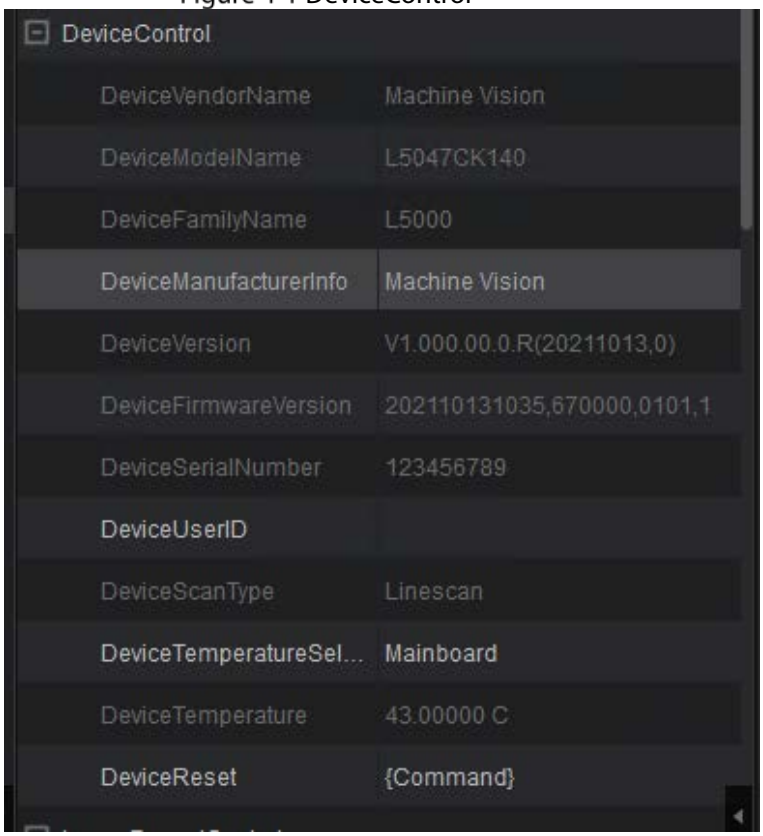


Table 4-1 Description of parameters in DeviceControl

Parameter	Description
DeviceVendorName	The vendor of the device.
DeviceModeName	The model of the device.
DeviceFamilyName	The device series.
DeviceManufacturerInfo	The manufacturer of the device.
DeviceVersion	The software version of the device, including date and SVN number.
DeviceFirmwareVersion	The firmware version of the device, including date and SVN number. The number next to the semicolon indicates the hardware version.
DeviceSerialNumber	The serial number of the device.
DeviceUserID	The custom name of the device.
DeviceScanType	The type of the device: line scan.

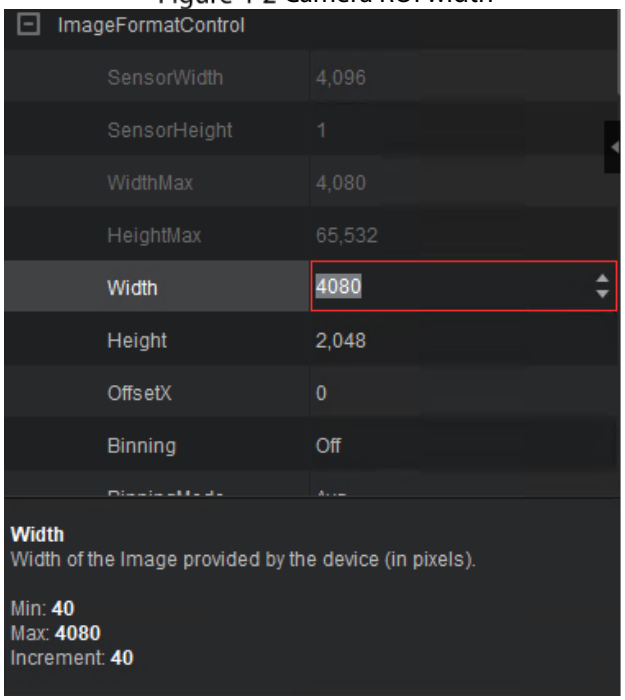
Parameter	Description
DeviceTemperatureSelector	Allows you view the temperature of the motherboard or sensor board. In general, only the temperature of the motherboard can be viewed.
DeviceTemperature	The temperature of the motherboard or sensor board.
DeviceReset	Restarts the device.

4.2 ImageFormatControl

In ImageFormatControl, you can modify image properties such as image size, image pixel format, and test image mode. The camera has its own image step size, if 10tap, 3tap, 2tap and other numbers that are not the multiple of the camera step size are selected when using the capture card, the width of the camera cannot be set the max. value.

For example, the default width of L5047CK140 is 4096, and the step size is 8. When 10tap is selected, the comprehensive step size can only be the largest common divisible 40, resulting in a camera width of 4080. Moreover, FPN correction can only be performed when the camera width is set to the max. value. If you perform FPN with the ROI of non-original width, modify the ROI width to the default max. value. After the FPN is completed, you can change the ROI width to the tap value you want.

Figure 4-2 Camera ROI width



Specific formats supported by industrial cameras might differ depending on the models.

Figure 4-3 ImageFormatControl

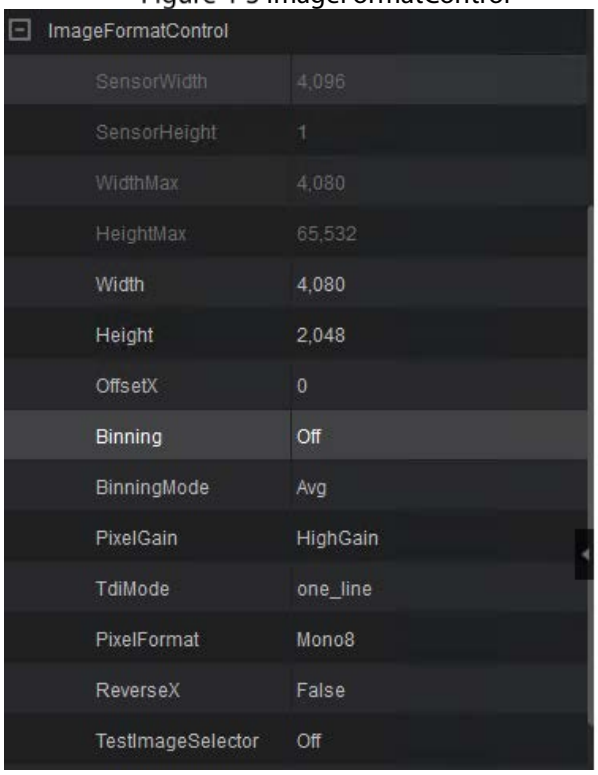


Table 4-2 Description of parameters in ImageFormatControl

Parameter	**Description**
SensorWidth	The original image width of the sensor, in pixels.
SensorHeight	The original image height of the sensor, in pixels.
WidthMax	The max. image width, in pixels.
HeightMax	The max. image height, in pixels. The height is limited by the capture card.
Width	The actual width of output images, in pixels. Each camera has the max. width, min. width and step size, which are displayed under the property bar. You can modify the ROI of the camera according to the step size and the min. width. In addition, since image transmission to the capture card is limited by the tap value, a specific tap value might lead to changes in the width step, resulting in changes in the max. width.
Height	The actual height of output images, in pixels. The max. value is limited by the max. line height of the capture card.
ReverseScanDirection	If the moving direction of the object captured by the color line scan camera is not perpendicular to the direction of the camera label, the color camera will have a different color at the edge of a line, which can be corrected by inverting the difference. Figure 5-3 shows the correct direction.
Binning	xXy: Sum or average x or y axis pixels into one pixel. Available on select models.
BinningMode	The Binning mode, including **Avg** and **Sum**. Available on select models.
PixelGain	High gain or low gain in single line scanning. Available on select models.
TdiMode	Image generation mode: one_line and TDI.
PixelFormat	The format of output images. The supported formats differ depending on the models.
ReverseX	The horizontal flipping of images. The flip is based on the original size of the sensor, not images after the ROI.

Parameter	Description
TestImageSelector	Test image type 1: Off, TestImage1 (static image), and TestImage2 (dynamic image). Test image type 2: **GradualMonoBar (gradient image from black to white), MonoBar (multiple gradient images from black to white), and ObliqueMonoBar (rhombic image)** Test images are only used for tests. **We recommend you keep the default width of a test image when you use it.**

Figure 4-4 Movement direction of objects captured by 4K color camera

Figure 4-5 Movement direction of objects captured by 8K color camera

Testimage (Test Mode)

The camera supports test mode. When the camera is in test mode, the camera does not output real-time images, but images generated by the internal program. When the real-time image is abnormal, you can almost know the reason of the image anomaly by checking whether the image in the test

mode has similar problems. This function is disabled by default. In this case, the image output by the camera is the data collected in real time.

- You can enable test mode by setting **TestImageSelector** to **On**. The default value is **Off**.
- After enabling test mode, the image displayed in the live window of the capture card software switches to test image. The specific test image depends on the test mode.

Figure 4-6 Gradient image from black to white

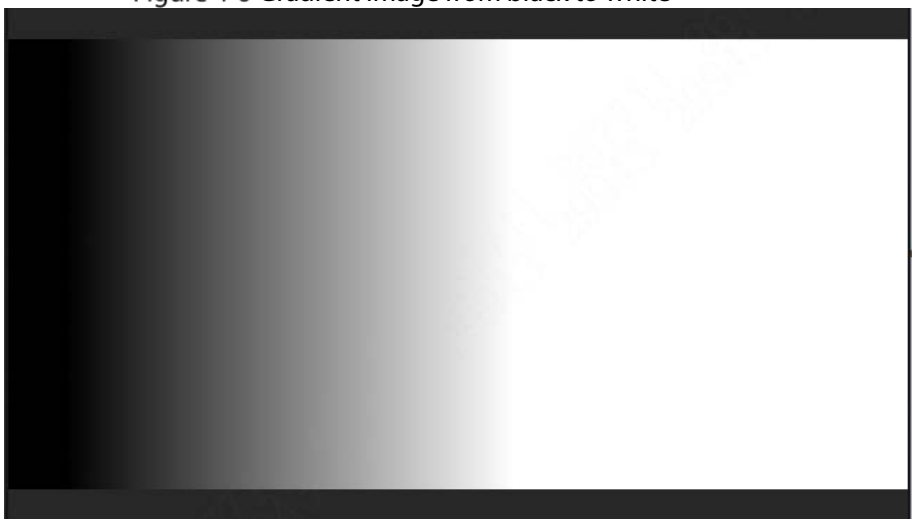
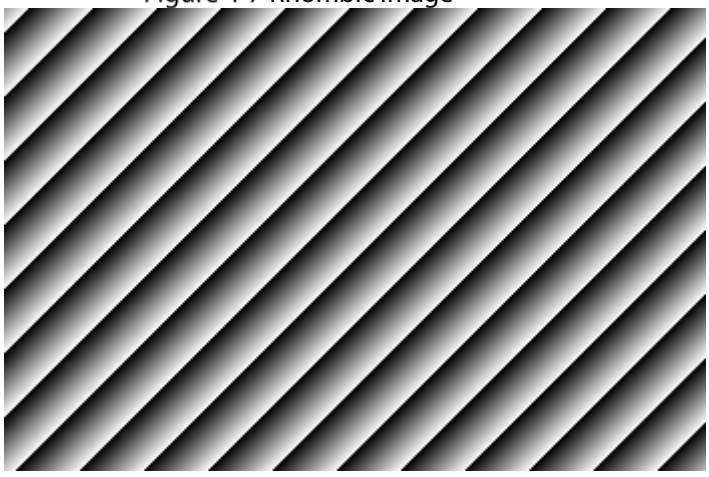


Figure 4-7 Rhombic image



Supported test images varies with different models.

4.3 AcquisitionControl

In AcquisitionControl, you can set the image capture mode, trigger mode, exposure time, and other parameters of the camera.

Figure 4-8 AcquisitionControl

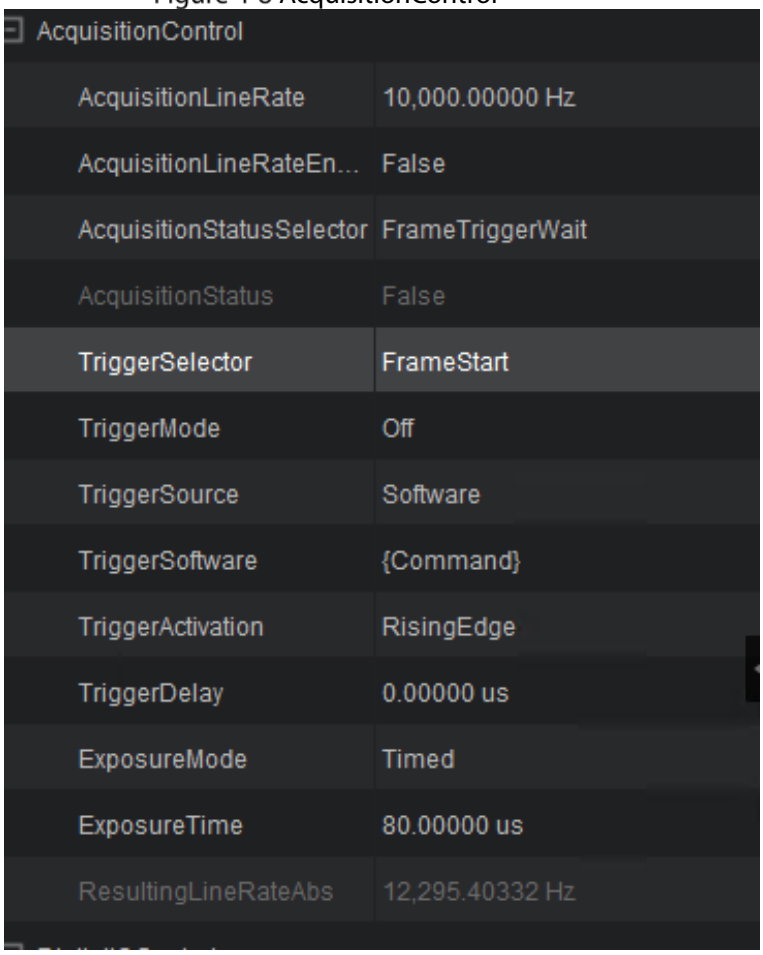


Table 4-3 Description of parameters in AcquisitionControl

Parameter	Description
AcquisitionFrameRate AcquisitionFrameRateEnable	The frame rate of images. The parameter is available when you set **AcquisitionFrameRateEnable** to **True**.
AcquisitionStatusSelector AcquisitionStatus	Select a trigger state to view. Select **AcquisitionTriggerWait** or **FrameTriggerWait** from **AcquisitionStatusSelector**, and then check **AcquisitionStatus**. **True** means image capture waits to be triggered, and **False** means image capture has been triggered.
TriggerSelector TriggerMode	The type of the trigger. Select **FrameStart** or **LineStart** from **TriggerSelector**, and then select **On** or **Off** from **TriggerMode** to enable or disable the trigger mode.
TriggerSoftware	The trigger method. Includes **SoftwareTrigger** and **lineN** (hardware trigger). If you select **SoftwareTrigger**, you can generate a software trigger by clicking **TriggerSoftware** or calling an API. If you select **lineN**, and set **TriggerActivation** to **RisingEdge** or **FallingEdge**, a hardware trigger is generated when external cables generate signals of rising or falling edges. You can separately select trigger sources for **AcquisitionStart** and **FrameStart**.
TriggerSource TriggerSoftware	The trigger method. Includes **SoftwareTrigger** and **lineN** (hardware trigger).

Parameter	Description
TriggerActivation	If you select **SoftwareTrigger**, you can generate a software trigger by clicking **TriggerSoftware** or calling an API. If you select **lineN**, and set **TriggerActivation** to **RisingEdge** or **FallingEdge**, a hardware trigger is generated when external cables generate signals of rising or falling edges.
TriggerDelay	The trigger delay, which is the period between the time when the camera receives a trigger signal and the time when the trigger takes effect. The parameter is available for both software trigger and hardware trigger.
ExposureMode	The mode exposure time, including **Timed** and **TriggerWidth**. For **Timed**, the exposure time is the value of **ExposureTime**. For **TriggerWidth**, the exposure time is the pulse width of hardware trigger. **TriggerWidth** is only available for select models.
ExposureTime	Exposure time.
ResultingframeRateAbs	The theoretical frame rate of the camera. The theoretical frame rate of the camera depends on network bandwidth, pixel format, image resolution and exposure time. The exposure time takes priority by default. When the exposure time is larger than the reciprocal of frame rate, the frame rate will be decreased priorly, instead of limiting the maximum exposure time.

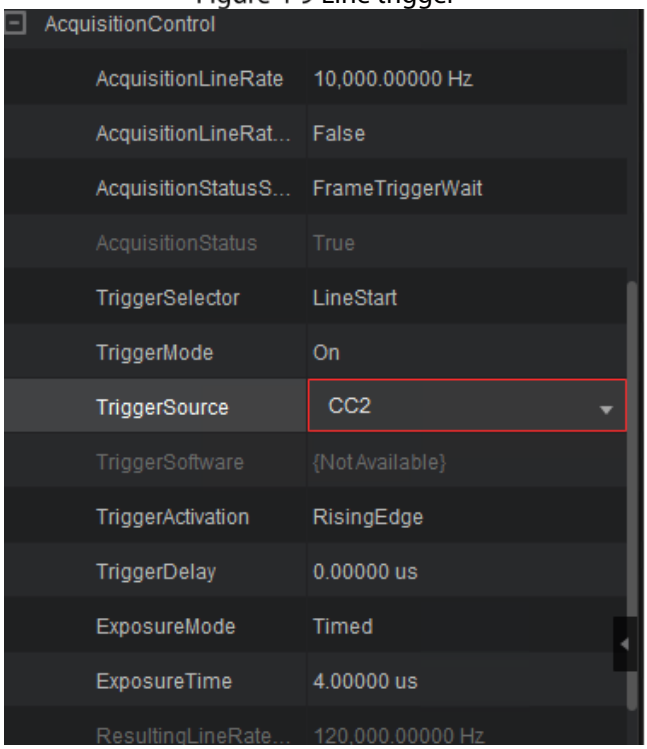
4.3.2 TriggerMode

Trigger modes of a line scan camera include line trigger, frame trigger and line + frame trigger. The trigger mode is determined by **Trigger Selector** and **Trigger Mode** in **Acquisition Control**.

Trigger Type

- Line trigger (LineStart): Outputs one line after receiving a trigger signal (rising edge or falling edge), and outputs a frame of image when the received signals meet the defined image height.
- The trigger of the CameraLink camera is usually input by the capture card, and the IO connection is usually connected to the IO trigger port of the capture card, which must be used according to the actual wiring instructions of the capture card. After configuring the settings in MV, the corresponding trigger settings must also be configured in the software of the capture card.

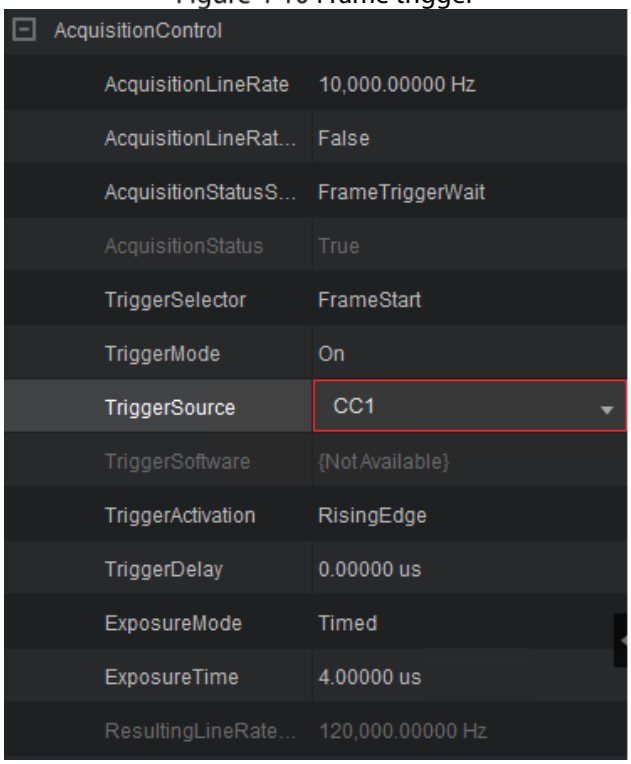
Figure 4-9 Line trigger



- Frame trigger (FrameStart): Outputs a frame of image after receiving a trigger signal (rising edge or falling edge).
- In general, the CameraLink line scan camera does not use **FrameStart** in MV.

Most of the use of frame trigger is controlled by the frame trigger of the capture card. For the CameraLink line scan camera, the camera is only responsible for stream output according to the configured logic, and the work of acquiring the image stream is completed by the capture card. Therefore, the camera configured with its own **FrameStart** might cause the abnormal stream output of the capture card. Therefore, most of the frame triggers are controlled by frame triggers on the capture card.

Figure 4-10 Frame trigger



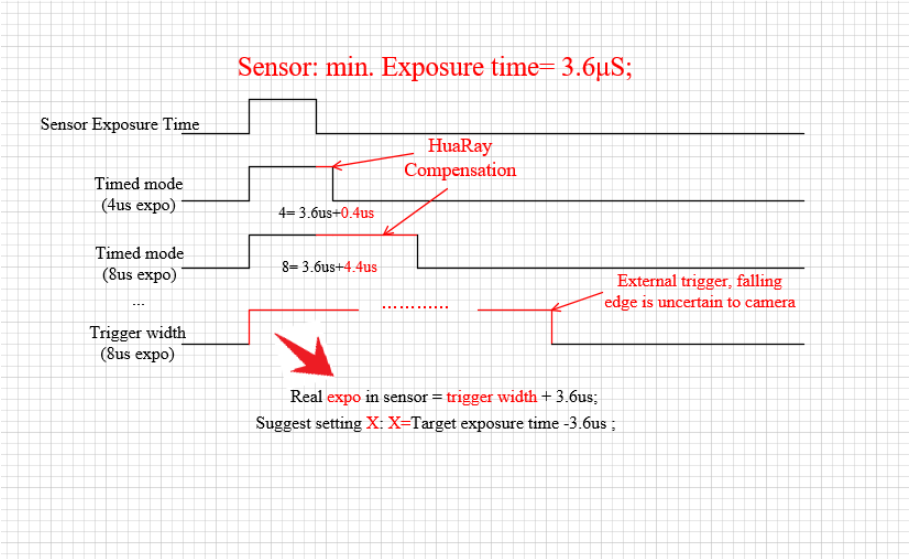
4.3.3 Sensor Exposure Logic

The sensor of each camera has a min. value. When you set the exposure value of the camera on the MV client, the sensor automatically calculates a multiple of its accuracy, add it to the min. value of the camera to reach the set exposure. For example, the min. exposure value of the sensor is 3.6 μs, and if you set the exposure to 4 μs, the multiple calculated by the sensor is +0.4 μs, allowing 3.6 μs + 0.4 μs = 4 μs.

The MV client automatically calculates the difference value.

- The min. exposure time of the L5047 series is 3.653 μs, and the sensor's accuracy to the exposure value is 0.077 μs.
- The min. exposure time of the L5087 series is 1.875 μs, and the sensor's accuracy to the exposure value is 0.0125 μs.
- The min. exposure time of the L5162 and L5082 series is 2 μs, and the sensor’s accuracy to the exposure value is 0.014 μs.

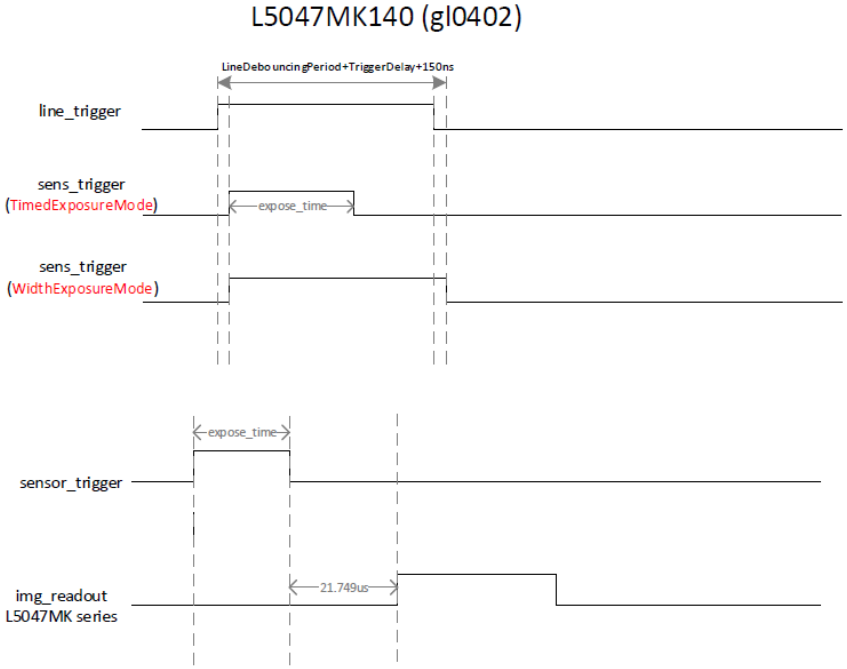
Figure 4-11 Sensor exposure logic



The relationship between the sensor of the CameraLink line scan camera and the line trigger signal is as follows:

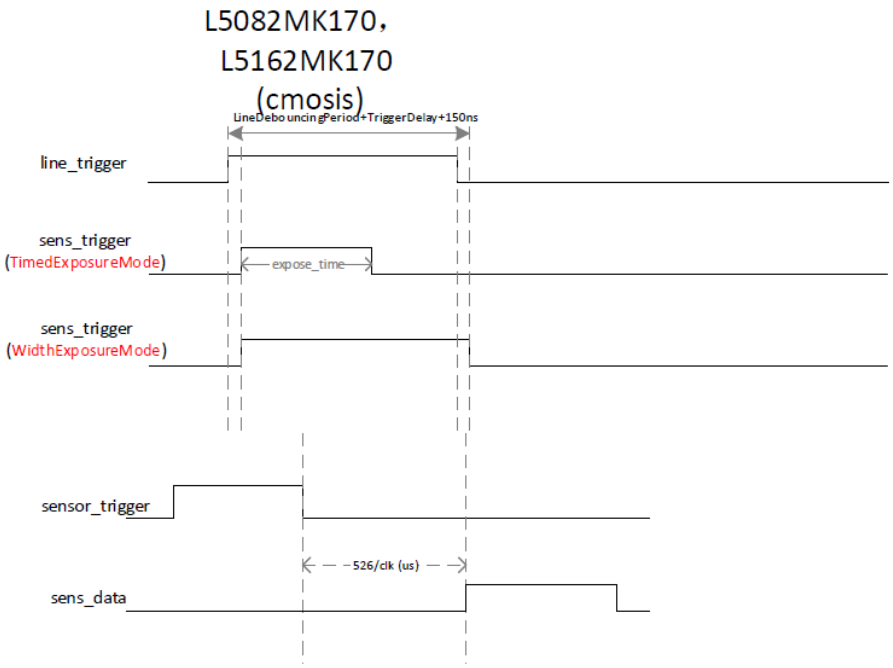
- The first signal is a line trigger signal: The delay in the dotted line is the filter + signal delay + 150 ns. The filter and the signal delay can delay the actual response to the sensor. If the 2 coefficients are 0, the sensor starts to expose 150 ns after the trigger signal arrives.
- Second signal: the actual exposure signal of the sensor when its working mode is timed exposure. The exposure value is based on that of the actual setting.
- Third signal: the actual exposure signal when its working mode is pulse width exposure, which will delay the line trigger signal accordingly.
- Fourth signal: the actual exposure signal of the sensor when its working mode is timed exposure or pulse width exposure.
- Fifth signal: the signal of acquiring camera streams. 21.749 us is the delay between the fifth signal and the actual exposure signal of the sensor.

Figure 4-12 Trigger logic of the sensor of L5047MK140



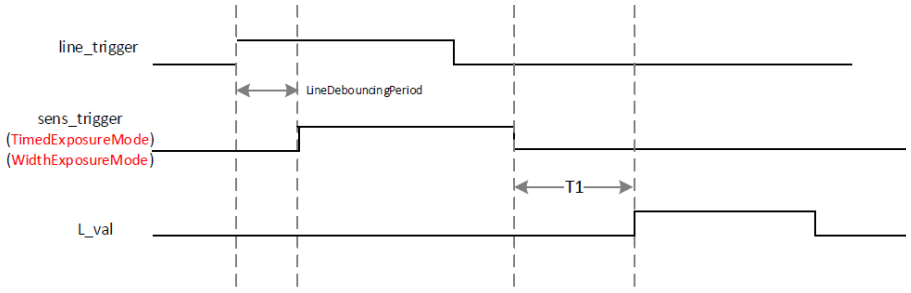
The delay of the fifth signal in the logic of the sensor of L5082MK170 and L5162MK170 and the actual stream acquiring of the camera is 526/clk us, where clk is the clock of the camera.

Figure 4-13 Logics of sensor of L5082MK170 and L5162MK170 and actual stream acquiring



- The first signal is the line trigger signal: The delay in the dashed line is signal filter, which can delay the actual trigger response to the sensor. If the value is 0, the sensor will immediately start to expose when the trigger signal arrives.
- Second signal: the actual exposure signal of the sensor, which includes timed exposure and pulse width exposure.
- Third signal: the signals of acquiring camera streams. T1 is the delay between the third signal and the actual exposure signal of the sensor.

Figure 4-14 Logics of sensor of L5087MK/CK and actual stream acquiring L5087M/CKXXX (GL0816)

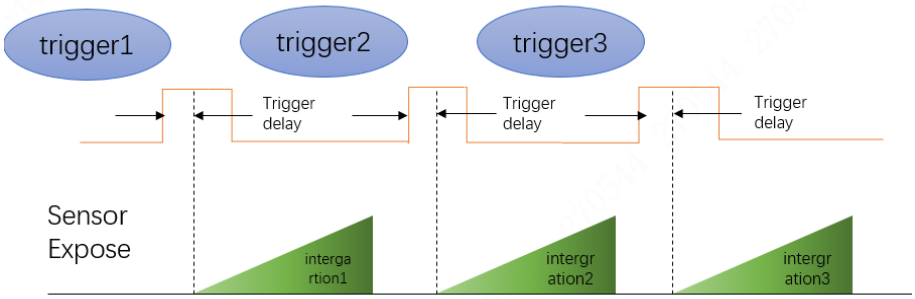


fourLine ：T1=(114+264*2)/80Mhz=8us;
TDI ：T1=(114+134*2)/80Mhz=4.8us;

4.3.4 TriggerDelay

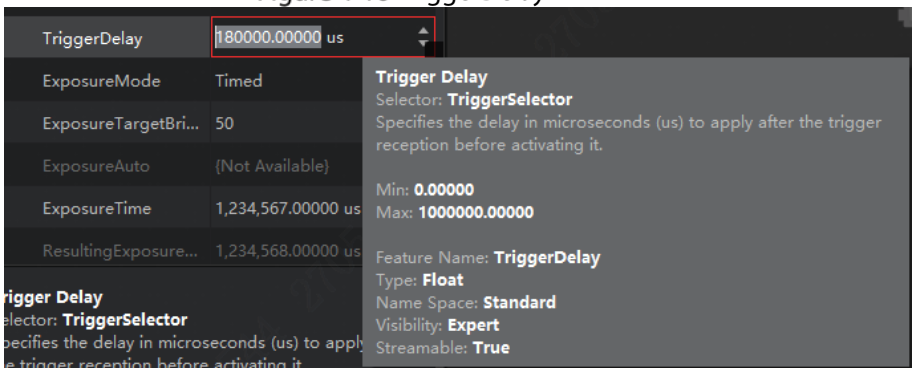
You can set delay between the time when the camera receives the trigger signal to the time when the camera responds to the signal to capture images.

Figure 4-15 Principle of trigger delay



The delay time is configured through TriggerDelay withμs as unit and ranges from 0–1000000 μs, namely, 0–1 s.

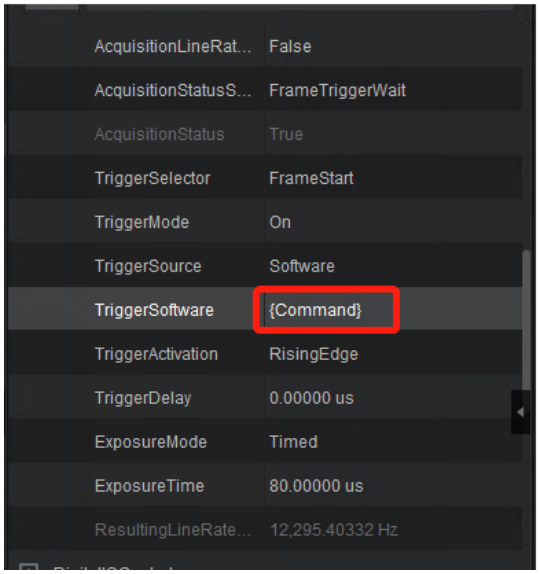
Figure 4-16 TriggerDelay



4.3.5 TriggerSource and TriggerControl

- Software trigger: Select **Trigger Software** from **AcquisitionControl** > **TriggerSoftware** to send trigger signals through the software. You can continute the operation through the MV attribute table or the software trigger button of the capture card interface.

Figure 4-17 Software trigger



- I/O trigger: The trigger signal is given to the camera by the capture card. The connection method depends on the electrical specifications of the capture card.

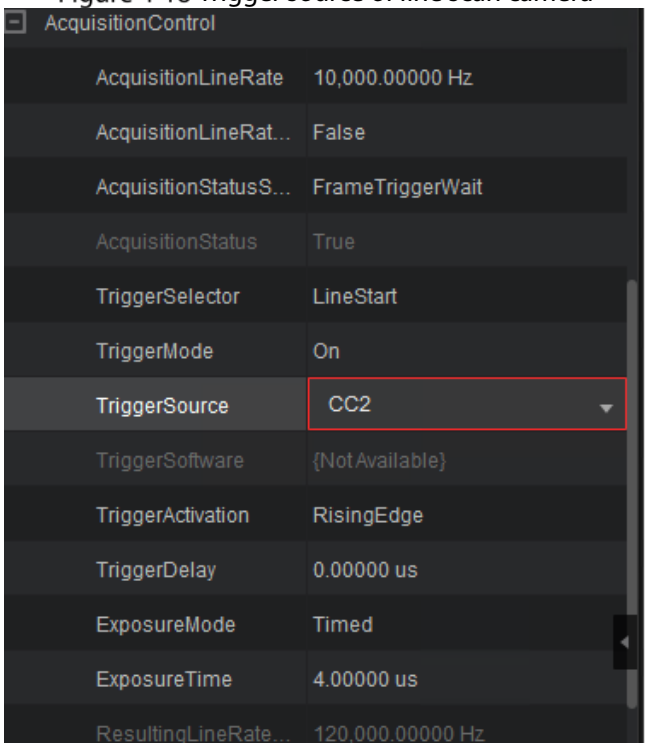
4.3.6 CameraLink Line Scan Camera Trigger

The trigger mode of CameraLink is different from that of Ethernet port line scan camera. External signals are accessed and fitted through the capture card, and then the capture card sends signals to the camera through the CameraLink cable for triggering.

As shown in the following figure, set **TriggerSelector** to **LineStart**, **TriggerMode** to **On**, **TriggerSource** to **CC2**, and **TriggerActivation** to **RisingEdge**. Then, connect the CC2 cable according to the I/O wiring rules of the capture card.

In addition, you must configure the settings in the software of the capture card connected to the actual camera.

Figure 4-18 Trigger source of line scan camera



4.4 DigitalIOControl

In DigitalIOControl, you can manage different I/O input or output signals.

Figure 4-19 I/O management

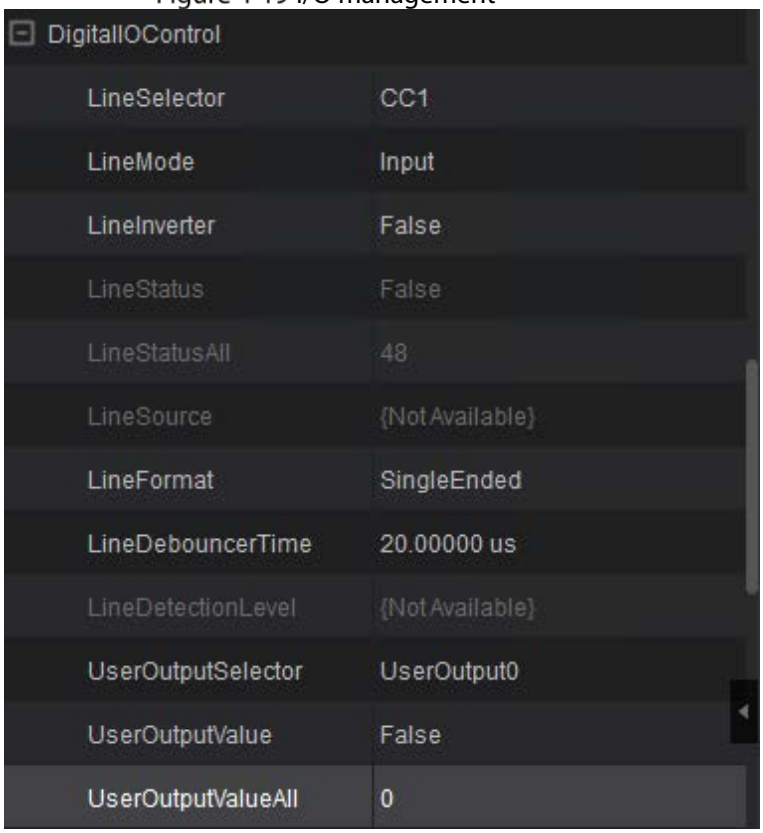


Table 4-4 Description of parameters in DigitalIOControl

Parameter	Description
LineSelector	The IO cable to be configured.
LineMode	The output mode of the selected IO cable, including **Input** and **Output**.
LineInverter	Specifies whether to reverse signals. **True**: Reverse signals. **False**: Not reverse signals.
LineStatus	Indicates the status of the selected physical input or output cables.
LineStatusAll	Returns the status of all usable cables.
LineSource	You can select a trigger source if the IO cable set as output. The following trigger sources are supported: **ExposureActive**: Outputs signal when exposure starts. **FrameTriggerWait**: Outputs waiting status signals of frame trigger. **Timer0Active**: Outputs signals when the timer0 reached its limit. **UserOutput0**: Output the value of UserCustom0. **AcquisitionTriggerWait**: Outputs waiting status signals of acquisition trigger. **LightTrigger**: Outputs the signal of light source control. 1 means the opto-coupler is connected, and 0 means disconnected.
LineFormat	The trigger type of the selected IO cable.
LineDebouncerTime	The length of debouncing. You can set the parameter if the IO cable is set as input. Pulse widths smaller than the set value will not be considered as an effective trigger input.
LineDetectionLevel	The threshold voltage for single-end signal.
UserOutputSelector	The output group.
UserOutputValue	The output value of the output group.
UserOutputValueAll	Set the output value of all output groups to 0 or 1.

If you need to process the signal filter, you need to configure corresponding settings for the capture card.

You can set the filter value of the camera for CC2 channel, and select the signal type and other attributes, as shown in the following figure.

Table 4-5 Processing of camera IO signals

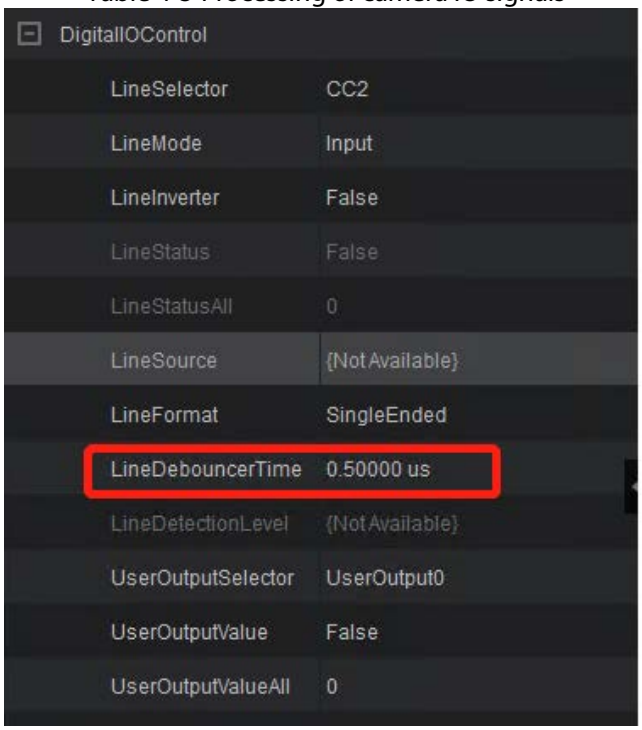


Table 4-6 Processing of signals from the capture card

As shown in the figure above, the pulse width of the input signal processed by the capture card must be larger than the filter value of the camera. Otherwise, the signal of the channel will be filtered out.

The reasons are as follows:

LineDebouncerTime: Signal debouncing, also known as filtering, is only supported in input mode. The level signal of the corresponding port is filtered according to the defined value. Signal will be filtered out when the signal value is smaller than the debouncing value.

For example, set **LineDebouncerTime** to 1500 ns.

Figure 4-20 Configure filter value

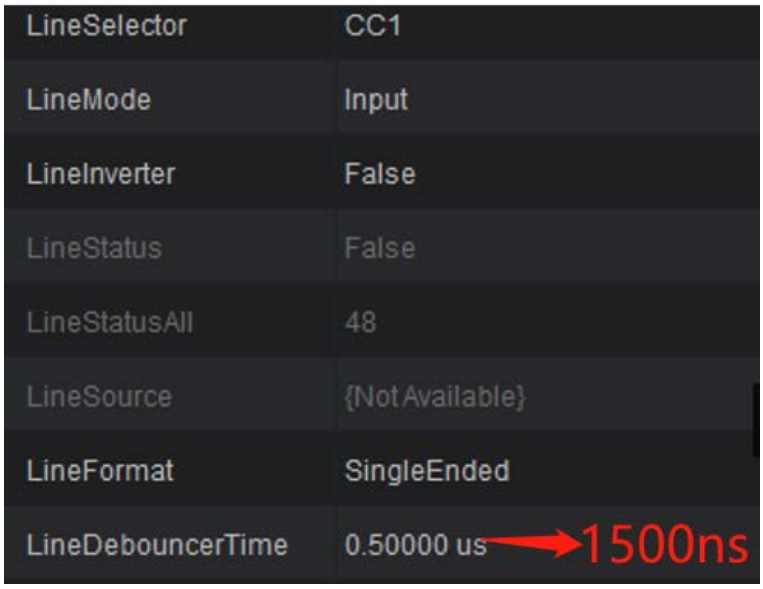


Figure 4-21 Before filtering

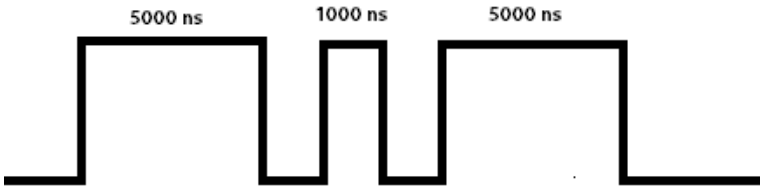
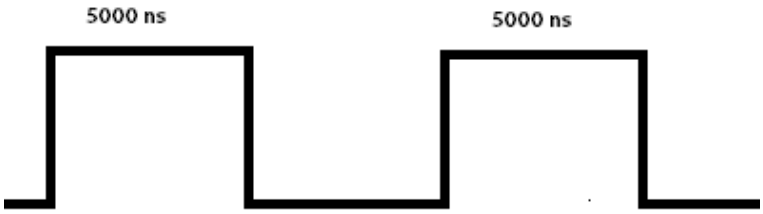


Figure 4-22 After filtering



When the value of **LineDebouncerTimeAbs** is greater than the value of high and low levels, as shown in the example above, if the filtering level is greater than 5000 us, the camera will not generate streams. Therefore, when setting **LineDebouncerTime**, make sure that its value is smaller than the high and low level.

4.5 Encoder

Encoders can convert the roller's angular displacement into an electrical signal, and the signal frequency is proportional to the angular displacement speed. The line scan camera can use this signal to perform line trigger. When the max. running speed of the roller does not exceed the upper limit of the encoder's signal accuracy, there is no abnormal stretching compression in the images taken compared with the actual ones.

Step 1 Select **ShaftEncoderinput** to confirm the signal source.

Each capture card manufacturer might name encoders differently. In this example, the dalsa capture card is used as an example.

Step 2 Select a rotary coding input source, which is PhaseA and PhaseB.

Connect cables to the input source according to the actual I/O electrical specifications of the capture card.

If Phase A or B is selected as a single phase, only the rotation of the encoder can be determined. However, the direction of the rotation is unknown. In this case, you can set Shaft Encoder Phase A and B to confirm the direction of the rotation.

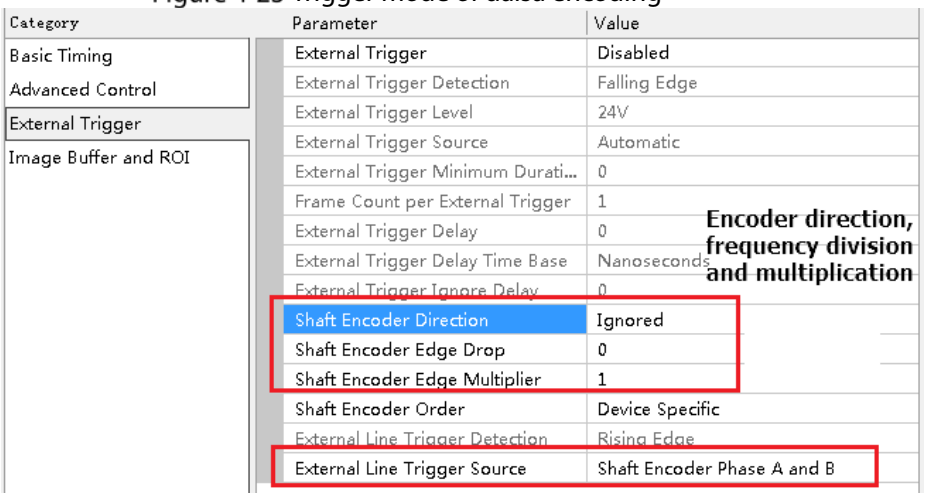
Step 3 Click **RotaryEncoderMode** to set the direction of the encoder.

The trigger mode of rotary encoding is divided into 3 modes: forward, backward, and any direction. When the platform translation trigger signal reaches the set line height, a frame will be generated.

- Forward direction: Images are output when the encoder rotates in a forward direction. During rotation in a backward direction, the number of reversed signals is recorded. Then, the number of reversed signals will be reduced during rotation in a forward direction, and the images are output until the number is reduced to 0. This achieves debouncing.
- Ignored: Images are output when the encoder rotates in any direction.
- Backward direction: Images are output when the encoder rotates in a backward direction and debouncing is achieved.

Different capture card manufacturers have similar naming and usage methods for each function of encoders, and the basic principle is the same.

Figure 4-23 Trigger mode of dalsa encoding



Advantages of encoder trigger:

- The output signal frequency of the encoder is proportional to the speed of the object, ensuring that the signal frequency is synchronized with the speed of the object's movement.
- The output pulse is used as the trigger signal of the line scan camera to synchronize the acquisition frequency of the camera with the movement speed of object.
- Images can be captured normally in the scene of non-uniform motion.
- When objects jitter in the environment, forward or backward rotation can eliminate the image impact caused by jitter.

4.6 Frequency Division and Multiplication Control

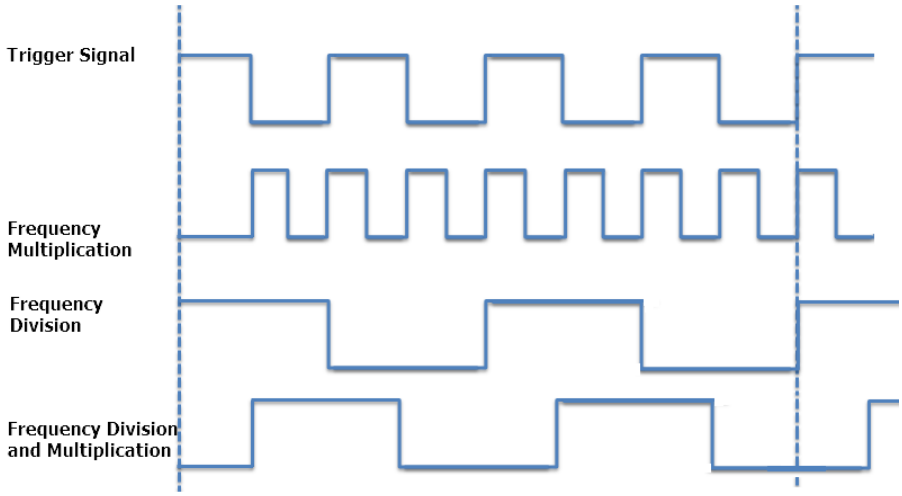
- Frequency division and multiplication description

The frequency division and multiplication of the CameraLink line scan camera is achieved by the capture card, and the settings must be configured based on the instruction manual of the capture card. However, the basic principles are similar. Generally, we recommend you set a small frequency division and multiplication coefficient. Otherwise, the effect is affected. For example, the signal frequency fluctuates too much after frequency multiplication.

- Frequency division and multiplication introduction

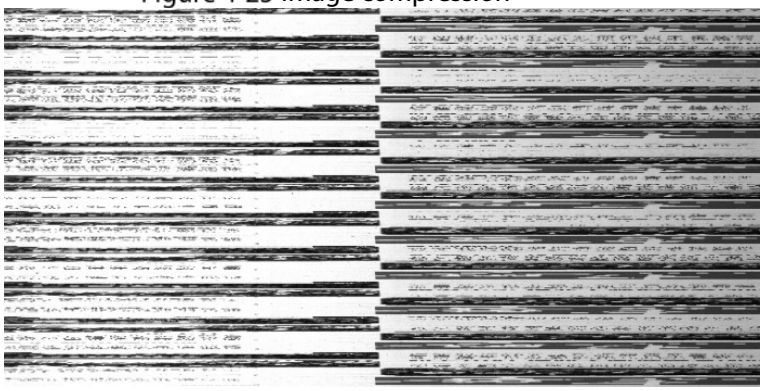
You can manage the frequency division and multiplication function of the signal source. For signal sources after frequency division, the frequency will become slow. For signal sources after frequency multiplication, the frequency will become faster. When the external signal triggers the camera to start working, and the actual pulse frequency of the signal source and the shooting length within the motion cycle of the object are not perfectly matched, resulting in poor image effect, such as serious stretching or compression. After excluding other issues, you can adjust the signal frequency to reduce or increase the line trigger frequency of the camera, so as to make the image display normal.

Figure 4-24 Frequency division and multiplication



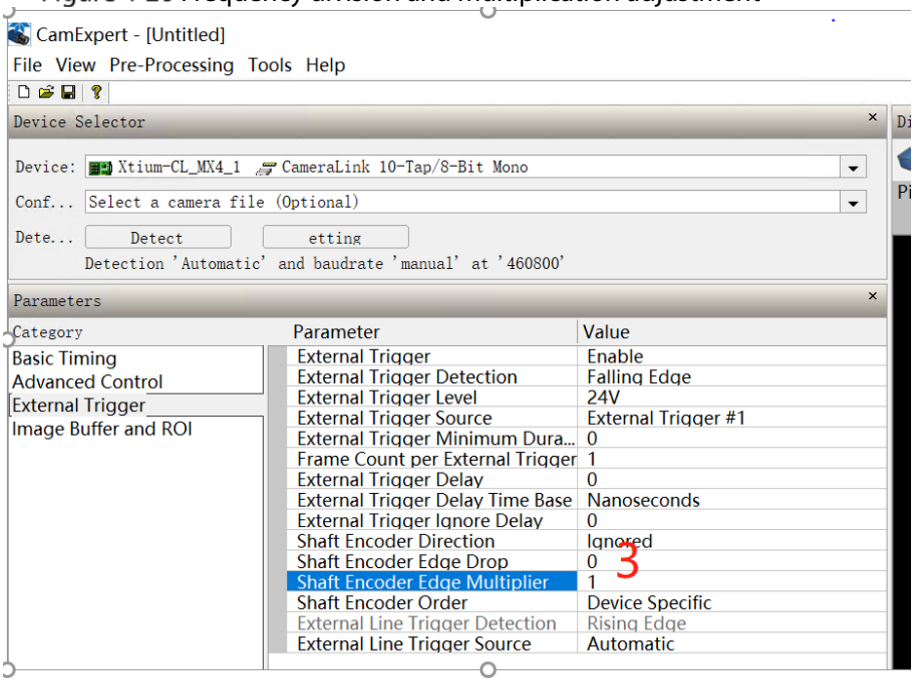
- The image line height is 2048, the theoretical line frequency is 28000, and the frame rate is 0.5 fps. The image is severely compressed. The horizontal scan rate (2048) of trigger signal is lower than movement speed of object, and cannot be changed. You can adjust the image by adjusting the frequency multiplication index.

Figure 4-25 Image compression



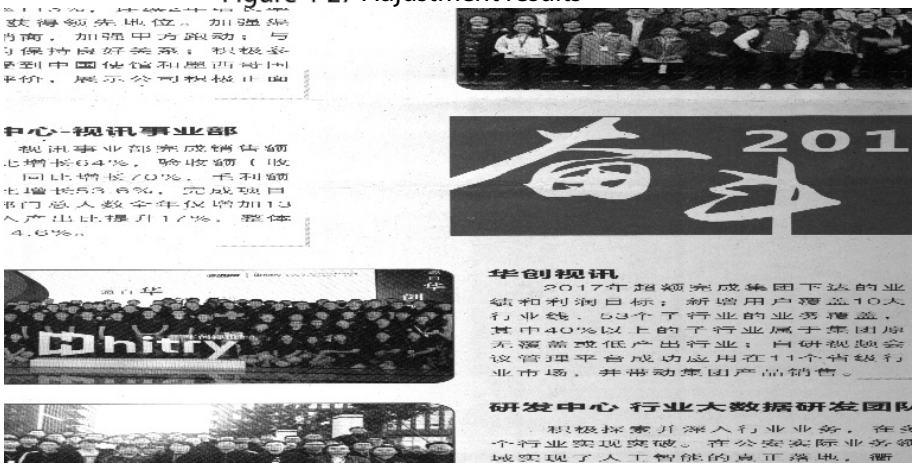
Set **Shaft Encoder Edge Multiplier** to 3 to increase the accepted encoder signal frequency by 3 times and the trigger line frequency to 2048×3=6144.

Figure 4-26 Frequency division and multiplication adjustment



- When the image is stretched, frequency division adjustment can be used: set **Shaft Encoder Edge Multiplier** to 1, and set **Shaft Encoder Edge Drop** for frequency division. If it is set to 3, the signal frequency will be reduced by 3 times.

Figure 4-27 Adjustment results



- Non-integer multiplication: To increase the signal frequency by 1.5, set **Drop** to 2 and **Multiplier** to 3. And vice versa.

4.7 Timed Strobing, Timed Exposure, and Line Extraction

Available on select models, such as L5087MKA70.

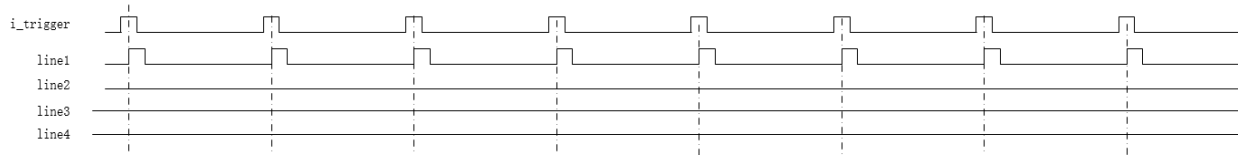
1. Timed Strobing

The camera supports timed exposure. You can use line1/line2/line3/line4 to control external light sources. The trigger pulse width of line1/line2/line3/line4 can be configured separately, which makes the brightness of light sources adjustable. The function has 2 working modes.

MOD1: Output trigger signals based on external trigger.

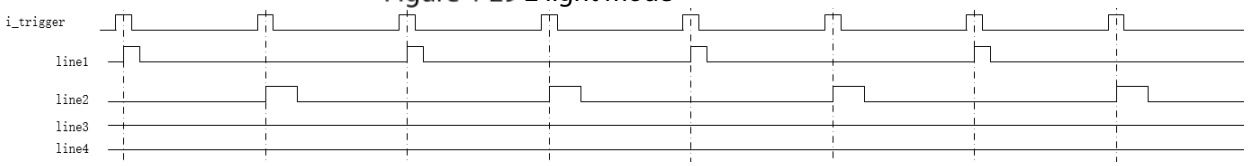
1 light mode: Only the first trigger line outputs signals. Others are in low level.

Figure 4-28 1 light mode



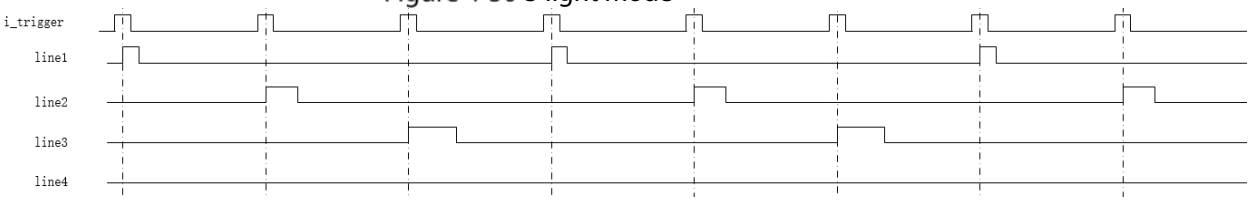
2 light mode: Only the first trigger line outputs signals. Others are in low level.

Figure 4-29 2 light mode



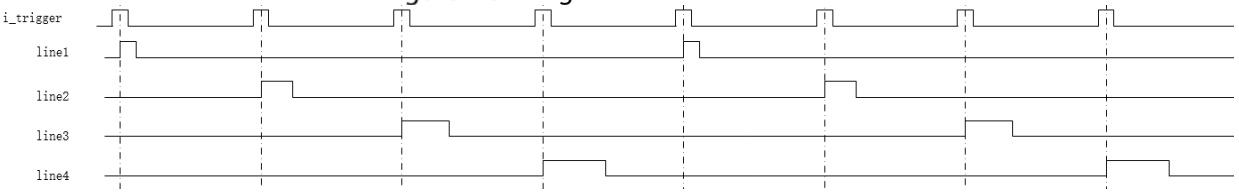
3 light mode: Only the first trigger line outputs signals. Others are in low level.

Figure 4-30 3 light mode



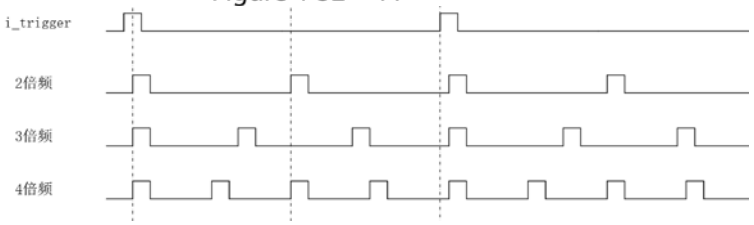
4 light mode: Only the first trigger line outputs signals. Others are in low level.

Figure 4-31 4 light mode



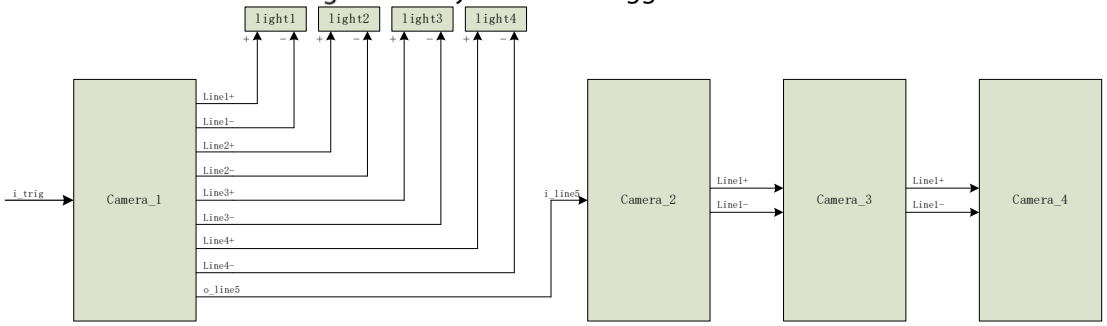
Mod2: Achieves frequency division and multiplication. Generates output trigger after configuration based on external trigger signals. A maximum of quadruple frequency is supported.

Figure 4-32 Mod2



2. Synchronous Trigger

Figure 4-33 Synchronous trigger



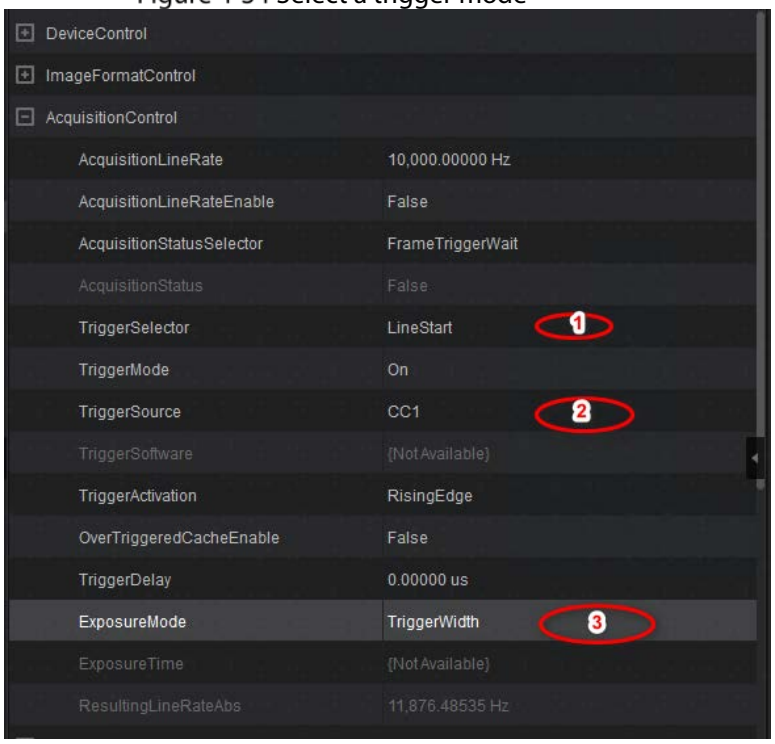
The preceding figure shows the connection of cameras under 4 camera trigger mode.

Configuration of camera 1:

1.1 Trigger type: Uses external trigger and line trigger as an example.

Select line trigger mode, set CC1-CC4 to external trigger source, and set trigger mode to pulse width trigger or timed exposure, as shown in the following figure.

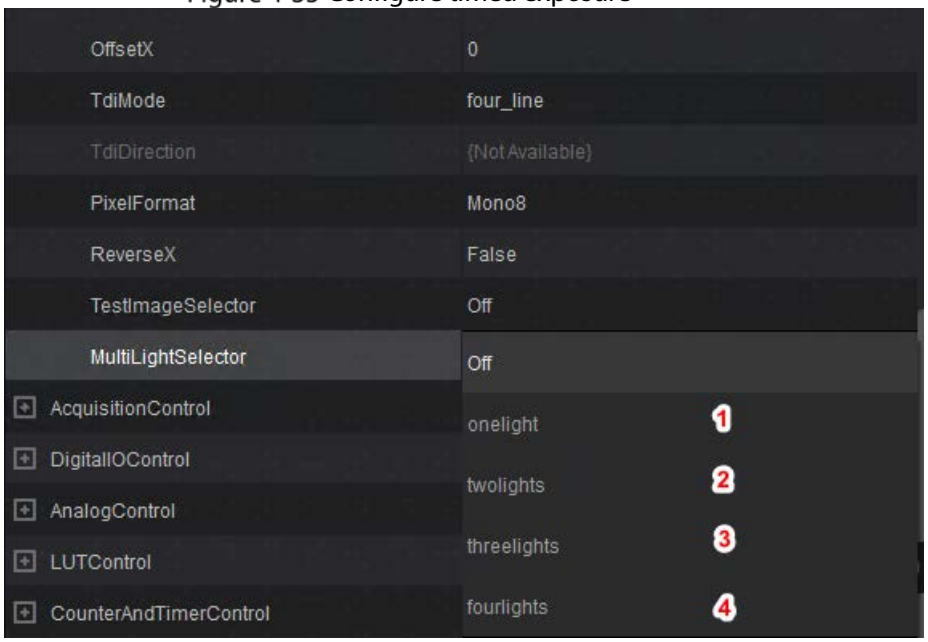
Figure 4-34 Select a trigger mode



1.2 Select the timed strobing function: Uses 4 timed strobing as an example.

Select a timed exposure mode in MultiLightSelector under ImageFormatControl. A maximum of 4 lights are supported.

Figure 4-35 Configure timed exposure



1.3 Configure light source trigger control pin and synchronous trigger pin: Uses 4 timed exposure as an example.

Set line1/line2/line3/line4 to output, and set LineSource to ExposureActive. The 4 signals are used to connect to light sources and control the brightness of light sources.

Synchronous trigger requires line5. Set line5 to output, and set LineSource to LinesSync. The signal is used as the trigger input signal of the second camera.

Figure 4-36 Configure light source trigger control pin (1)

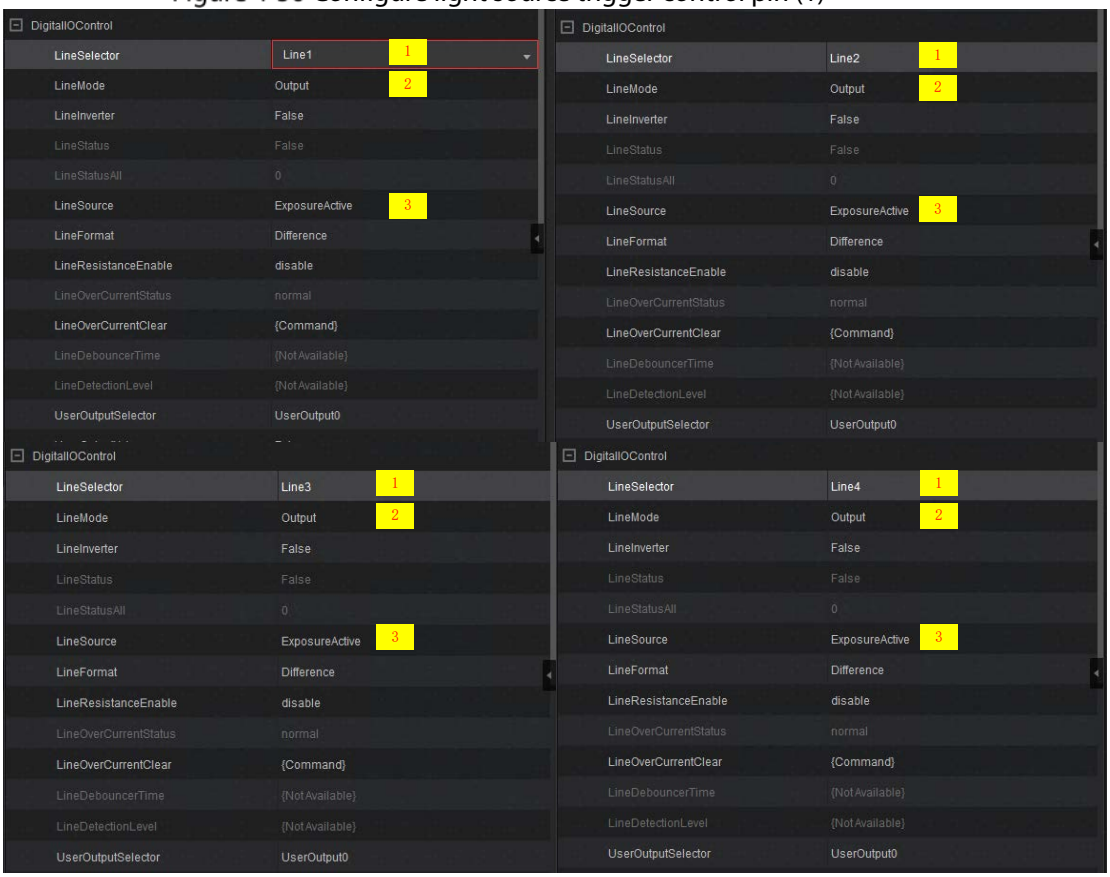


Figure 4-37 Configure light source trigger control pin (2)

So far the first camera is configured.

Configuration of camera 2: Uses 4 timed exposure as an example.

Step 1 Select fourlights.

Step 2 Select external line trigger mode.

Step 3 Select external trigger sources. line1-line4 is a differential signal, and line5 is a single-end signal. Since the synchronous trigger of camera 1 is set to line5, we recommend you also select line5 as the input trigger source of camera 2.

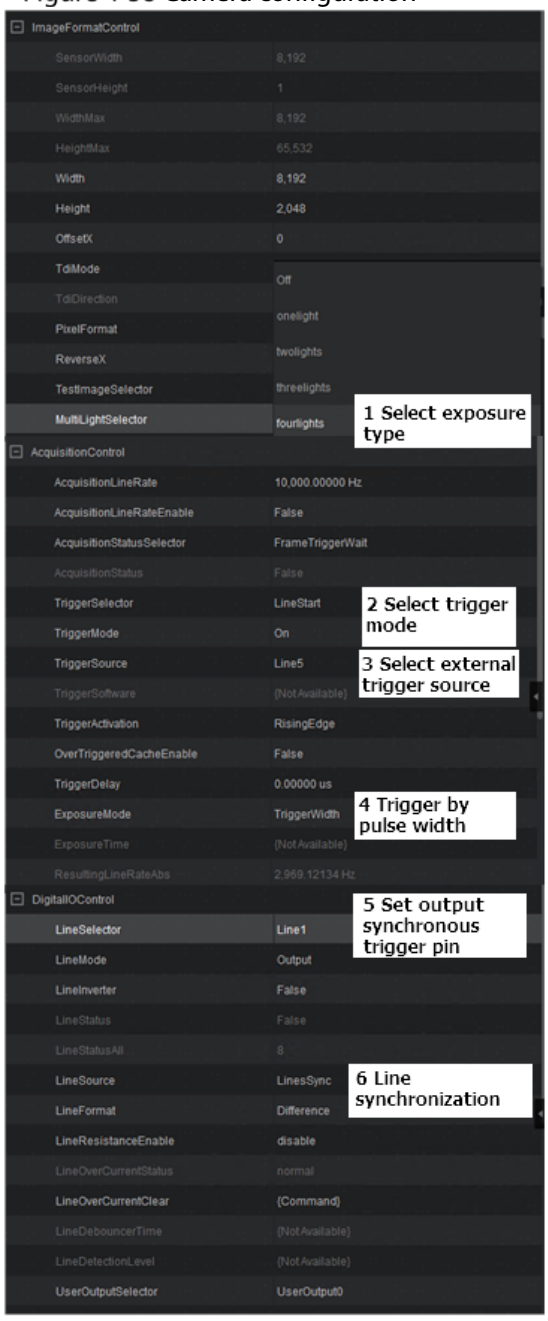
Step 4 Select timed trigger or pulse width trigger.

Step 5 Configure synchronous trigger signal for the next camera. You can select a line from line1-line4. After the selection, connect external trigger lines.

Step 6 Example: Select line1 as the synchronous output of camera 2, and line1 as the input source of camera 3. In this case, you need to connect the line1 of camera 2 and camera 3.

Step 7 Select LinesSync.

Figure 4-38 Camera configuration



Configuration of camera 3 and camera 4

Refer to the configuration of camera 2 to configure camera 3 and camera 4. Step 3 and Step 5 are different.

Change the input and output trigger source based on external connection. Other configurations can be modified as needed.

Timed Exposure + Line Extraction

The camera supports processing output images according to timed strobing. According to the number and sequence of strobe lights, the camera extracts lines and assembles frames for images with distinct bright and dark areas. As a result, the camera outputs multiple groups of images.

LineSpellingSelector

Width setting on the capture card side: W = X * N. Height setting: Y/N.

Therefore, if 3 groups of polling is set for timed exposure, the line height of the camera needs to be set as a multiple of 3. Otherwise, the line height on the capture card side cannot be set as an appropriate integer.

2 Group Mode

Figure 4-39 Line extraction

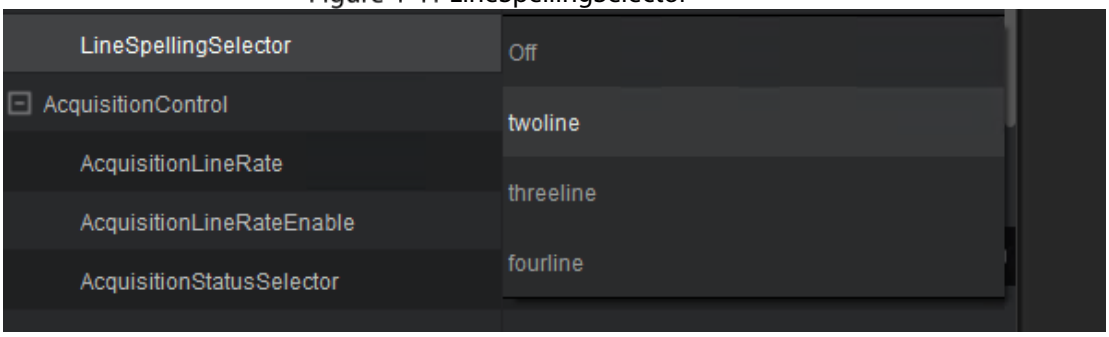
Set **LineSequencerConfigurationMode** to **On**.

Set **LineSequencerMode** to **On**.

Set **LineSpellingSelector** to **On**.

Figure 4-40 LineSequenceMode

Figure 4-41 LineSpellingSelector



4.8 AnalogControl

In AnalogControl, you can adjust the image analog signals collected by the camera, including gain, black level, white balance, and Gamma correction. The analog gain is an internal property of the sensor.

When pulling streams to acquire images, the camera performs FPN correction, deducts black level, and then correct white balance.

Figure 4-42 AnalogControl

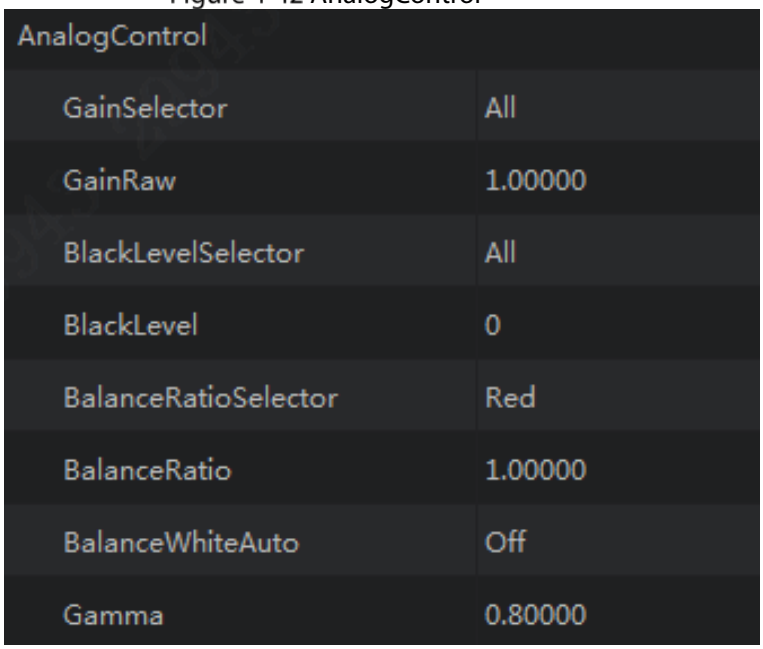


Table 4-7 Description of parameters in AnalogControl

Parameter	Description
GainSelector	Not available. Leave it as default.
GainRaw	The larger the value, the brighter the image. The available setting range is different depending on the models. The default value is 1. Analog gain takes priority.
BlackLevelSelector	The channel for which black level is configured.
BlackLevel	Black level is used to eliminate the impact caused by the dark current of the sensor. For example, under fully dark conditions, the image brightness is larger than 0, which is the dark current of the sensor. You can adjust the black level to make the channel brightness closer to that of the actual image. The value ranges from 0 to 255.
BlackLevelAuto	● When **BlackLevelAuto** is set to **Off**, the black level subtracted by the algorithm is the value of **BlackLevel**. ● When **BlackLevelAuto** is set to **Once**, **BlackLevel** is automatically set once based on the return value of the sensor. Then, **BlackLevelAuto** changes to **Off**. ● When **BlackLevelAuto** is set to **Continues**, **BlackLevel** is continuously set based on the return value of the sensor. The black level changes along with the temperature. We recommend you obtain the value when the temperature is constant.
BalanceRatioSelector	Select the Red, Green or Blue channel to set the white balance. Adjust the image color by setting R, G and B to make the image more vivid.
BalanceRatio	● If **BalanceWhiteAuto** is set to **Off**, you can set the value of Red, Green and Blue channels in **BalanceRatio**.
BalanceWhiteAuto	● If **BalanceWhiteAuto** is set to **Once**, the camera performs auto white balance once. Runs white balance adjustment automatically for a period and then stops based on the current situation. ● If **BalanceWhiteAuto** is set to **Continues**, the camera continuously performs white balance. White balance correction is only applicable for color cameras. The white balance of black and white cameras is 1 by default.

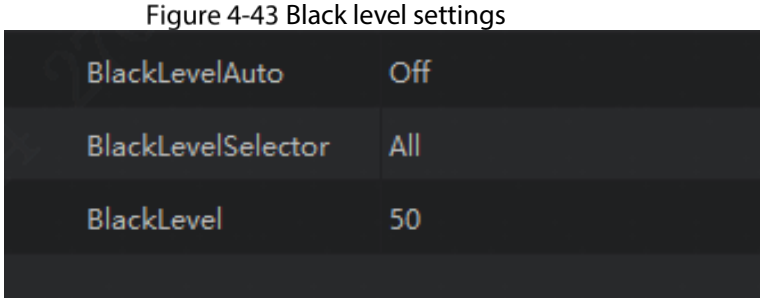
Parameter	Description
Gamma	The Gamma value of the image. Gamma is a non-linear correction of the image data due to non-linear response of the display. The larger the Gamma value, the darker the image. The range is 0–3.99998. 1 means no gamma process.
SensorBOC	Specifies whether to enable auto black level correction for the sensor. If the function is enabled, the black level output by the sensor is a constant value instead of changing with the temperature. This helps adjust the brightness change of images and eliminate the impact of black blocks on white blocks.

4.8.2 Black Level

Black level helps you adjust the gray value offset of the output data. The gray value offset determines the average gray value when the sensor is not sensitive (the lens is covered). Different bit depth modes have different black level parameters. If you need to set the black level, enter a value for **Black Level**.

Generally, the black level of cameras is corrected before delivery. If the contrast of light and dark fields needs to be enhanced or decreased in actual use, you can adjust the black level.

Figure 4-43 Black level settings



4.8.3 Gain

The camera gain is divided into analog gain and digital gain.

The noise of digital gain is more obvious than that of analog gain. We recommend you use analog gain.

- Analog gain can multiply the image analog signal of the sensor.

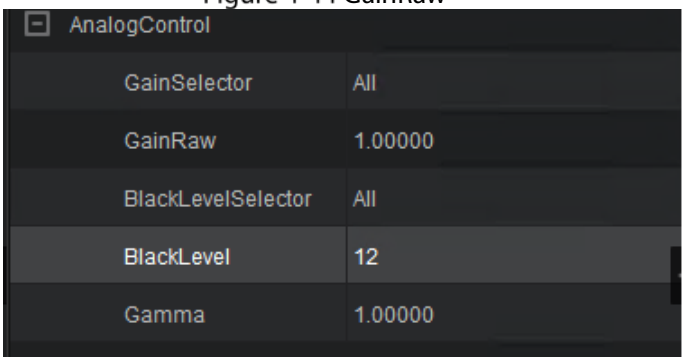
Gain value ranges from 1–32. We recommend you set a small value. During FPN, when the analog gain value is that of the actual sensor, the FPN effect is the best.

We recommend you perform FPN correction at the gain level of your target image to achieve the best effect. See the following table for details. For example, for L5082MK170, if you set the analog gain to 7, the actual analog gain of the sensor will be adjusted to 3.5, and then multiplied by 2. In this scenario, if you need to do FPN calibration, adjust the gain level to 3.5 to achieve the best effect. You can restore the gain value to 7 after FPN correction.

Table 4-8 Analog gain stages of the camera

Camera model	Number of analog gain stages	Analog gain stage
L5047CK140	5	1 1.4 1.6 2.4 3.2
L5047MK140		
L5082MK170	2	1 3.5
L5087CK670	6	1 1.6 2.7 3 3.5 4.6
L5087MK470	7	1 1.6 2.7 3 3.5 4.6 6.2
L5162MK170	2	1 3.5

Figure 4-44 GainRaw



- Digital gain can amplify the electrical signal of the image after FPGA conversion.

Set **DigitalShift** between 0 and 4. The higher the value, the stronger the gain, the higher the brightness and the more the noise.

Figure 4-45 Digital gain

4.8.4 White Balance

White balance allows you to adjust the corresponding R/G/B values to compensate for color cast that occurs when capturing images in different light sources. It keeps the white parts of the image white under different color temperature.

White balance supports **Off**, **Once** and **Continuous** mode.

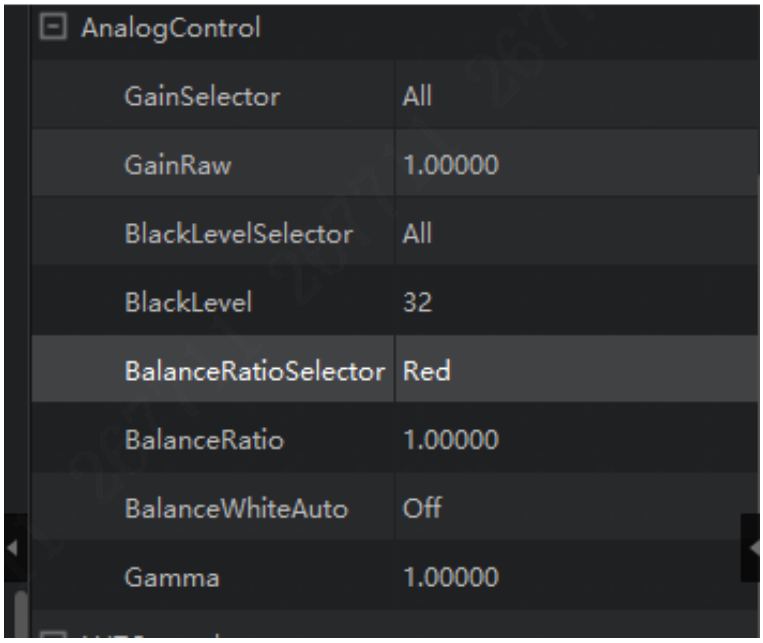
Table 4-9 Configure white balance.

White balance mode	Working mode
Manual	You can manually set the value of Red, Green and Blue channels in **BlackLevelSelector** and **BalanceRatio**.
Automatic once	Runs white balance adjustment automatically for a period and then stops based on the current situation.
Continuous	Automatically and continuously adjust the white balance according to the scenario.

When the color effect of the camera image is different from the actual situation, you can solve the problem through white balance calibration.

Step 1 Set BalanceWitheAuto to Off.

Figure 4-46 Configure BalanceWitheAuto

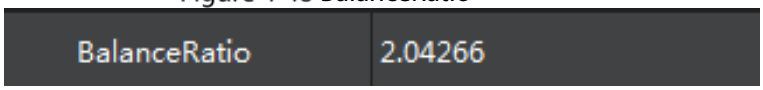


Step 2 Select R/G/B channels to be adjusted in **BlackRatioSelector**.

Figure 4-47 BlackRatioSelector

Step 3 Adjust the BalanceRatio to a reasonable value among 0–15. Do the same for R/G/B.

Figure 4-48 BalanceRatio



- Save the parameters after correction to avoid repeated configuration in case of unexpected occasions.
- You need to do white balance correction again if the light source or color temperature changes on the camera position.

4.8.5 Gamma

Gamma is a non-linear correction of the image data due to non-linear response of the display. The larger the Gamma value, the darker the image. Gamma coefficient ranges from 0 to 3.99998.

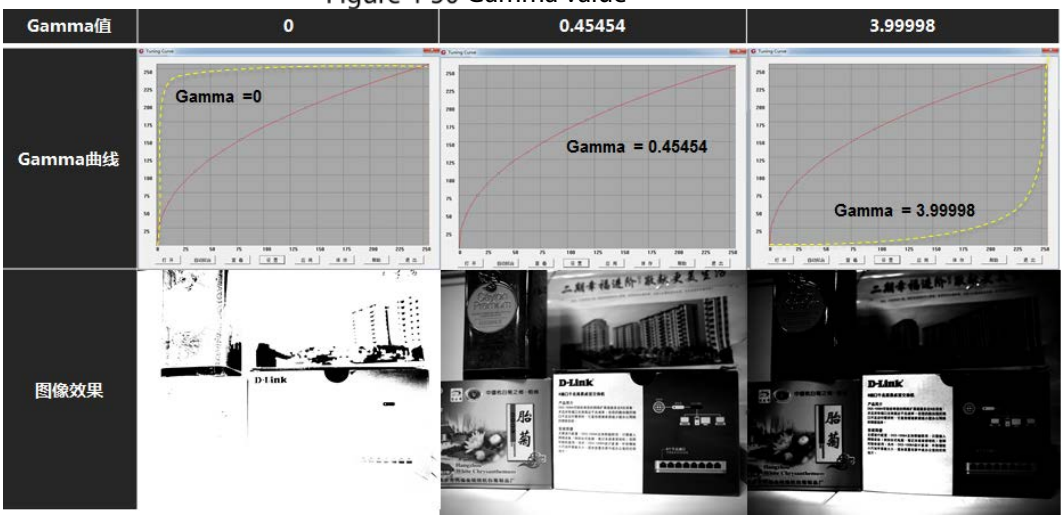
Adjust the Gamma value to make the image brightness meet the requirements.

Figure 4-49 Adjust Gamma value

Gamma	1.00000

Gamma and **LookUpTable** are on oppsite sides. When Gamma is enabled, LUT is unavailable. To make it available, set Gamma value to 1.

Figure 4-50 Gamma value



4.9 LUTControl

In LUTControl, you can stretch or highlight the grayscale range of interest areas in a linear curve or a custom mapping curve.

- LUT is short for LookUpTable.
- **LUT** and **Gamma** are mutually exclusive. When Gamma is enabled, LUT will not take effect. To make it available, set Gamma value to 1.

Figure 4-51 LUTControl

LUTControl	
LUTSelector	Luminance
LUTEnable	False
LUTIndex	0
LUTValue	0
LUTValueAll	(Register)

Table 4-10 Description of parameters in LUTControl

Name	Description
LUTSelector	The channel of LUTControl. Only **Luminance** is supported.
LUTEnable	Specifies whether to enable LUTControl.
LUTIndex	The number points in the lookup table. The value range is 0-4095.
LUTValue	The value of LUTIndex.
LUTValueAll	Change the value of all indexes to the same one.

4.10 CounterAndTimerControl

The counter can divide the frequency of the externally input trigger signal to perform exposure control according to the user's logic.

Before you use CounterAndTimerControl, set a trigger source. For details, see4.3.4 TriggerSource and TriggerControl

Figure 4-52 CounterAndTimerControl

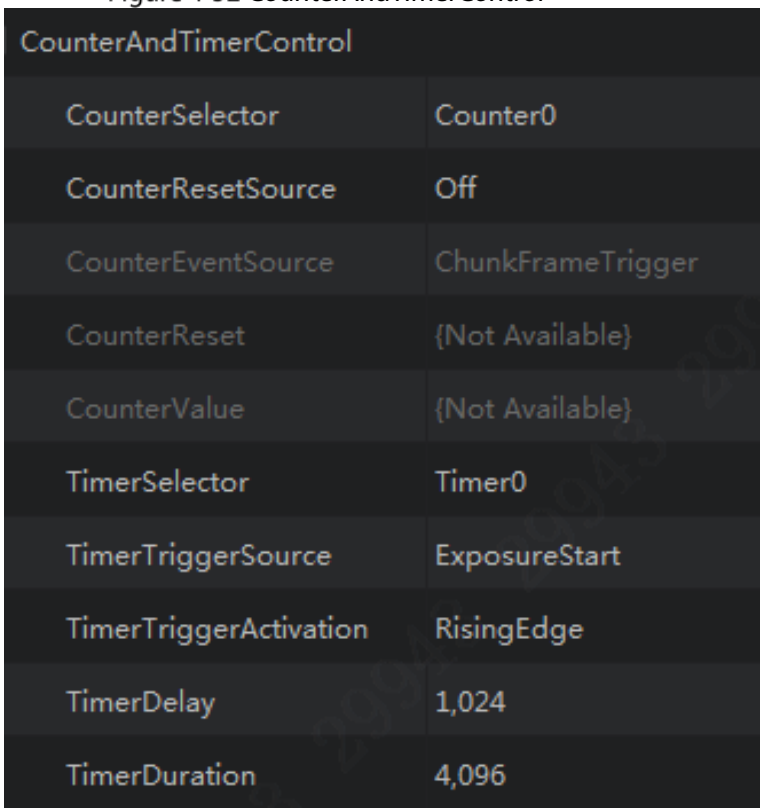


Table 4-11 Description of parameters in CounterAndTimerControl

Name	Description
CounterSelector	The counter to be set: Counter0 and Counter1. ● If you select Counter0, CounterEventSource is set to FrameTrigger. ● If you select Counter1, CounterEventSource is set to FrameStart.
CounterResetSource	Select the signal source to reset the counter: **Off** (no reset), **SoftwareSignal0** (software signal reset) and **Line1** (hardware signal reset).
CounterEventSource	Displays the event sources that will be added to the counting: **FrameTrigger** and **FrameStart**.
CounterReset	Reset the counter.
TimerSelector	The counter to be set. The default is **Timer0**.
TimerTriggerSource	The trigger source for starting the timer. The default is **ExposureStart**.
TimerTriggerActivation	The trigger mode for starting the timer, including **RisingEdge**, **FallingEdge** and **AnyEdge** (rising edge or falling edge).
TimerDelay	The delay between receiving the trigger signal and starting the timer.
TimerDuration	The duration of the timed pulse.

4.11 ISPControl

Figure 4-53 FPN correction

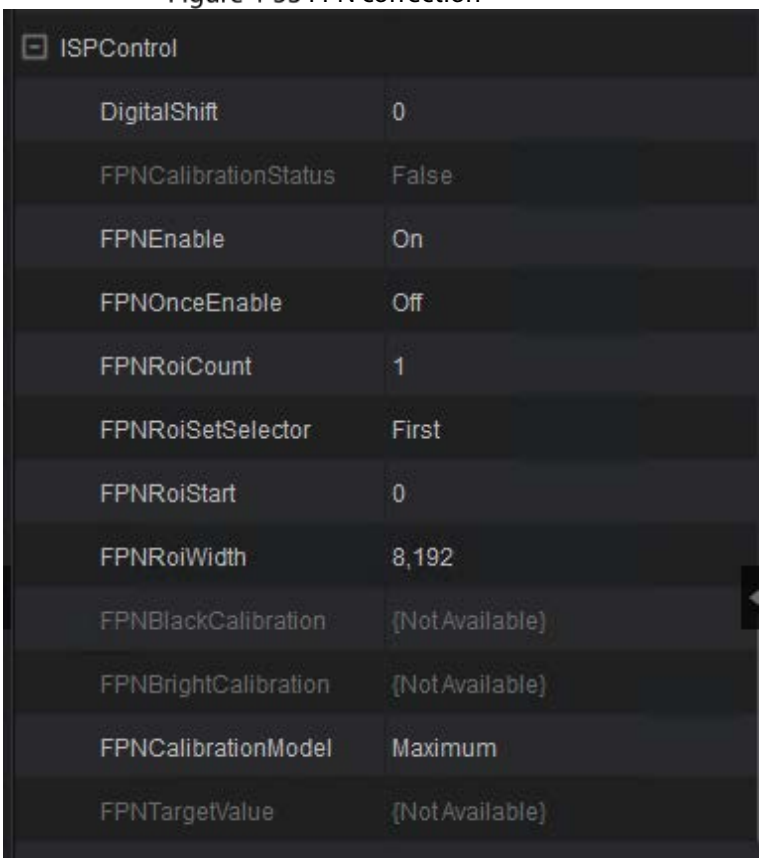


Table 4-12 Description of parameters in ISPControl

Parameter	Description
DigitalShift	Increase the value of **DigitalShift** by one, and the image brightness is doubled.
FPNEnable	Specifies whether to enable FPN. During FPN, when the analog gain value is that of the actual sensor, the FPN effect is the best. For details, see 4.7.2 Gain Raw.
FPNOnceEnable	Apply the FPN effects of different analog levels to other levels. Evenly apply the FPN coefficient of the level with the analog gain of 1 to the other analog gain levels (available on select models.).
FPNRoiCount	The number of effective FPN areas.
FPNRoiSetSelector	Switch effective FPN areas.
FPNRoiStart	The start point of effective FPN areas. (FPN takes effect only within the area specified by **Start** and **Width** of **FPNRoi**.
FPNRoiWidth	The end point of effective FPN areas.
FPNBlackCalibration	Specifies whether to enable dark field correction.
FPNBrightCalibration	Specifies whether to enable bright field correction.
FPNCalibrationModel	Select the FPN effect from **Maximum**, **Average** and **User** (custom). **Average** is recommended.
FPNTargetValue	Custom effect value: 50–240. The higher the value, the stronger the correction.
RestoreDefaultCalibration	Restores default FPN data. This covers FPN performed by users after FPN is enabled.
LineSpatialCorrectionEnable	Specifies whether to enable RGB differential. An enabling button is supported by select models.
LineSpatialCorrectionDirection	r_g_b: Captured objects are vertically towards the label. b_g_r: Captured objecs are vertically away from the label.

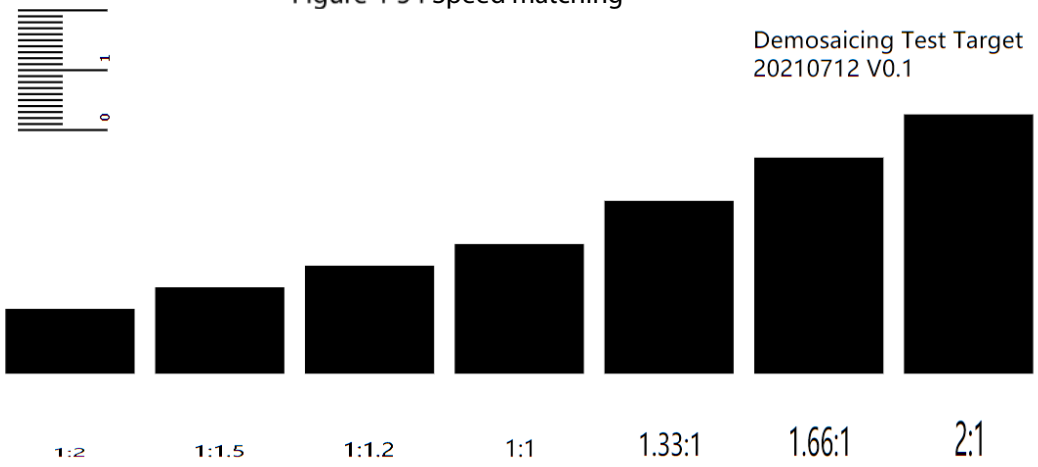
Parameter	Description
LineSpatialCorrection	When the line frequency has matched the shooting speed but there is still tail color, adjust the value between 0.5 and 2 until the tail color disappears. Generally, adjust the value below 1. Before adjusting the value, make the line frequency of the camera match the object's movement speed with the optimal line frequency value. You can draw a square to check the aspect ratio in the image for calculation.

Spatial correction of RGB color camera:

Speed Matching

Perform speed matching based on the test image in the appendix. The rules are as follows:

Figure 4-54 Speed matching



Eg1: When the black block corresponding to 1:2 is a square, the current speed is 0.5.

Eg2: When the black block corresponding to 1:1 is a square, the current speed is 1.

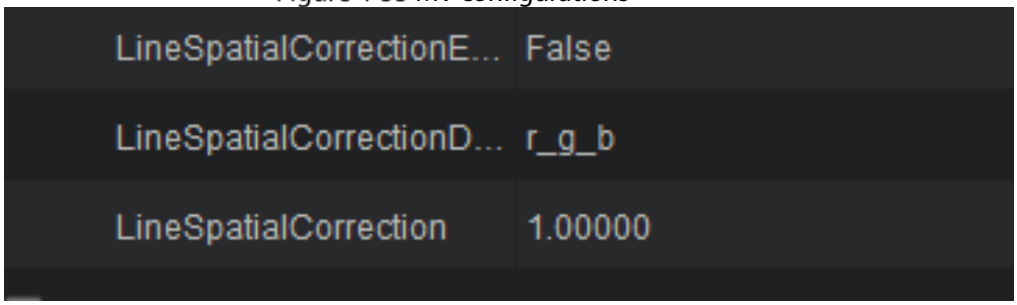
Eg3: When the black block corresponding to 1.33:1 is a square, the current speed is 1.33.

We recommend you keep the speed around 1.

MV Configurations:

Parameters in the following figure are used to enable spatial correction, set the direction, and correct the space respectively.

Figure 4-55 MV configurations



We recommend you set the speed between 1 and 2. A speed of 1 is the best.

Procedure:

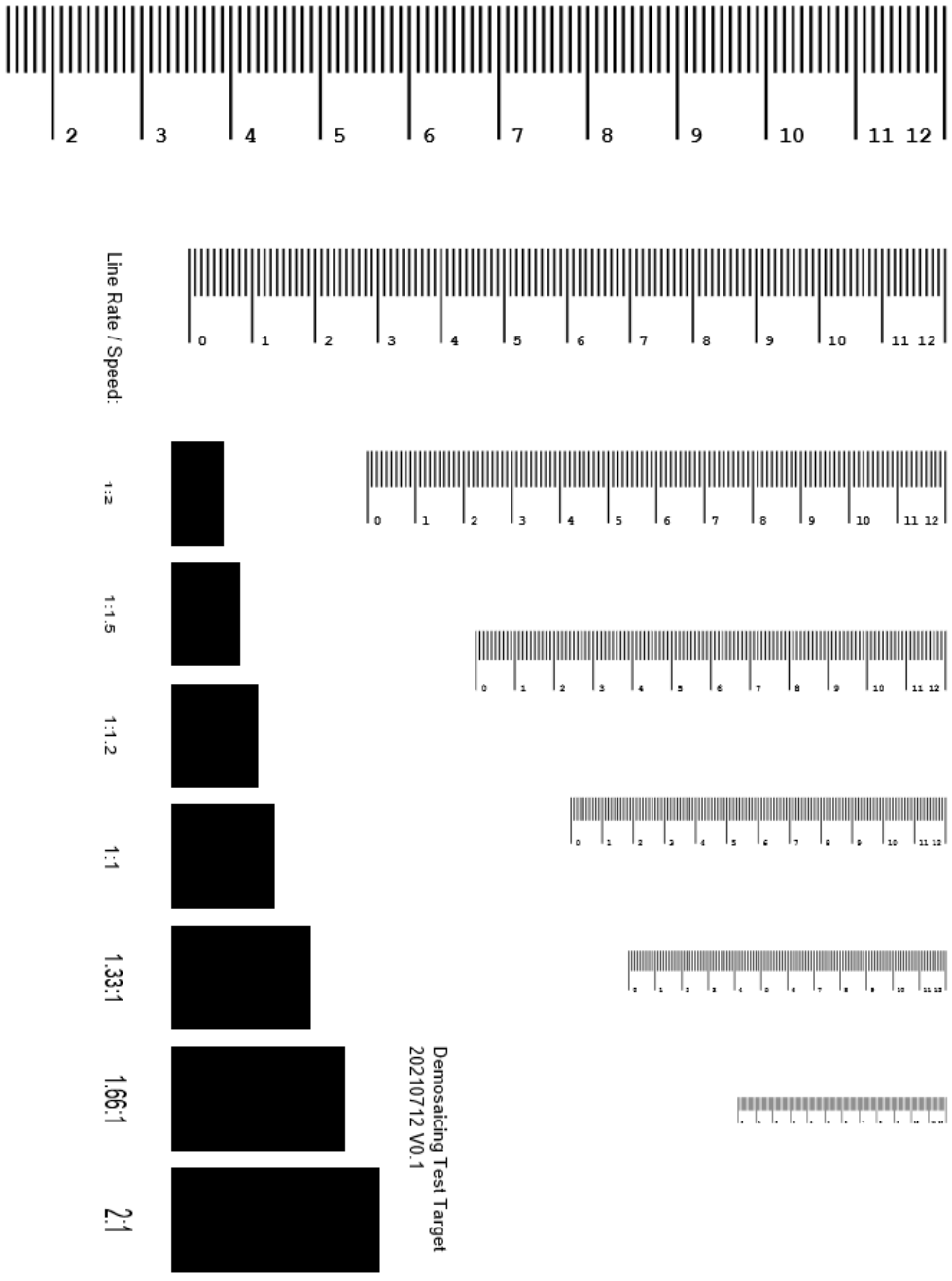
Set **LineSpatialCorrection** to an appropriate value.

Set **LineSpatialCorrectionE** to **True**. If the tail color of the image is worse, set **LineSpatialCorrectionD** to **b-g-r**.

If the preceding operations do not work, we recommend you change the direction of the camera and then repeat the preceding operations.

We recommend you set **LineSpatialCorrection** between 1 and 2.

Figure 4-56 Example



4.12 FPN

FPN correction is applied to ensure image uniformity of line scan cameras.

Step 1 Enable FPN.

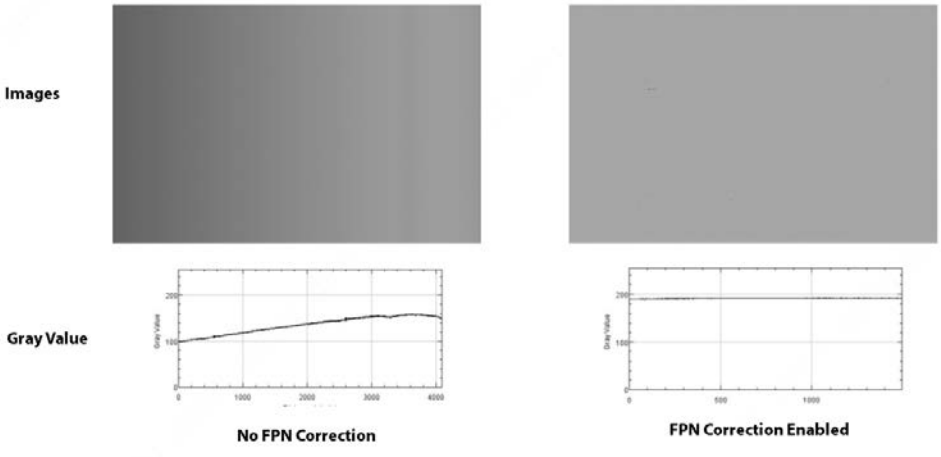
Step 2 (Optional) Cover the camera with the lens cap, and then click **FPNBlackCalibration**. Generally, you do not need to change FPNBlackCalibration settings.

Step 3 Remove the lens cover, place a uniform board to cover the field of view (white paper is also acceptable), and adjust the exposure to make the image gray value between 160 and 200. If the vertical lines of the image in **FPNBrightCalibration** are clearer, the lens needs to defocus to blur the vertical lines, so that the FPN correction effect is the best.

Step 4 Click **FPNBrightCalibration**, and then set **FPNenable** to **On**. FPN takes effect.

Step 5 It can be seen from the gray value curve that FPN makes the gray value of each line of the collected image more uniform.

Figure 4-57 Correction effect

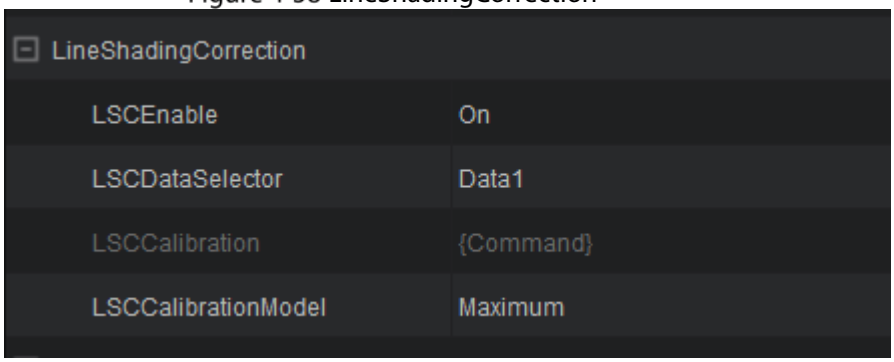


FPN operations require images with the default max. width.

Therefore, if the tap number selected for CameraLink camera is not the common divisor fof the default camera resolution, it is not divisible. This is according to the CL protocol. The ROI width of the camera will be automatically adjusted so that it can be divided into tap number, which might cause FPN fail to be performed. You can perform FPN in tap with the max. default width, and then switch to 10tap or 3tap.

4.13 LineShadingCorrection

Figure 4-58 LineShadingCorrection



Based on FPN and shades caused by lens and light source, you can correct external optical environments through line shading correction.

To perform line shading correction, you must enable FPN and place a white paper or uniform plate.

LSCEnable: Specifies whether to enable line shading correction.

LSCDataSelector: The data for line shading correction.

LSCCalibration: Perform line shading correction.

LSCCalibrationModel: The correction mode, including **Maximum** and **Average**.

You use Camtool to export line shading correction coefficients and import the coefficients to other cameras of the same type. Only select models support the function.

4.14 TransportLayerControl

Figure 4-59 Transmission layer management

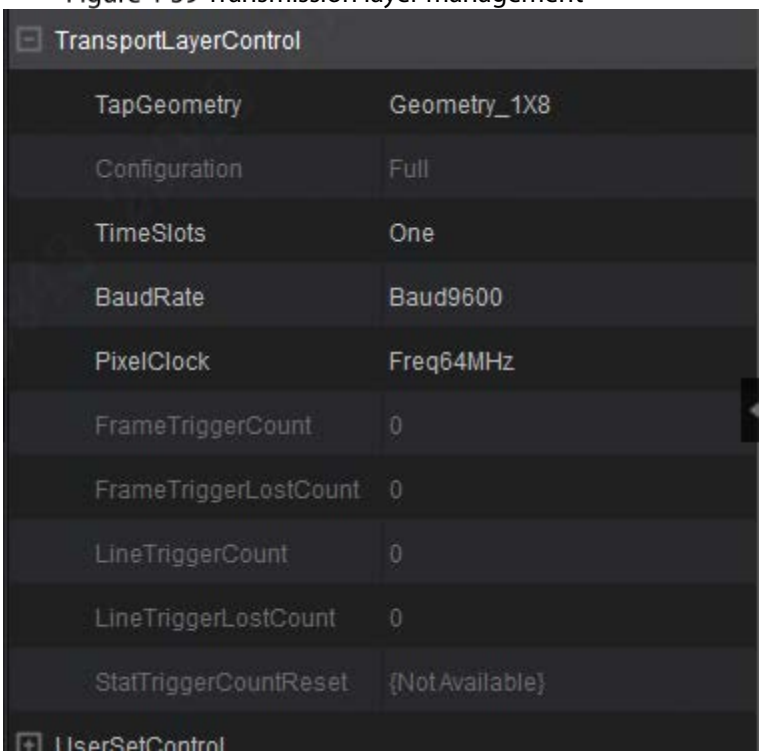


Table 4-13 Transmission layer management

Parameter	Description
TapGeomety	The arrangement format of output images. The format must be the same as that on the capture card.
Configuration	The output type, including **Base**, **Medium**, **Full**, and **Deca**.
TimeSlots	It is **One** by default.
BaudRate	The baud rate.
PixelClock	The clock frequency of pixel transmission. The larger the value, the faster the transmission, and the greater the line frequency.
FrameTriggerCount	Statistics of the camera's external trigger frame signals.
FrameTriggerLostCount	Statistics of the camera's external trigger frame signal loss.
LineTriggerCount	Statistics of the camera's external trigger line signals.
LineTriggerLostCount	Statistics of the camera's external trigger line signal loss.
StatTriggerCountReset	Clearance of statistics.

4.15 UserSetControl

You can save or adjust the parameters, and set the default parameters when the client starts.

Figure 4-60 UserSetControl

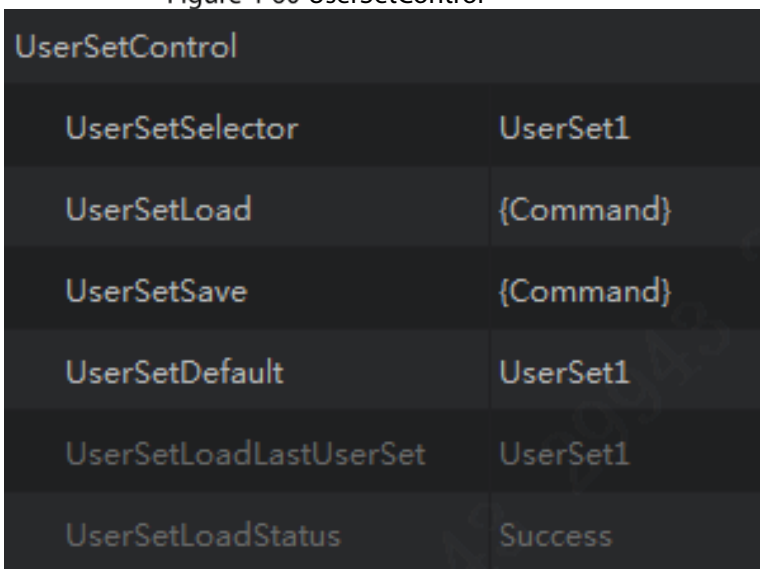


Table 4-14 Description of parameters in UserSetControl

Parameters	Description
UserSetSelector	The user group. User groups include **Default**, **UserSet1**, and **UserSet2**. FPN coefficient cannot be saved or copied to other cameras.
UserSetLoad	Loads user settings as camera settings.
UserSetSave	Saves the current settings to a user group. The settings cannot be saved to the **Default** user group.
UserSetDefault	The default settings that take effect after the camera is powered on. For **UserSet1** and **UserSet2**, you must set **UserSetSave** first.
UserSetLoadLastUserSet	The last used settings.
UserSetLoadStatus	The loading status of user settings. UserSetLoad

5 FAQs

5.1 Camera Connection

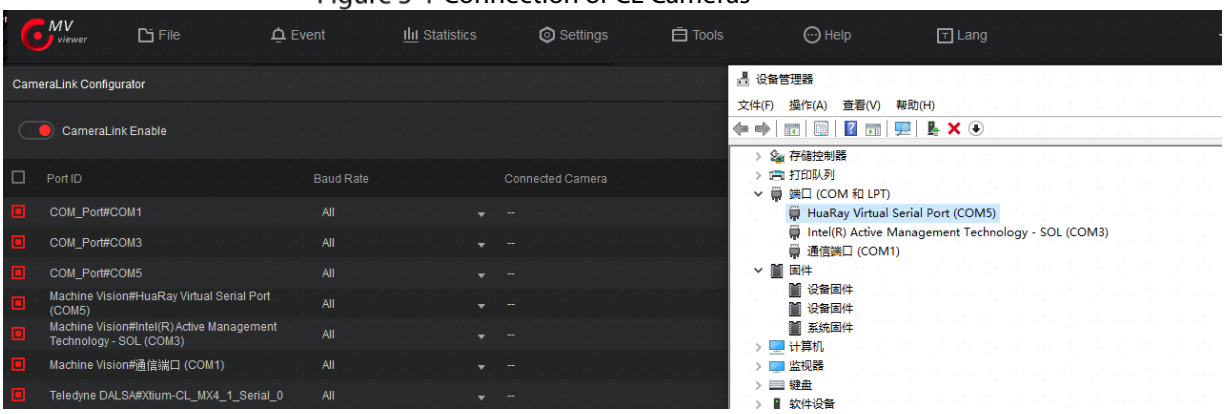
5.1.1 Connection of Ethernet Port Cameras

Check whether the communication of the network port is normal and whether the IP addresses of the network adapter and camera are correctly set.

5.1.2 Connection of CL Camera

- Check whether CL1 and CL2 are invertly inserted.
- Check whether the XML of the camera is occupied due to the opening of the capture card software.
- Check whether the local XML file is damaged. If yes, delete all files in C:\ProgramData\GenICam\xml.
- Check whether the software of a competing company is installed. The software might maliciously modify the files in the MV installation path of our company. In this case, you need to uninstall the software.
- Check whether the capture card software is correctly installed, or whether the CameraLink tool on MV has enabled ports of the capture card.
- If multiple CL cameras are connected to a computer, another camera cannot be detected under the current MV. You can open another MV to detect cameras.

Figure 5-1 Connection of CL Cameras

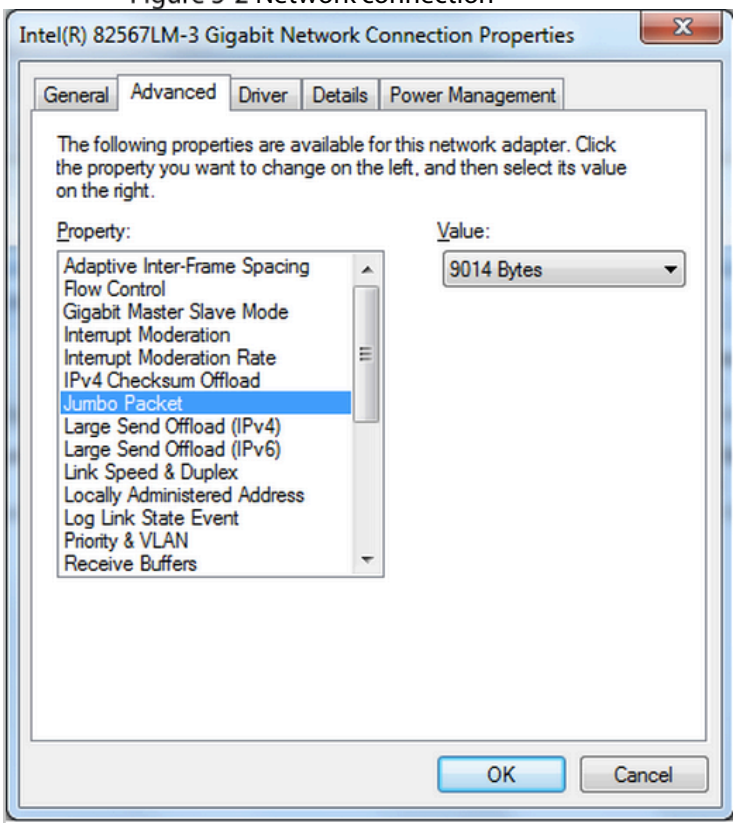


5.2 Issues Related to Image Acquiring

5.2.1 Stream Acquiring Failed

The port is not a GigE port and Jumbo is disabled. Trigger is disabled for the camera.

Figure 5-2 Network connection



5.2.2 CL Cameras: Failed Image Acquiring

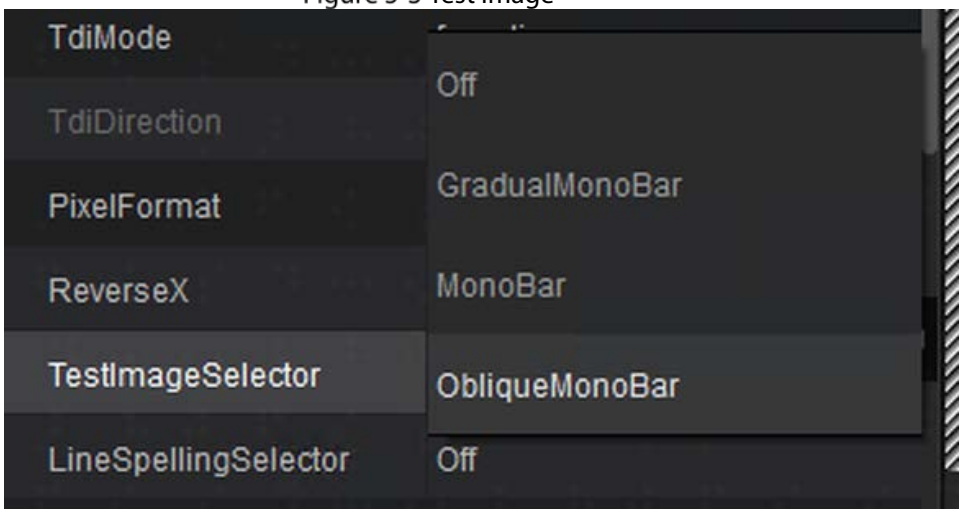
1. First, set the camera to free stream pulling, and set the capture card to free capture mode. Check whether the tap width and height and the image format are the same for the capture card and camera. If it is in RGB, 10tap, and other formats, the capture card might need to change the RGB template, or use the update software of the capture card to upgrade 10tap to set these attributes.
2. When the trigger cannot acquire the stream: Generally, the capture card is equipped with the line scan camera, or the mode of the capture card frame trigger + camera line trigger is used. First, check whether the trigger channel sends the actual IO signal to the CC channel of the capture card, and whether the camera line trigger uses the corresponding CC channel.

If you are not sure whether there is a problem with your configurations, you can use the internal trigger of the capture card. If the camera can pull the stream according to the internal trigger frequency, the configurations are correct. Then, change the external trigger and check the wiring problems. Trigger in the capture card refers to a self-defined internal signal of the capture card. You can set frequency and pulse width in the software.

5.2.3 Test Image

We recommend you keep the default width of a test image when you use it. Meaning of multiple test images: gradient image from black to white > multiple gradient images from black to white > rhombic image.

Figure 5-3 Test image



5.3 Abnormal Image Color

5.3.1 Scan Direction

In general, the installation direction of color line camera and scanned objects are towards the label. However, the installation direction of L5047CG, L5042CG; L5087CK670, and scanned objects are away from the label.

Figure 5-4 Example

When TDI is enabled for the black and white camera, if the scanning direction does not follow the preceding rule, TDI reversal also needs to be enabled.

When the bayer color camera is used with the capture card, there is color cast after format conversion. The default RGGB mode will be used to transform images to bayer images during stream acquiring. You need to change the bayer mode to GRBG. Otherwise, the color cast appears.

Each capture card has a bayer image processing module. You need to set the module. However, if the capture card acquires the XML attributes of the camera, the capture card will automatically match the bayer conversion module according to the current image format. In this case, you cannot change the module.

When the automatic matching is successful, the bayer image conversion module of the capture card cannot be changed. In this case, the connection between the capture card and the camera needs to be disconnected. Then, you can use MV to open the XML of the camera, and change the bayer image conversion mode of stream acquiring in the capture card.

Figure 5-5 Camera settings (1)

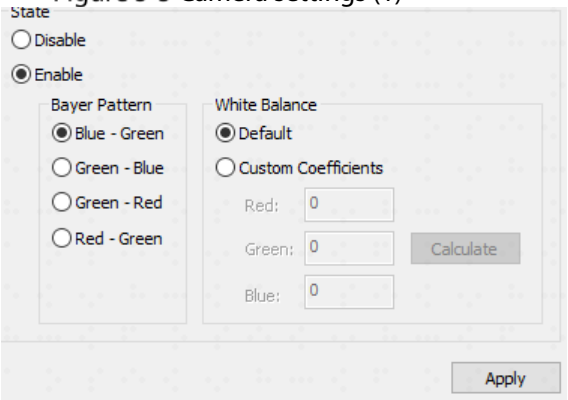
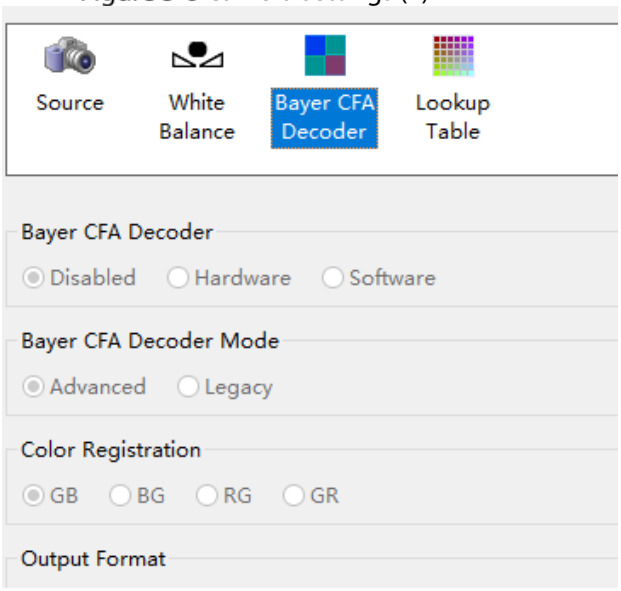


Figure 5-6 Camera settings (2)



5.3.2 Spatial correction of RGB color camera

LineSpatialCorrectionEnable	Specifies whether to enable RGB differential. An enabling button is supported by select models.
LineSpatialCorrectionDirection	r_g_b: Captured objects are vertically towards the label. b_g_r: Captured objecs are vertically away from the label.
LineSpatialCorrection	When the line frequency has matched the shooting speed but there is still tail color, adjust the value between 0.5 and 2 until the tail color disappears. Generally, adjust the value below 1. Before adjusting the value, make the line frequency of the camera match the object's movement speed with the optimal line frequency value. You can draw a square to check the aspect ratio in the image for calculation.

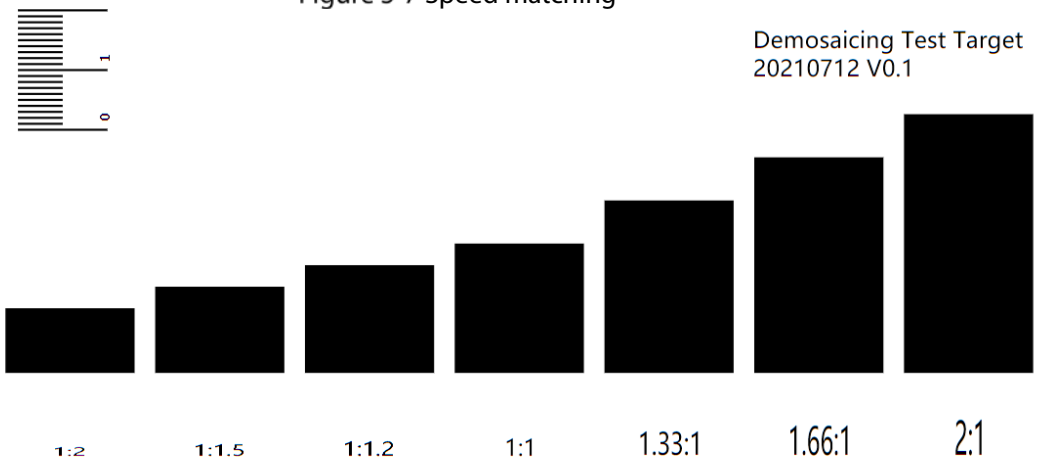
Spatial correction of RGB color camera:

Speed Matching

Perform speed matching based on the test image in the appendix. The rules are as follows:

When the object in the image is a square, the current speed is the displayed speed.

Figure 5-7 Speed matching



Eg1: When the black block corresponding to 1:2 is a square, the current speed is 0.5.

Eg2: When the black block corresponding to 1:1 is a square, the current speed is 1.

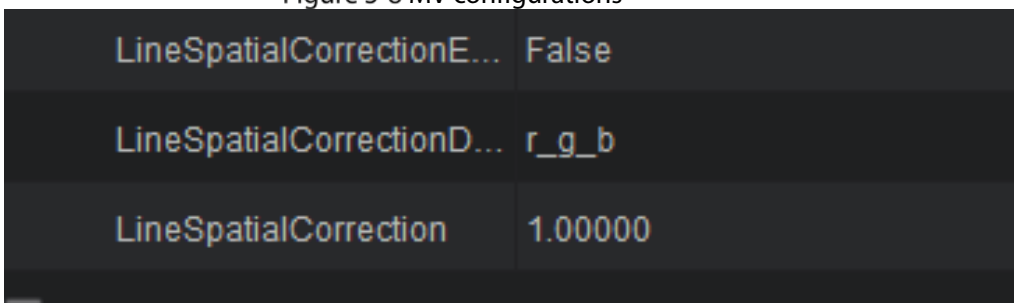
Eg3: When the black block corresponding to 1.33:1 is a square, the current speed is 1.33.

We recommend you keep the speed around 1.

MV Configurations:

Parameters in the following figure are used to enable spatial correction, set the direction, and correct the space respectively.

Figure 5-8 MV configurations



We recommend you set the speed between 1 and 2. A speed of 1 is the best.

Configuration Steps:

Set **LineSpatialCorrection** to an appropriate value.

Set **LineSpatialCorrectionE** to **True**. If the tail color of the image is worse, set **LineSpatialCorrectionD** to **b-g-r**.

If the preceding operations do not work, we recommend you change the direction of the camera and then repeat the preceding operations. We recommend you set LineSpatialCorrection between 1 and 2.

5.3.3 Stretched or Compressed Images

This section introduces a formula for adjusting line frequency to make sure that captured are not stretched or compressed.

View MM: S

ROI width: X

Speed: V

Line frequency: K=V/(S/X)

Make sure that the units of speed and view are the same. (recommended: cm/s, view unit: cm, line frequency unit: /s)

5.3.4 Black Images

1: The issue might occur when you perform FPN in a bright environment but run the command for correction in a dark environment.

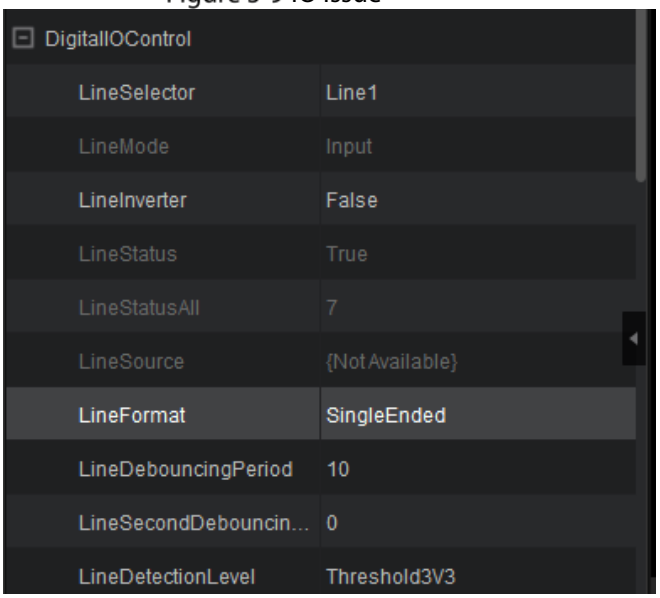
2: The number of taps is abnormal, or the camera ROI does not equal the capture card ROI.

5.4 Invalid Trigger

5.4.1 Trigger of Ethernet Port Cameras

- When one IO trigger fails, you can avoid the issue by using another IO as the trigger cable, or checking whether the attribute settings of the IO management terminal conform to actual signal conditions: single-end or differential filter, signal, and signal level.

Figure 5-9 IO issue



- **Encoder**

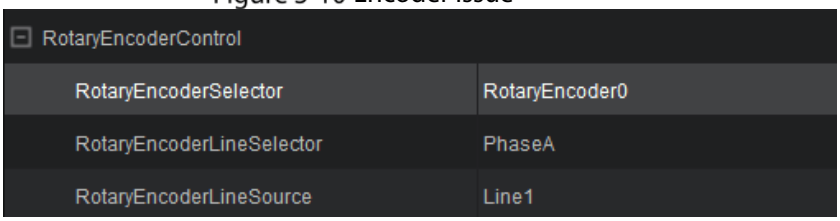
There are many types of encoders in the market, including single-end encoders, differential encoders, incremental encoders, and absolute encoders. Therefore, you must select an appropriate encoder. In addition, the transmission distance is very important.

After the encoder is connected and a channel is selected, you can perform the following steps if the camera does not generate images:

1 Perform frame trigger for 2 lines of the encoder to check whether there is signal output.

2 Check whether the cable connection of the encoder is A+ A- B+ B-, and select lines based on Phase and PhaseB.

Figure 5-10 Encoder issue

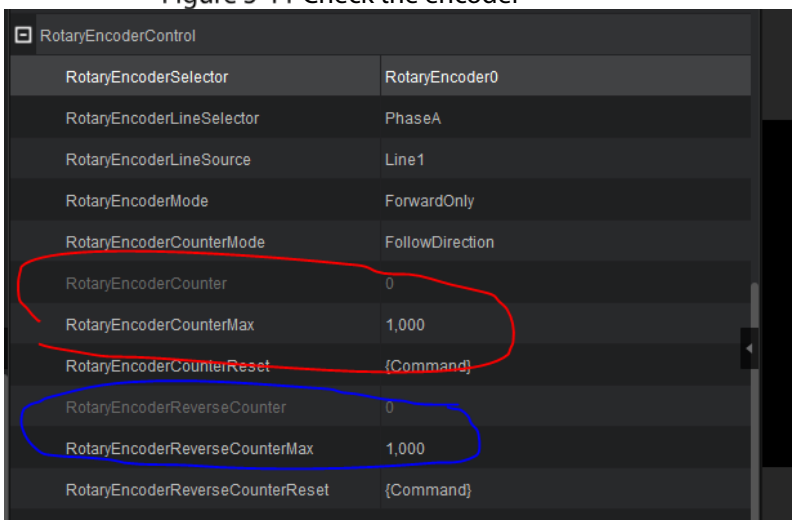


- **Check the encoder**

Check whether the value of **RotaryEncoderCounterMax** changes.

Check whether the debouncing counter changes when the encoder is reversed, and whether the value is set too large.

Figure 5-11 Check the encoder



5.4.2 Trigger of CL Cameras

Trigger of CameraLink cameras is more complicated. The camera can be triggered by the IO to CC channel of the capture card or by the IO of the camera itself. For issue caused by the camera IO, see the preceding section. This section introduces the IO trigger logic of the capture card.

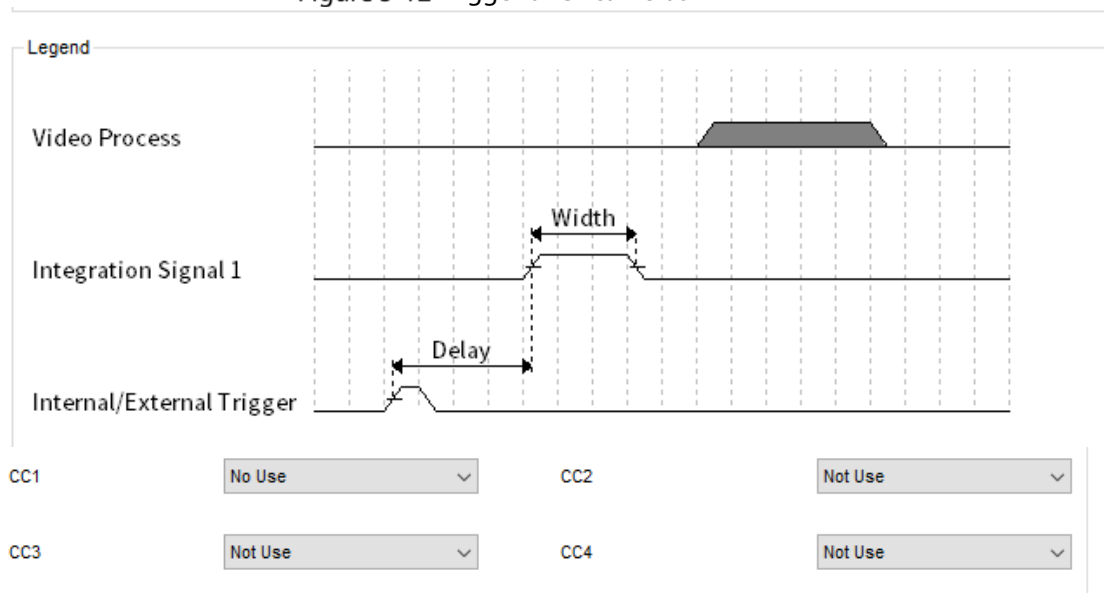
Conversion of capture card trigger

The capture card obtains the signal through the actual IO, or defines a signal through the internal clock. Then, it generates an internal pluse signal by triggering the conversion, and the signal is given to the CC channel.

The principle is that the capture card obtains the IO signal defined by the external connection or the signal defined by the internal clock, and generates an internal signal to CC1-CC4 through the delay and defined signal width (custom high and low level).

Some capture cards might call the internal signal given to the CC channel: reset, pluse, integration Trigger, time, and output. Some manufacturers make this part into a separate module, which can set width Delay. Set trigger by the polarity of rising/falling edge or high and low level, and then set the capture card as the trigger source of grab mode.

Figure 5-12 Trigger of CL cameras

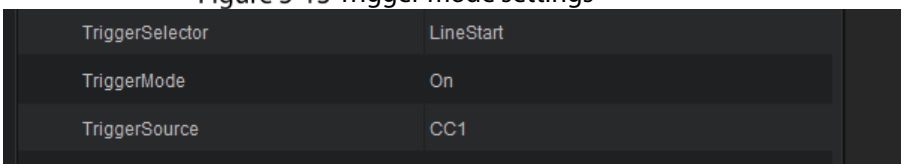


Capture card frame trigger: IO of the capture card is directly used as the trigger source. According to the signal type, trigger by the rising/falling edge or by high/low level can be selected. Generally, select **Hardware Trigger** or set **trig mode** to **hard**.

Some capture cards call"trigger" as external trigger. You can configure the trigger based on the corresponding user's manual.

Capture card line trigger: The line trigger of line scan cameras is basically the encoder line trigger. You must connect the encoder according to the user's manual of the capture card IO, convert the encoder signal into internal pluse given to the CC channel, and then use CC channel for the line trigger of the camera. Frequency division and multiplication of encoders are also performed on the encoder side.

Figure 5-13 Trigger mode settings

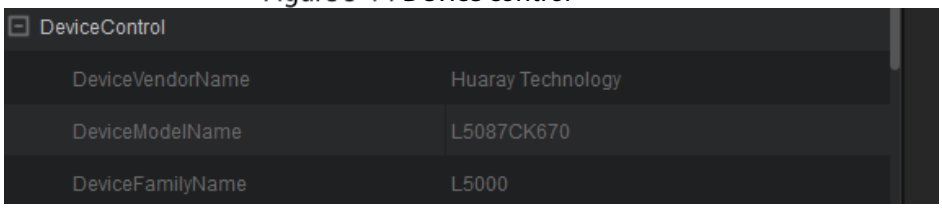


5.5 Camera Upgrade and Version

Although some cameras share an external model, their internal models vary. You can only use firmware with the same material number for upgrade. If you are not sure of internal models, check whether the values of **DeviceFamilyName** are the same.

L5000 and LH5000 firmware of different FPGA platforms cannot be used interchangeably for upgrade, such as L5162MK170 and LH5162MK170.

Figure 5-14 Device control



5.5.2 CL Camera Upgrade

If you use a CameraLink camera, we recommend you set the baud rate to the max. value supported by the capture card. If you use 2 cables, you can set the baud rate to 921600. If only a CL cable is used, we recommed you set the baud rate to 115000. During upgrade, you can double-click the progress bar to download logs that display whether the baud rate is delivered, the status of flash, and more.

MV download path: http://download.huaraytech.com/pub/sdk/Ver2.2.5/.

Figure 5-15 CL camera upgrade (1)

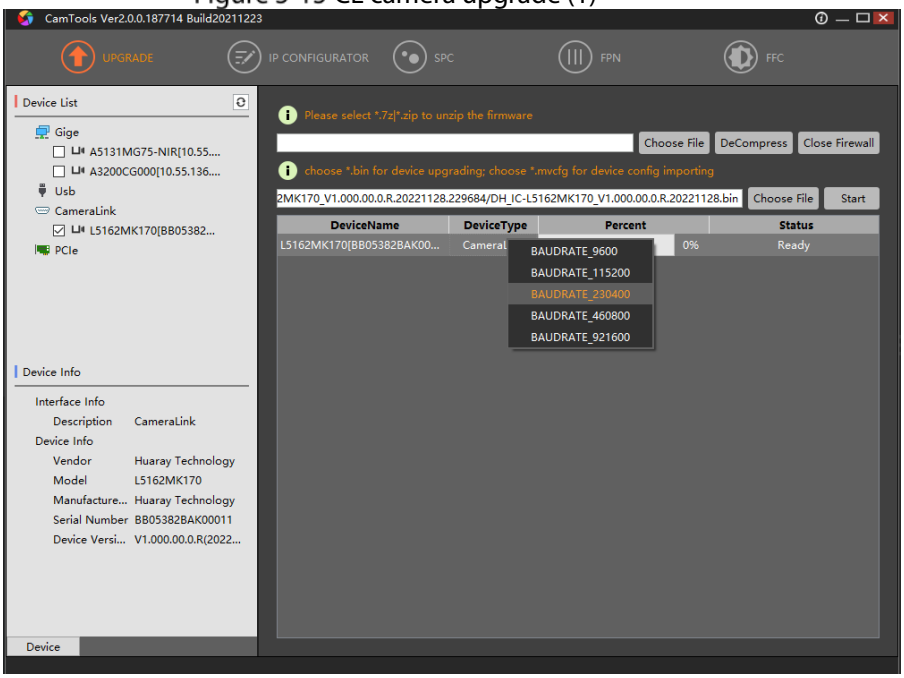
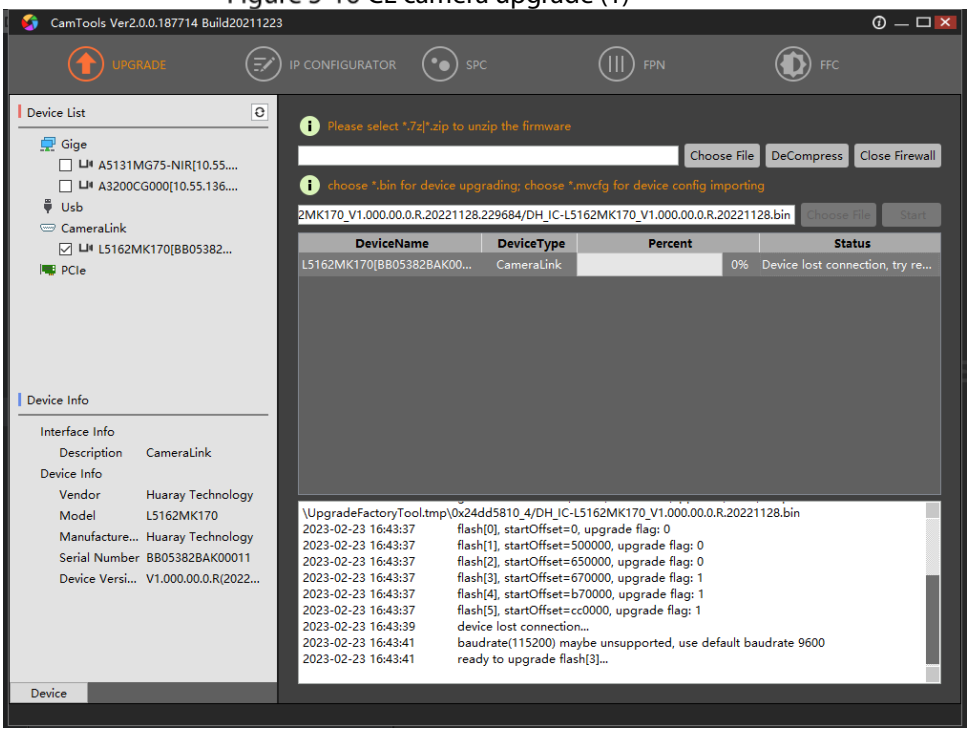


Figure 5-16 CL camera upgrade (1)



5.5.3 Ethernet Port Camera Upgrade

You do not need to take actions if the camera is offline during upgrade.

Because the upgrade requires disconnection between MV (or capture card) and the camera.

5.5.4 Failed Upgrade

If the upgrade fails, check whether the firmware matches with the internal model of the camera. For details, contact technical support.

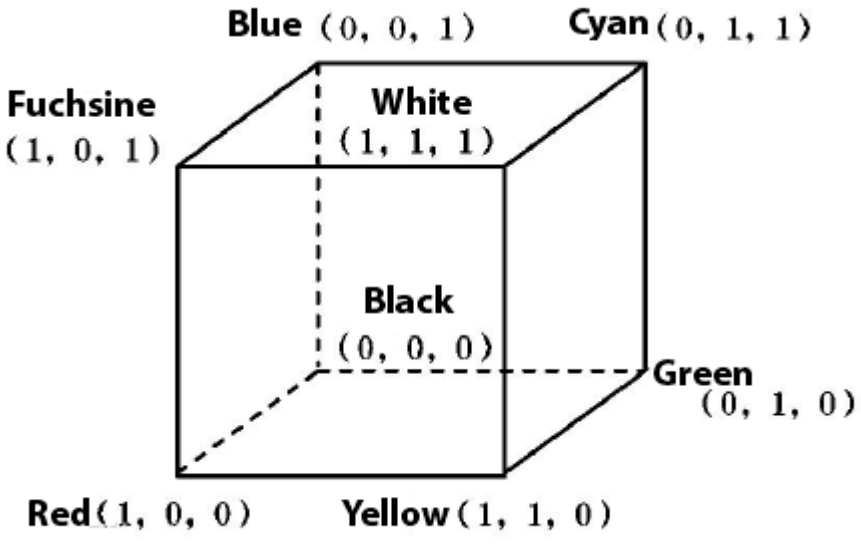
Do not power off the camera to stop upgrade. Instead, you can close Camtool to stop upgrade.

5.6 Issues Related to White Balance and FPN

5.6.1 How to Do White Balance

Before the delivery of cameras, we adjust the RGB uniformity response of the camera, so that the response of the RGB of the camera is 1:1:1 under pure white light source. This way, images captured by cameras have uniform colors. The proportion of RGB affects the color of images, as shown in the following figure.

Figure 5-17 RGB



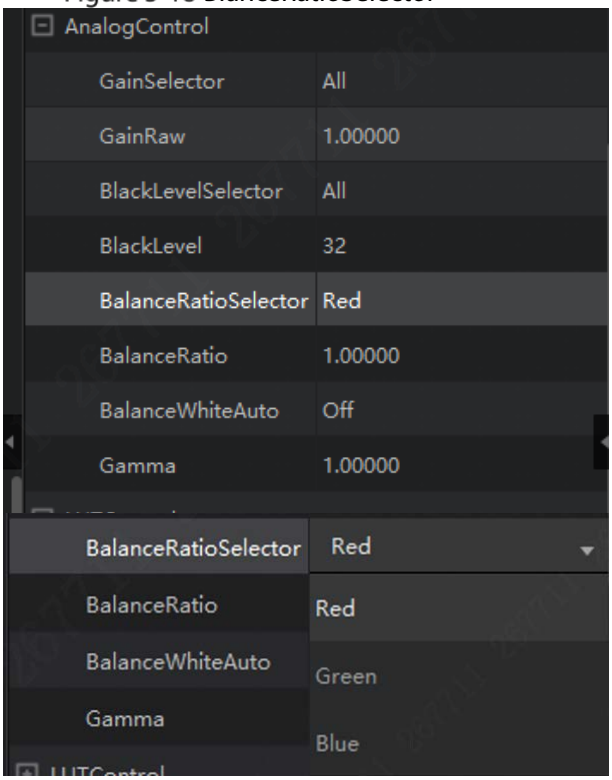
Due to the difference in the light source in each scene, the actual response of camera to RGB is different from the image capture by eyes, we need to do the white balance again,

Place a white paper in the view of the camera.

Click **AnalogControl**, then set **BalanceWhiteAuto** to **Once**. White balance is completed if **Once** changes back to **Off**. If the color of images is greenish, try increase exposure value (exposure time).

During white balancing, images can not be overexposed. Click the image to view the gray value, and adjust the exposure value to make sure that the gray value is between 100 and 200.

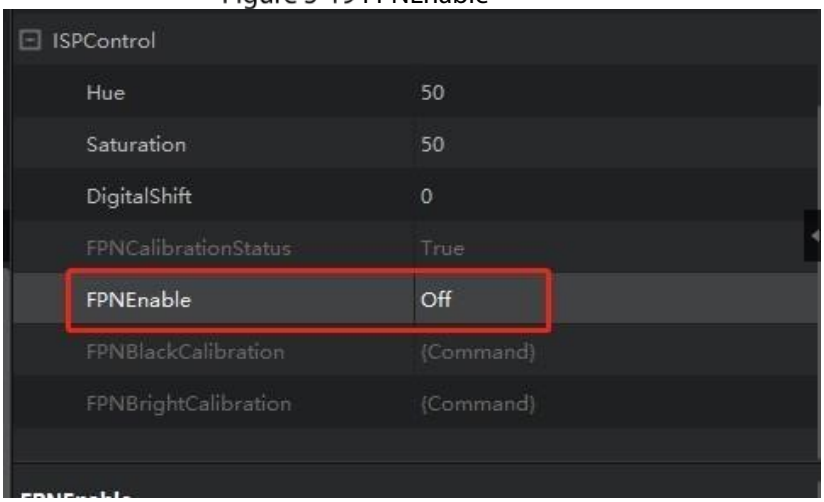
Figure 5-18 BlanceRatioSelector



5.6.2 FPN

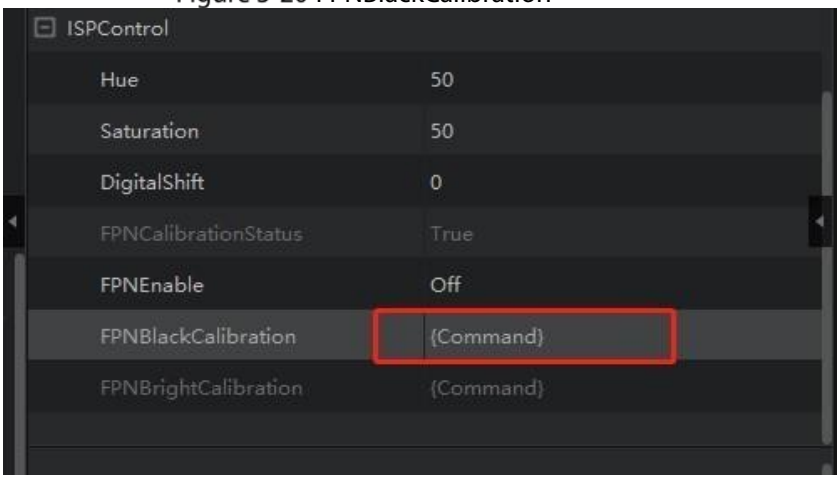
In ISPControl, set **FPNEnable** to **Off**.

Figure 5-19 FPNEnable



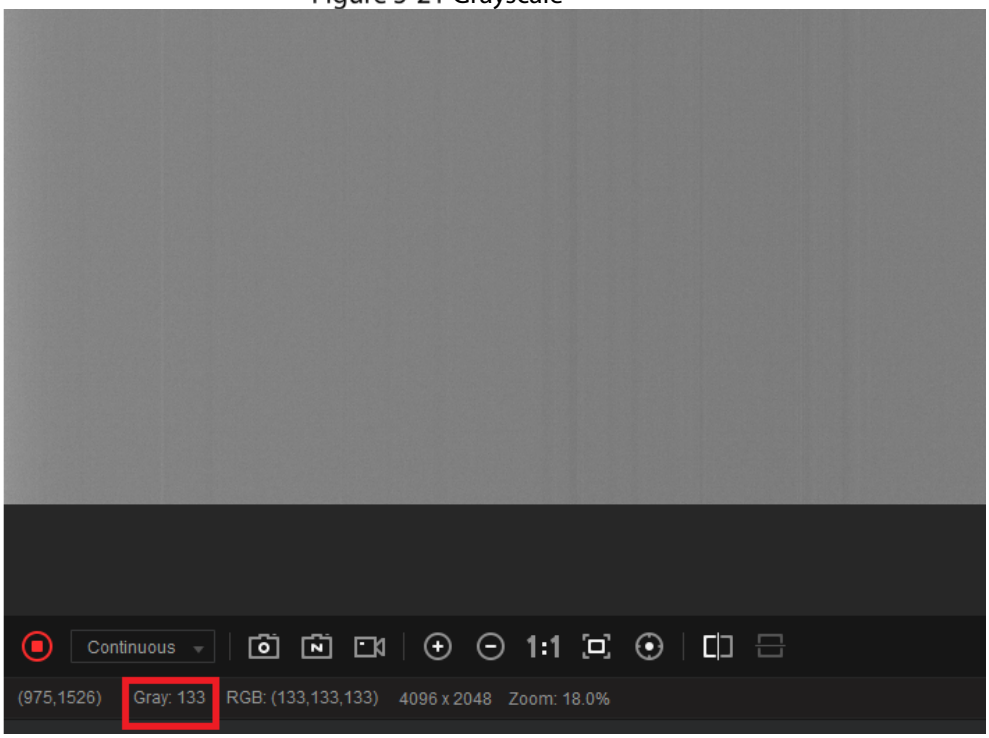
In a dark environment, completely cover the lens, and then click **{Command}** next to **FPNBlackCalibration**.; Wait for the command to take effect, and then click to capture images.

Figure 5-20 FPNBlackCalibration



In a bright environment, place white paper in the view of the camera. The focus of the lens must be blurred to blur the overall image. Images can not be overexposed. Click the image to view the gray value, and adjust the exposure value to make sure that the gray value is between 100 and 200.

Figure 5-21 Grayscale

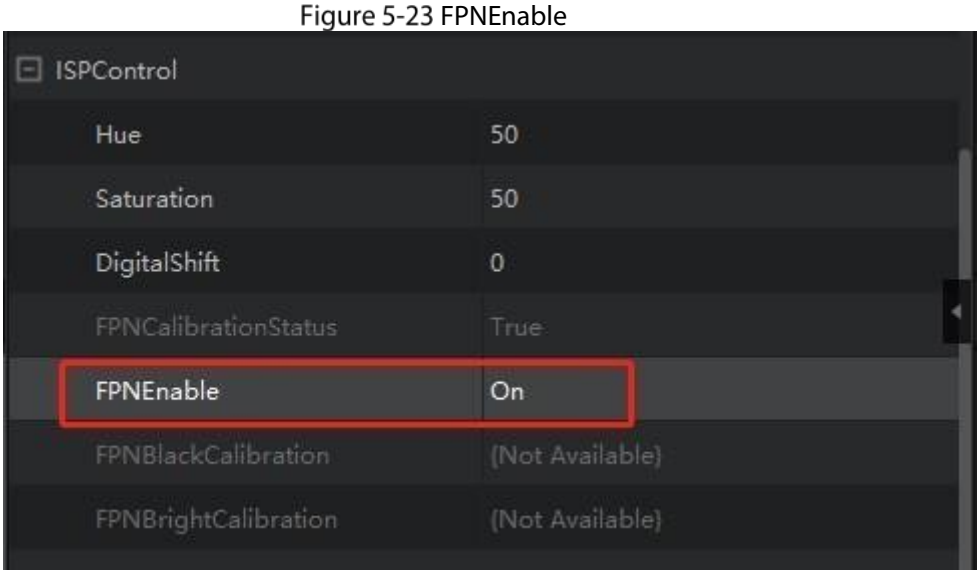


Click **{Command}** next to FPNBrightCalibration. Wait for the command to take effect, and then click to capture images.

Figure 5-22 FPNBrightCalibration

Set **FPNEnable** to **On** to complete correction. If the effect is abnormal, it is possible that the edge of the dark/bright environment is bright or dark, or the lens is not blurred and the paper has much texture.

Figure 5-23 FPNEnable



⚠

Images must not be overexposed.

5.6.3 Why FPN is Not Supported by CL Cameras

FPN operations require images with the default max. width. Therefore, if the tap number selected for CameraLink camera is not the common divisor fof the default camera resolution, it is not divisible. This is according to the CL protocol. The ROI width of the camera will be automatically adjusted so that it can be divided into tap number, which might cause FPN fail to be performed. You can set tap to 8 for FPN. After FPN is completed, set tap to 10. The effect of FPN still exists.

5.6.4 Influence of Sensor Analog Gain Level on FPN

If the analog gain is 1 when FPN is performed, the effect might not be good when the analog gain is adjusted to 3. Therefore, it is necessary to perform FPN correction at 3.5, so that the camera has FPN correction coefficient for both analog gain 1 and analog gain 3.5. When the analog gain is the same as that of the sensor, FPN has the best effect. For details, see the following table.

- We recommend you perform FPN at the gain stage of the target image. For example, the anglog gain stage of L5082MG170 is 7 and the anglog gain stage of the sensor is 3.5. In this case, you need to perform FPN at 3.5. After FPN is completed, change the anglog gain stage back to 7.
- **FPNOnceEnable** applies the FPN effect of different anglog gain stages to other stages. Some models support evenly applying the FPN coefficient under the anglog gain stage of 1 to other stages.

Table 5-1 Anglog gain stage

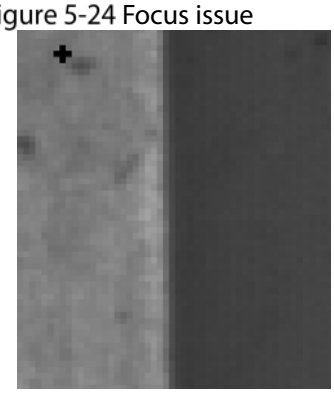
Model	Number of stages	Stage
L5022CG141	1	1
L5022MG141	1	1
L5027CG140	5	1 1.4 1.6 2.4 3.2
L5027MG140	5	1 1.4 1.6 2.4 3.2
L5042CG141	2	1 4
L5042MG141	1	1
L5047CG140	5	1 1.4 1.6 2.4 3.2
L5047MG140	5	1 1.4 1.6 2.4 3.2
L5082MG170	2	1 3.5
L5047CK140	5	1 1.4 1.6 2.4 3.2
L5047MK140	5	1 1.4 1.6 2.4 3.2
L5082MK170	2	1 3.5
L5087CK670	6	1 1.6 2.7 3 3.5 4.6
L5087MK470	7	1 1.6 2.7 3 3.5 4.6 6.2
L5162MK170	2	1 3.5

5.7 Issues Related to Debugging and Installation

1 Only a line is captured by the camera: It is possible that the sensor and the scan line is not in parallel

2 Focus issue: Use an object (without burrs) with a clear border between the bright side and dark side to make the camera focus on the border.

Figure 5-24 Focus issue



3 Images of the same type of products have huge differences: The light source is not in parallel with the captured object. We recommend you install the line scan camera horizontally. If the camera is installed slantly, you can install a fixed part to unify the installation angle.

Figure 5-25 Light source not in parallel with the camera

4 Errors are reported when exporting or importing camera attributes:

MV only traverses the attribute tree of the current XML page when saving camera settings. When you modify the hidden attribute tree, such as time-sharing strobing, 4 groups of polling exposure and gain setting, MV only saves the exposure gain value of the polling group on the current XML page. When you import the settings to other cameras, the hidden 3 sets of polling parameters cannot be imported.

Similarly, some XML attributes might be deleted or added after the upgrade of camera firmware. If you import the settings saved in the old firmware to a camera upgraded with the new firmware, an XML import error might be reported. The impact will not be significant. However, the attributes in the imported MCF configuration that are different from the actual camera will not be processed.

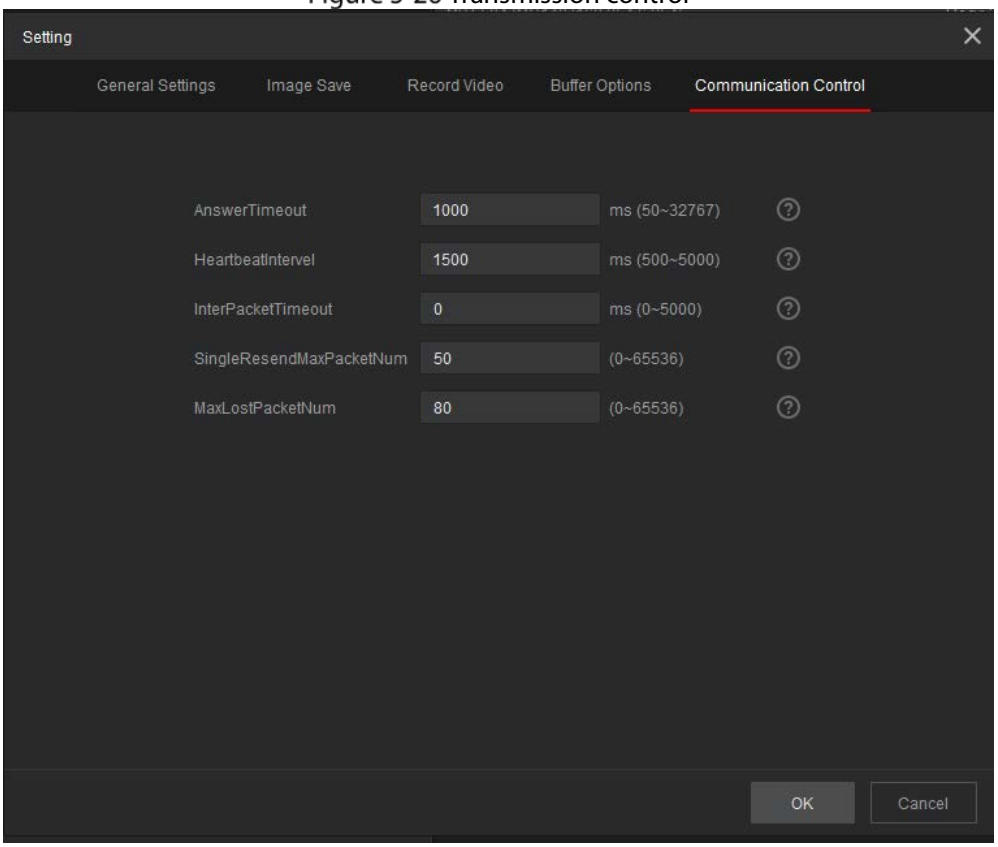
If your firmware versions are inconsistent and attribute trees are inconsistent, import errors will be reported. However, it will not affect the use of cameras. The inconsistent attributes will be set to default values.

5 Images stretched or compressed: Check whether lostcout has lost lines, and make sure that the external trigger frequency is less than or equal to the theoretical line frequency of the camera. After eliminating line loss, enable frequency division.

6 Line loss of line scan cameras

When line trigger is enabled, the stream packet timeout needs to be set to 0. Otherwise, when the line signal interval is too large, lines will be lost.

Figure 5-26 Transmission control



CL cameras need to match with the line trigger signal to check whether the filter value of the signal channel is greater than the signal pulse width of the CC channel.

7 Abnormal images during debugging

When changing the gain, there is a transition zone in the middle of the image. This is because the modification of the gain involves the synchronous modification of sensor level and FPGA gain. The switching speed of sensor level is less than that of FPGA gain modification, so there is a certain delay. We recommend you stop pulling streams when changing camera attributes.

Appendix 1 Serial Port Commands

Command name	Command (x indicates a value)	Description
Help	get Help	Refreshes and prints the status of common camera attributes.
Width	set Width x	Sets or reads the width of output images. x must be a multiple of 16.
	get Width	
ExposureTime	set ExposureTime x	Sets or reads the exposure value.
	get ExposureTime	
ReverseX	set ReverseX x	Enables or disables X-axis flip.
	get ReverseX	
GainRaw	set GainRaw x	Sets or reads the analog gain value of the camera.
	get GainRaw	
BlackLevel	set BlackLevel xxx	Sets the black level of the camera.
	;get BlackLevel	
BlackLevelAuto	set BlackLevelAuto xxx	Enables auto black level.
	get BlackLevelAuto	
Gamma	set Gamma x	Sets or reads the Gamma value of the camera.
	get Gamma	
TriggerSelector	set TriggerSelector x	Enables trigger and selects a trigger mode.
	get TriggerSelector	
TriggerMode	set TriggerMode x	Enables or disables trigger status.
	get TriggerMode	
trigger source	get TriggerSource	0x0: software 0x10-0x13: cc1-cc4 0x14-0x1A: line0-line6 0x1B: FrequencyConverter 0x1C： RotaryEncoder0
	set TriggerSource xxx	Trigger sources not supported by the camera are unavailable.
LineSelector	set LineSelector x	Selects a trigger channel.

	get LineSelector	
LineDebouncingPeriod	set LineDebouncingPeriod x	Sets the filter value of the current trigger channel.
	get LineDebouncingPeriod	
TriggerActivation	set TriggerActivation x	Sets edge trigger.
	get TriggerActivation	
TapGeometry	set TapGeometry x	Sets or reads the tap value of the camera.
	get TapGeometry	
PixelClock	set PixelClock x	Sets or reads the frequency of the camera clock.
	get PixelClock	
FPNEnable	set FPNEnable x	Enables or disables FPN, and reads the staus of FPN.
	get FPNEnable	
FPNBlackCalibration	set FPNBlackCalibration x	Obtains a FPN black image.
FPNBrightCalibration	set FPNBrightCalibration x	Obtains a bright image under a uniform black plate.
UserSetSelector	get UserSetSelector	Selects user configurations.
	set UserSetSelector x	
UserSetDefault	get UserSetDefault	Selects user configurations loaded by the camera by default.
	set UserSetDefault x	
UserSetSave	set UserSetSave	Saves the current user configurations.
UserSetLoad	set UserSetLoad	Downloads selected user configurations.
TestImage	set TestImage	Switches test image mode.
ResultingLineRateAbs	get ResultingLineRateAbs	Obtains the current theoretical line frequency.
AcquisitionLineRate	set AcquisitionLineRate x-y	Sets theoretical line frequency. x specifies the line frequency. The value range is 100-1000000. y specifies whether to enable line frequency, including 0 and 1. Separate x and y with -.
BalanceWhiteAuto	set BalanceWhiteAuto	Sets white balance (only supported by color cameras). 0: Disables white balance. 1: Performs white balance once. 2: Continuously performs white balance.

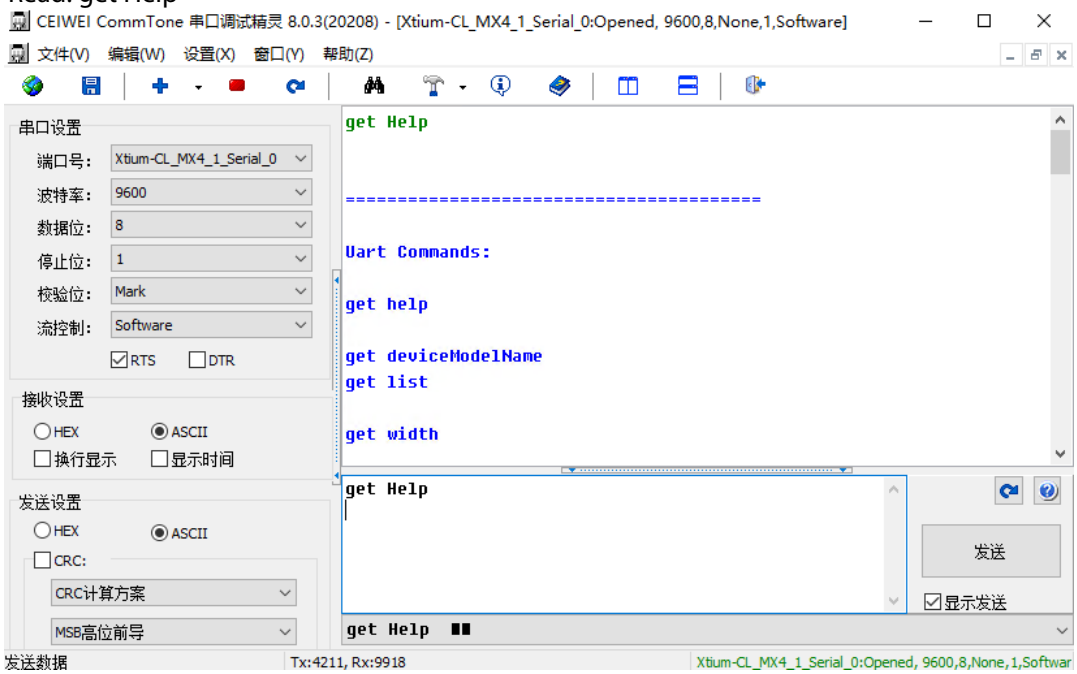
<table>
<tr><td>FrameLineTransform</td><td>set FrameLineTransform x</td><td>Sets line frequency switch.</td></tr>
<tr><td>ResumeFactorySetting</td><td>set ResumeFactorySetting</td><td>Restores camera settings to factory settings.</td></tr>
<tr><td rowspan="2">PixelFormat</td><td>set PixelFormat xxx;</td><td rowspan="2">Sets the image format:
<table><tr><th>Mode</th><th>Command value</th></tr><tr><td>Mono8</td><td>MONO8</td></tr><tr><td>Mono10</td><td>MONO10</td></tr><tr><td>Mono10Packed</td><td>MONO10P</td></tr><tr><td>Mono12</td><td>MONO12</td></tr><tr><td>Mono12Packed</td><td>MONO12P</td></tr><tr><td>BayerGR8</td><td>GR8</td></tr><tr><td>BayerRG8</td><td>RG8</td></tr><tr><td>BayerGB8</td><td>GB8</td></tr><tr><td>BayerBG8</td><td>BG8</td></tr><tr><td>BayerGR10</td><td>GR10</td></tr><tr><td>BayerRG10</td><td>RG10</td></tr><tr><td>BayerGB10</td><td>GB10</td></tr><tr><td>BayerBG10</td><td>BG10</td></tr><tr><td>BayerGR12</td><td>GR12</td></tr><tr><td>BayerRG12</td><td>RG12</td></tr><tr><td>BayerGB12</td><td>GB12</td></tr><tr><td>BayerBG12</td><td>BG12</td></tr><tr><td>BayerGR10Packed</td><td>GR10P</td></tr><tr><td>BayerRG10Packed</td><td>RG10P</td></tr><tr><td>BayerGB10Packed</td><td>GB10P</td></tr><tr><td>BayerBG10Packed</td><td>BG10P</td></tr><tr><td>BayerGR12Packed</td><td>GR12P</td></tr><tr><td>BayerRG12Packed</td><td>RG12P</td></tr><tr><td>BayerGB12Packed</td><td>GB12P</td></tr><tr><td>BayerBG12Packed</td><td>BG12P</td></tr><tr><td>RGB8Packed</td><td>RGB8P</td></tr><tr><td>YUV422_8_UYVY</td><td>YUV422P</td></tr></table></td></tr>
<tr><td></td><td>get PixelFormat</td></tr>
<tr><td>Binning</td><td>set Binning xxx; get Binning</td><td><table><tr><th>Mode</th><th>Command value</th></tr><tr><td>off</td><td>0</td></tr><tr><td>TwoByOne</td><td>1</td></tr><tr><td>TwoByTwo</td><td>2</td></tr><tr><td>OneByTwo</td><td>3</td></tr><tr><td>FourByFour</td><td>4</td></tr><tr><td>FourByOne</td><td>5</td></tr></table></td></tr>
</table>

<table>
<tr><td></td><td></td><td><table><tr><td>OneByFour</td><td>6</td></tr><tr><td>FourByTwo</td><td>7</td></tr><tr><td>TwoByFour</td><td>8</td></tr><tr><td>ThreeByThree</td><td>9</td></tr></table></td></tr>
<tr><td>BinningMode</td><td>set BinningMode xxx;
get BinningMode</td><td><table><tr><th>Mode</th><th>Command value</th></tr><tr><td>Avg</td><td>0</td></tr><tr><td>Sum</td><td>1</td></tr></table></td></tr>
</table>

Examples:

Command: Help Refreshes and prints the status of common camera attributes.

Read: get Help

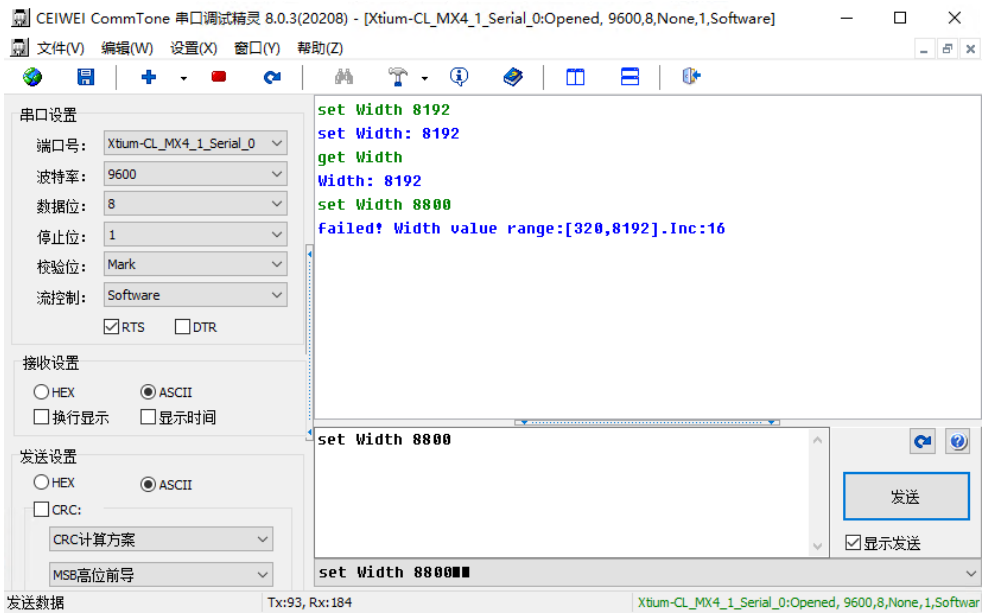


Parameter: Width

Read: get Width

Write: set Width + value

If the set value is larger than the max. width, smaller than the min. width, or the step size is incorrect, the following error message is displayed:

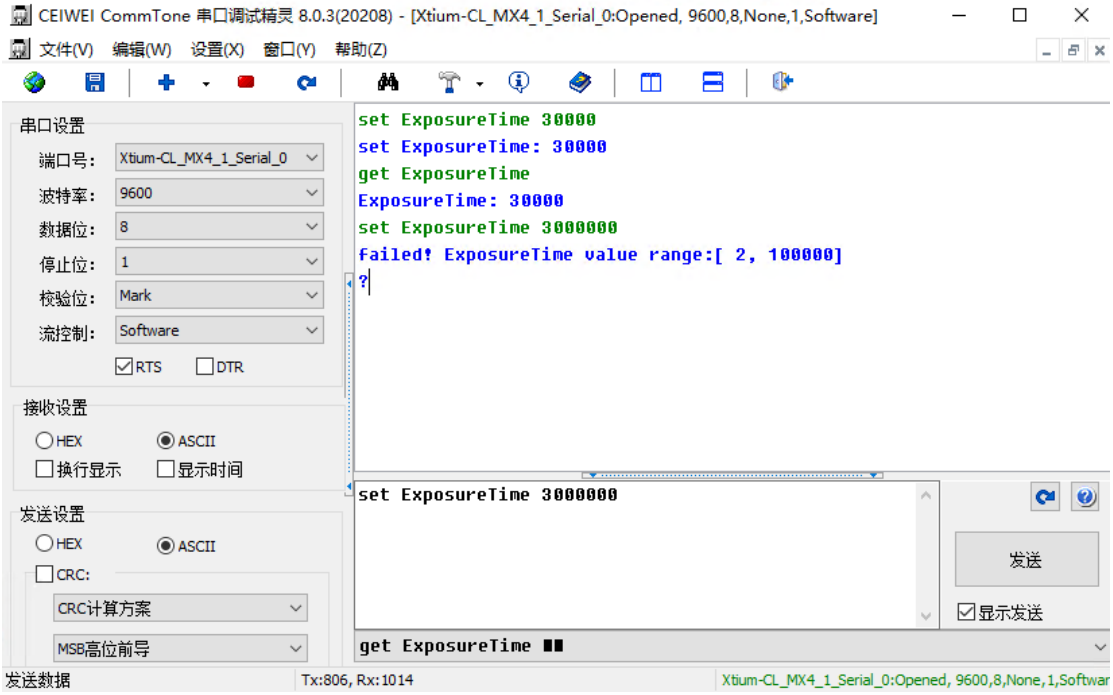


Parameter: ExposureTime

Read: get ExposureTime

Write: set ExposureTime + value

If the set value is larger than the max. exposure value, or smaller than the min. exposure value, the following error message is displayed:



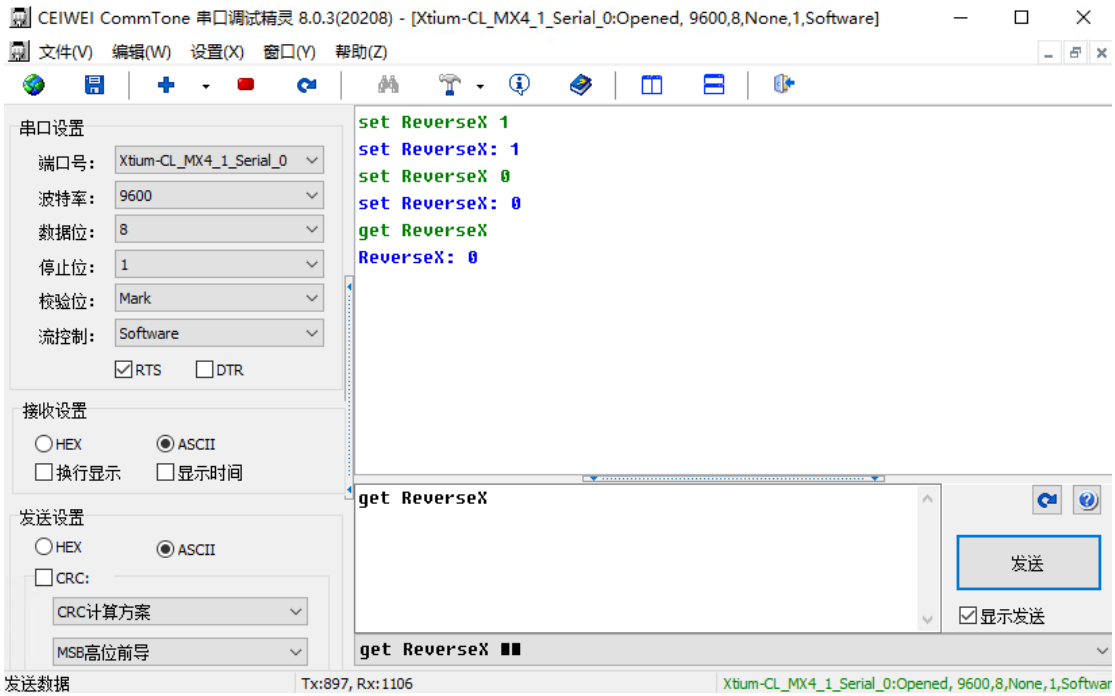
Parameter: ReverseX

Read: get ReverseX

Write: set ReverseX + value

0: Disables X-axis flip. 1: Enables X-axis flip.

If you set **ReverseX** to a value other than 0 and 1. the following error message is displayed.

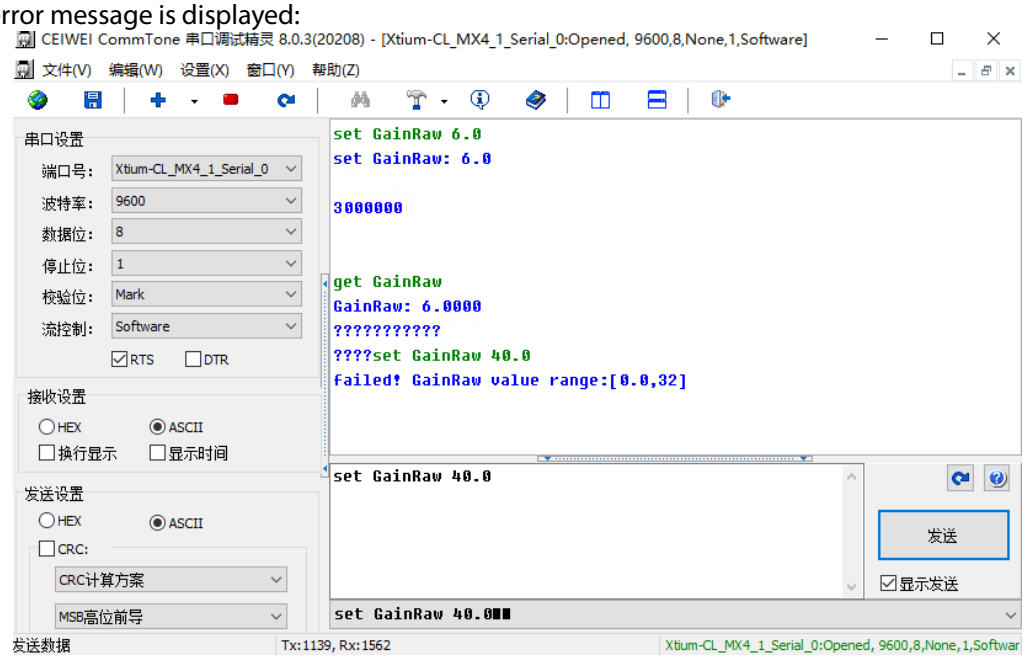


Parameter: GainRaw

Read: get GainRaw

Write: set GainRaw + value

If the set value is larger than the max. gain value, or smaller than the min. gain value, the following error message is displayed:

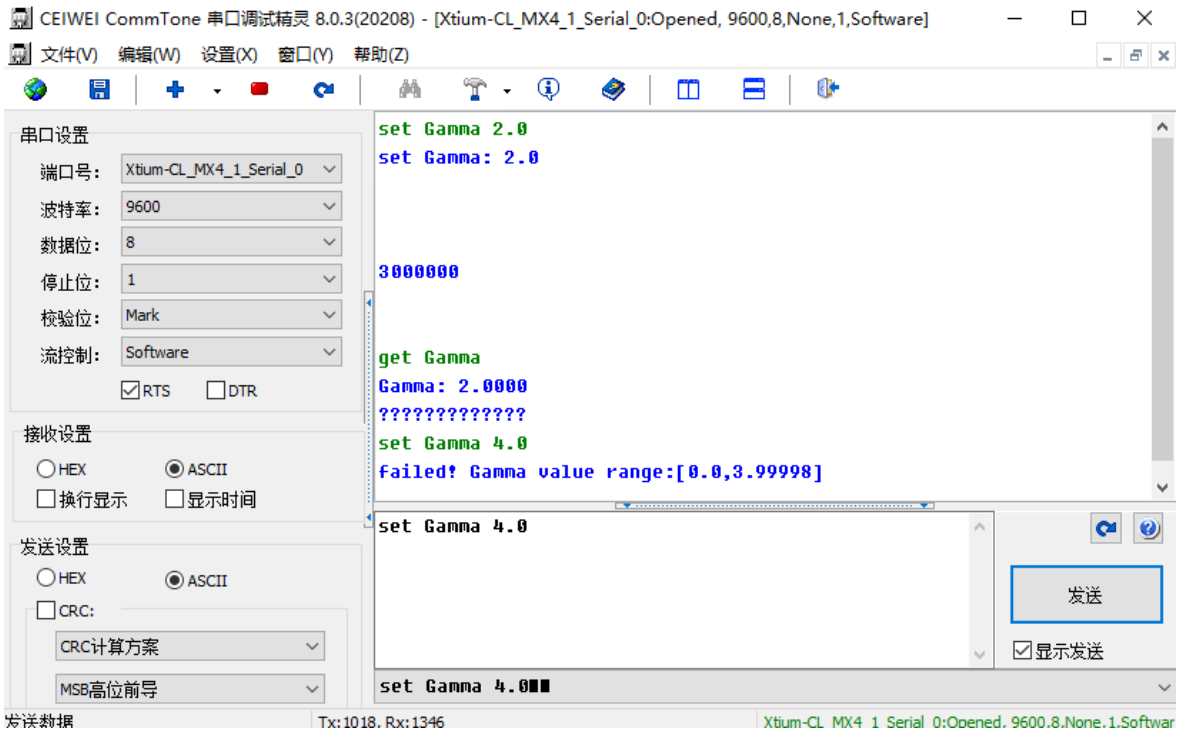


Parameter: Gamma

Read: get Gamma

Write: set Gamma + value

If the set value is larger than the max. Gamma value, or smaller than the min. Gamma value, the following error message is displayed:



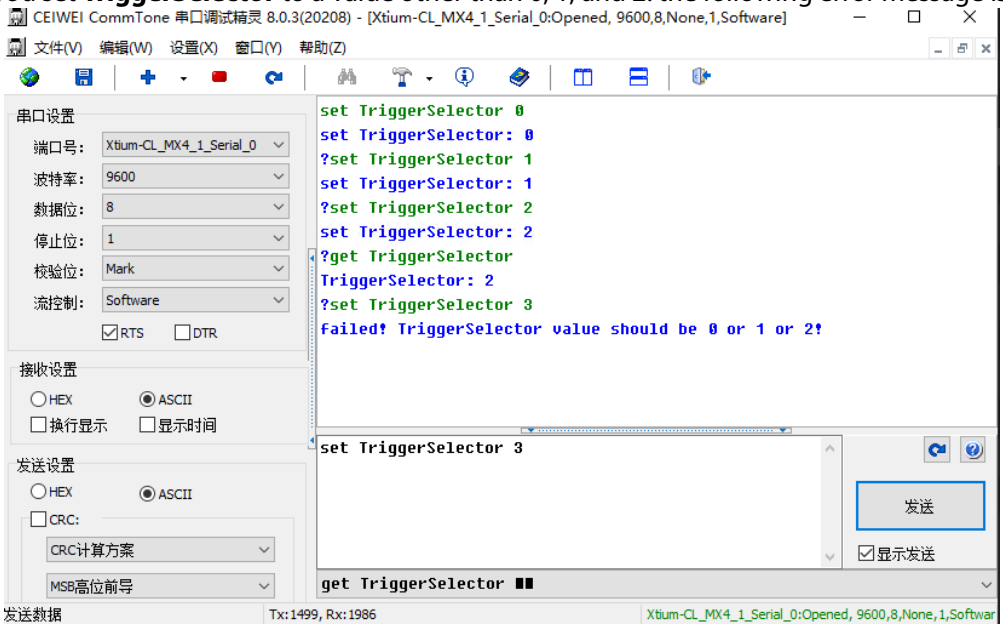
Parameter: TriggerSelector

Read: get TriggerSelector

Write: set TriggerSelector + value

0: AcquisitionStart. 1: FrameStart. 2: LineStart.

If you set **TriggerSelector** to a value other than 0, 1, and 2. the following error message is displayed:



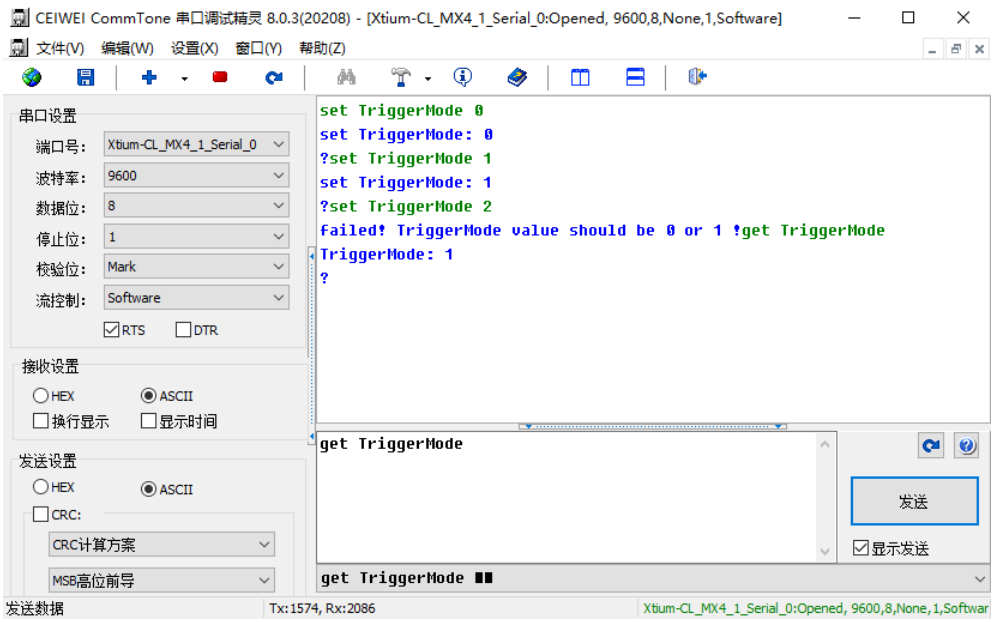
Parameter: TriggerMode

Read: get TriggerMode

Write: set TriggerMode + value

0: Disables trigger. 1: Enables trigger.

If you set **TriggerMode** to a value other than 0 and 1. the following error message is displayed:



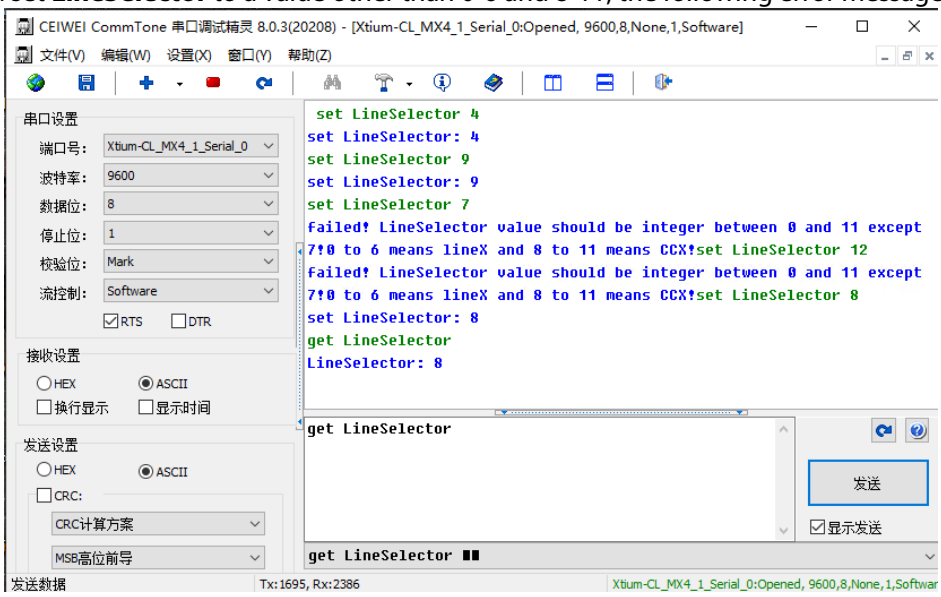
Parameter: LineSelector

Read: get LineSelector

Write: set LineSelector + value

0-6: line0-line6. 8-11: CC1-CC4.

If you set **LineSelector** to a value other than 0-6 and 8-11, the following error message is displayed:

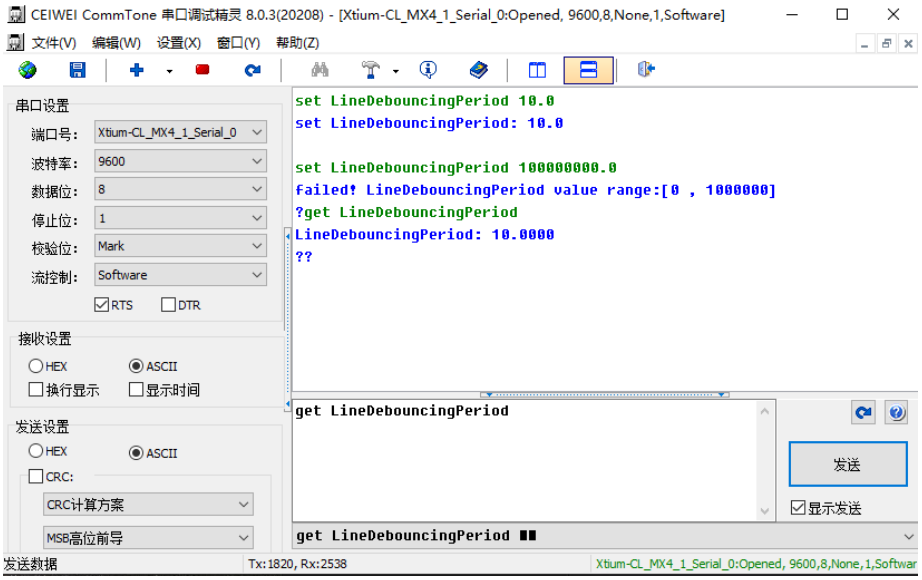


Parameter: LineDebouncingPeriod

Read: get LineDebouncingPeriod

Write: set LineDebouncingPeriod + value

If the set value is larger than the max. value of **LineDebouncingPeriod**, or smaller than the min. value of **LineDebouncingPeriod**, the following error message is displayed:



Parameter: TriggerActivation

Read: get TriggerActivation

Write: set TriggerActivation + value

0: trigger by rising edge. 1: trigger by falling edge.

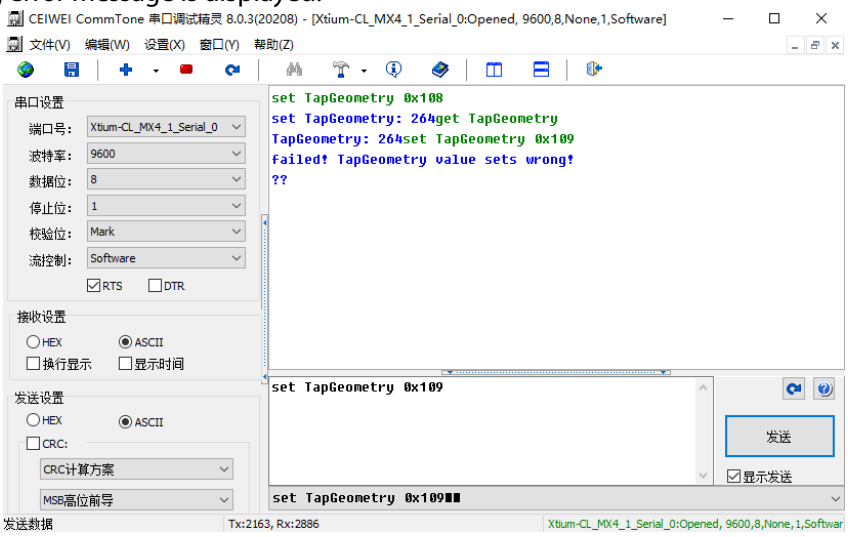
Parameter: TapGeometry

Read: get TapGeometry

Write: set TapGeometry + value

0x102: Geometry_1X2_1Y. 0x103: Geometry_1X3_1Y. 0x104: Geometry_1X4_1Y. 0x106: Geometry_1X6_1Y. 0x108: Geometry_1X8_1Y. 0x10A: Geometry_1X10_1Y.

If you set **TapGeometry** to a value other than 0x102, 0x103, 0x104, 0x106, 0x108, and 0x10A, the following error message is displayed:



Different cameras support different TapGeometry. If you set a value not supported by the current camera, the following error message is displayed:

failed!Current conditions don't support changing this property!

Therefore, check TapGeometry supported by the camera in MV before you set TapGeometry.

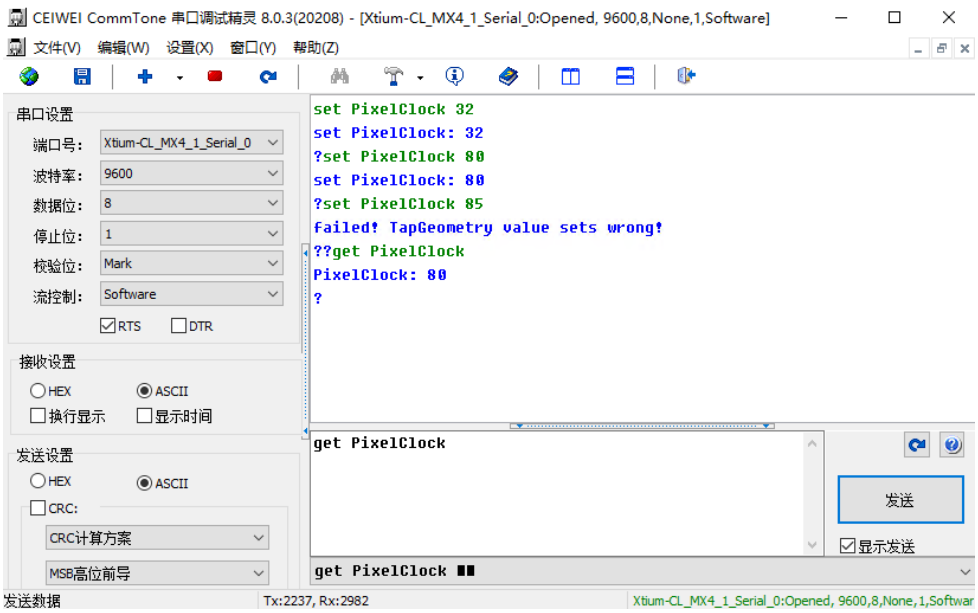
Parameter: PixelClock

Read: get PixelClock

Write: set PixelClock + value

32: Freq32MHz. 48:Freq48MHz. 64: Freq64MHz. 80: Freq80MHz.

If you set **PixelClock** to a value other than 32, 48, 64, and 80. the following error message is displayed:



Different cameras support different PixelClock. If you set a value not supported by the current camera, the following error message is displayed:

failed!Current conditions don't support changing this property!

Therefore, check PixelClock supported by the camera in MV before you set PixelClock.

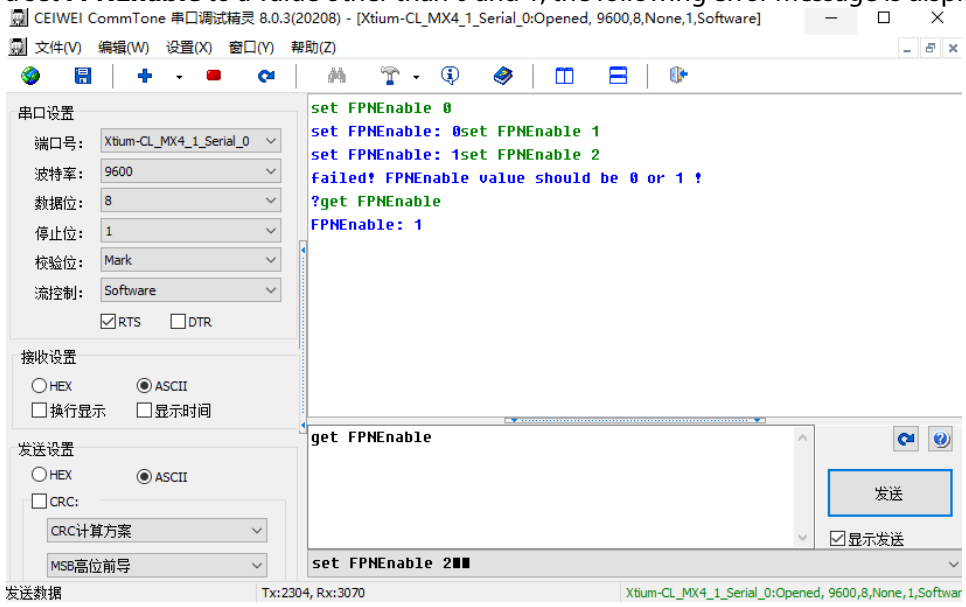
Parameter: FPNEnable

Read: get FPNEnable

Write: set FPNEnable + value

0: Disables FPN. 1: Enables FPN.

If you set **FPNEnable** to a value other than 0 and 1, the following error message is displayed:

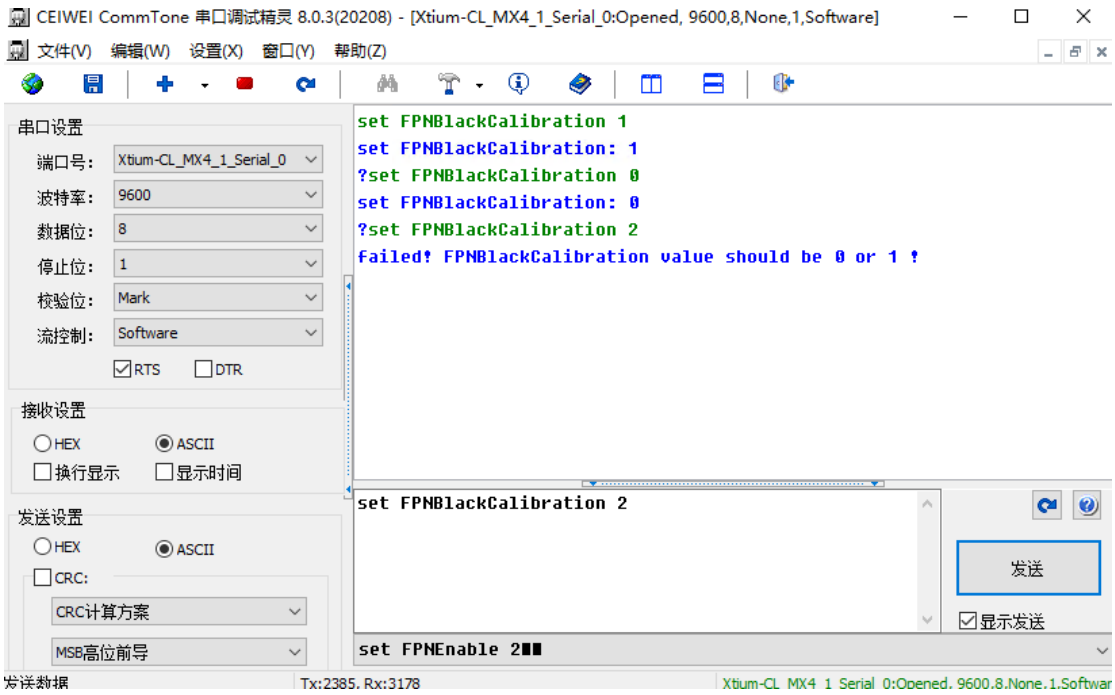


Parameter: FPNBlackCalibration

Write: set FPNBlackCalibration + value

0: Disables FPN black correction. 1: Enables FPN black correction.

If you set **FPNBlackCalibration** to a value other than 0 and 1, the following error message is displayed:



If FPNBlackCalibration is not enabled, the following error message is displayed when reading and writing values.

failed!The function of FPNBlackCalibration didn't open ! "

You must disable FPN and set width to the sensor width. Otherwise, the following error message is displayed:

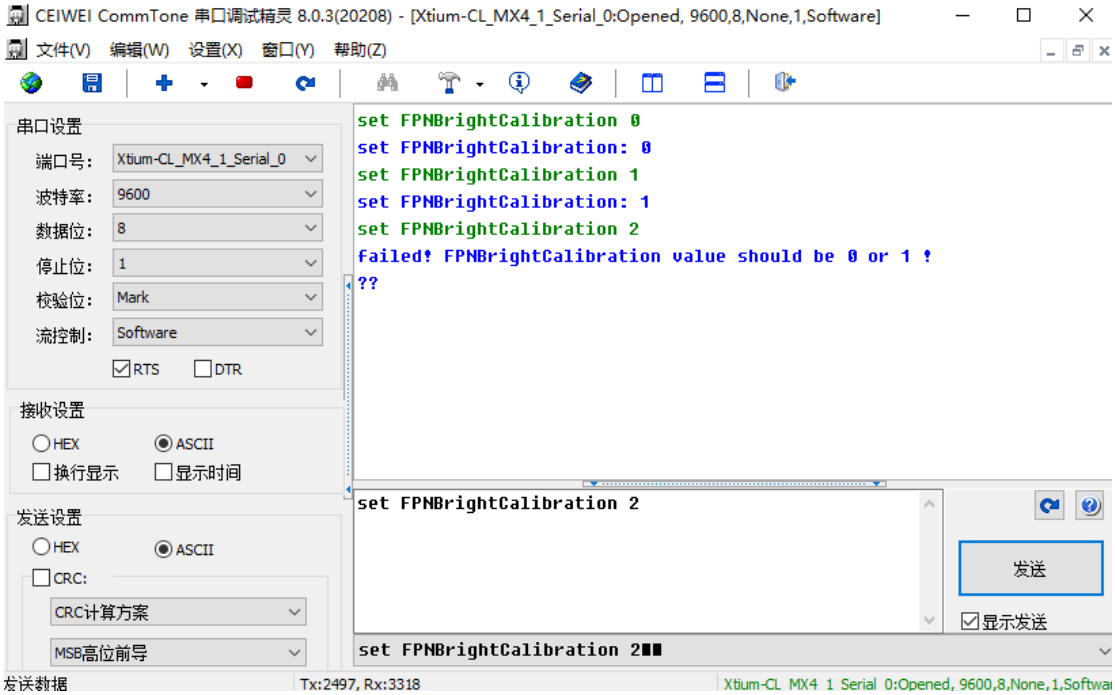
failed!Current conditions don't support changing this property!

Parameter: FPNBrightCalibration

Write: set FPNBrightCalibration + value

0: Disables FPN bright correction. 1: Enables FPN bright correction.

If you set **FPNBrightCalibration** to a value other than 0 and 1, the following error message is displayed:



If FPNBrightCalibration is not enabled, the following error message is displayed when reading and writing values.

failed!The function of FPNBrightCalibration didn't open ! "

You must disable FPN and set width to the sensor width. Otherwise, the following error message is displayed:

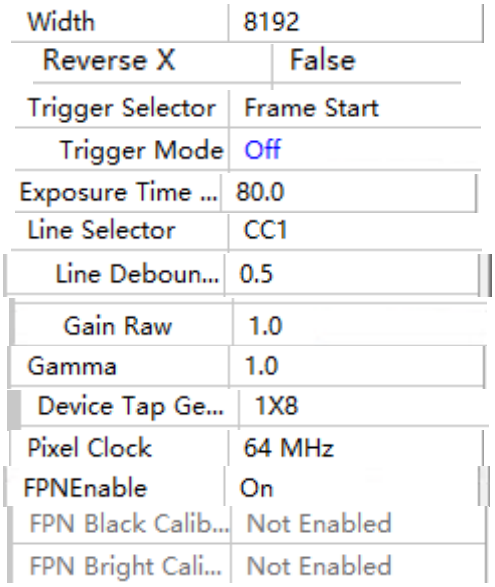
failed!Current conditions don't support changing this property!

Parameter: FrameLineTransform

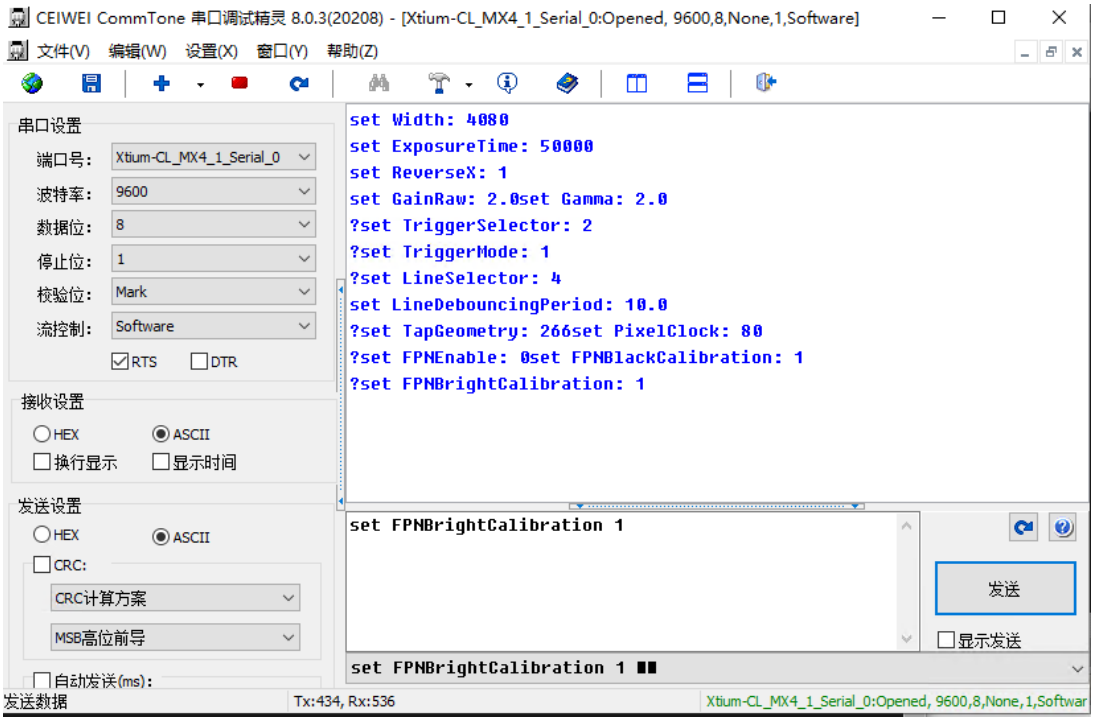
Write: set FrameLineTransform + value

0: Switches to line mode. 1: Switches to frame mode.

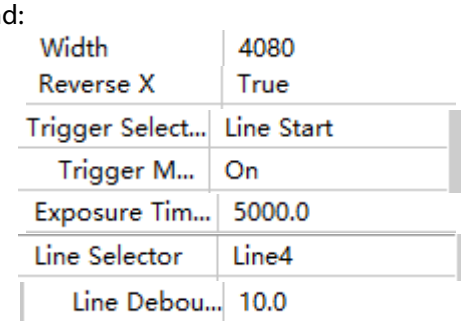
Before entering a command:

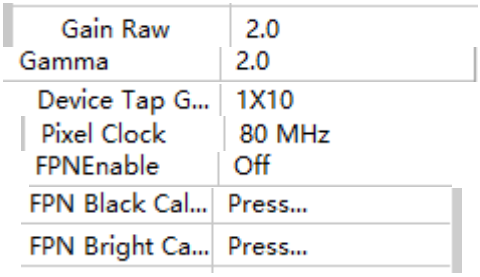


Entered command:



After entering a command:





Adds user configurations

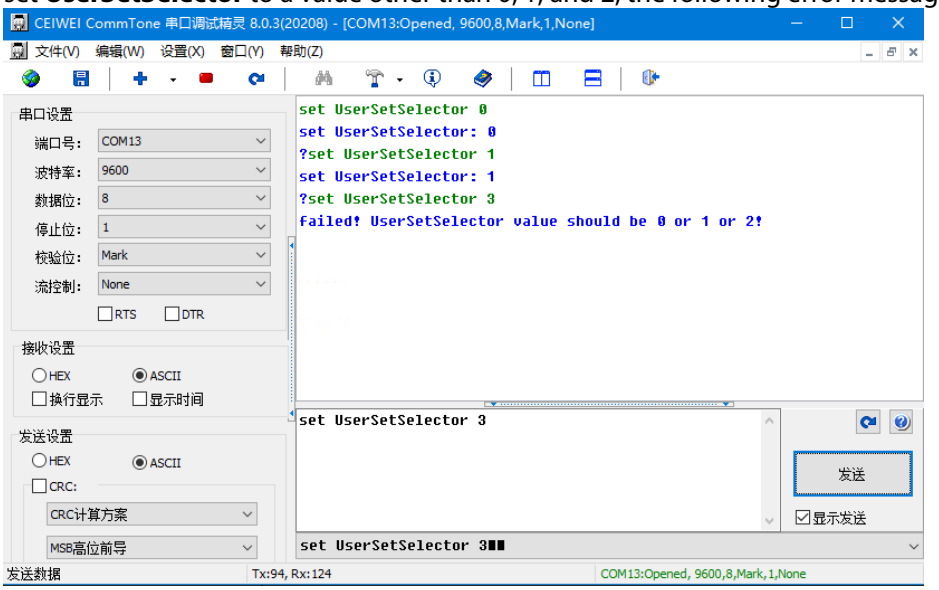
Parameter: UserSetSelector

Read: get UserSetSelector

Write: set UserSetSelector + value

0: Default. 1: userset1. 2: userset2.

If you set **UserSetSelector** to a value other than 0, 1, and 2, the following error message is displayed:



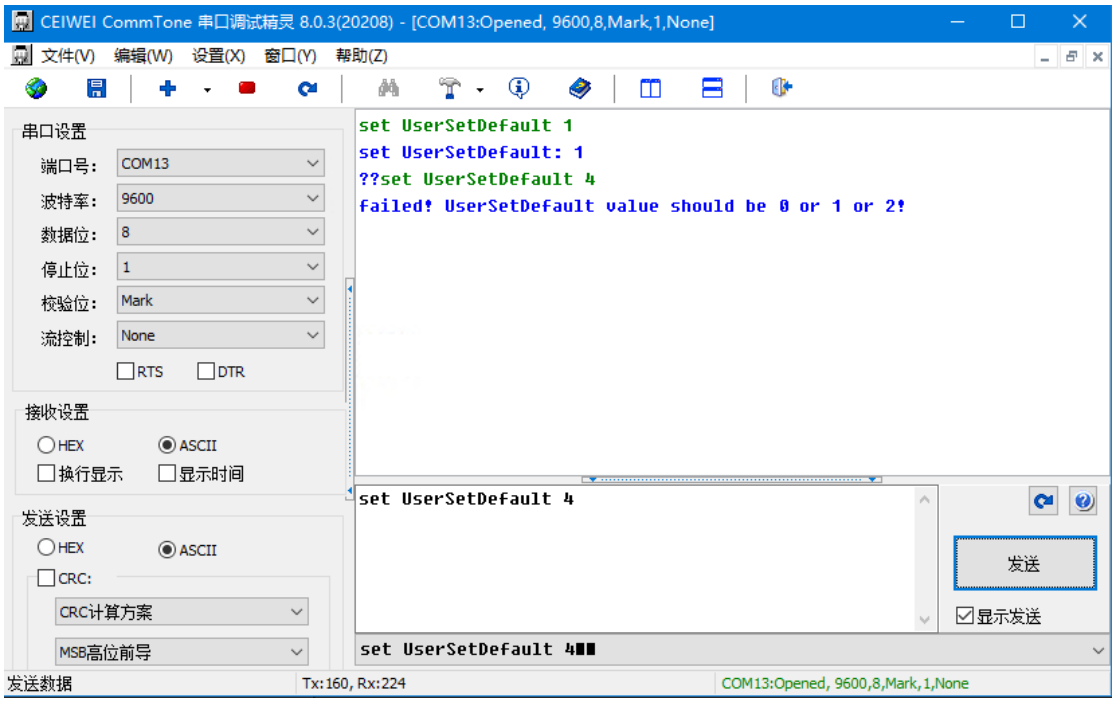
Parameter: UserSetDefault

Read: get UserSetDefault

Write: set UserSetDefault + value

0: Sets Default to default configurations. 1: Sets userset1 to default configurations. 2: Sets userset2 to default configurations.

If you set **UserSetSelector** to a value other than 0, 1, and 2, the following error message is displayed:

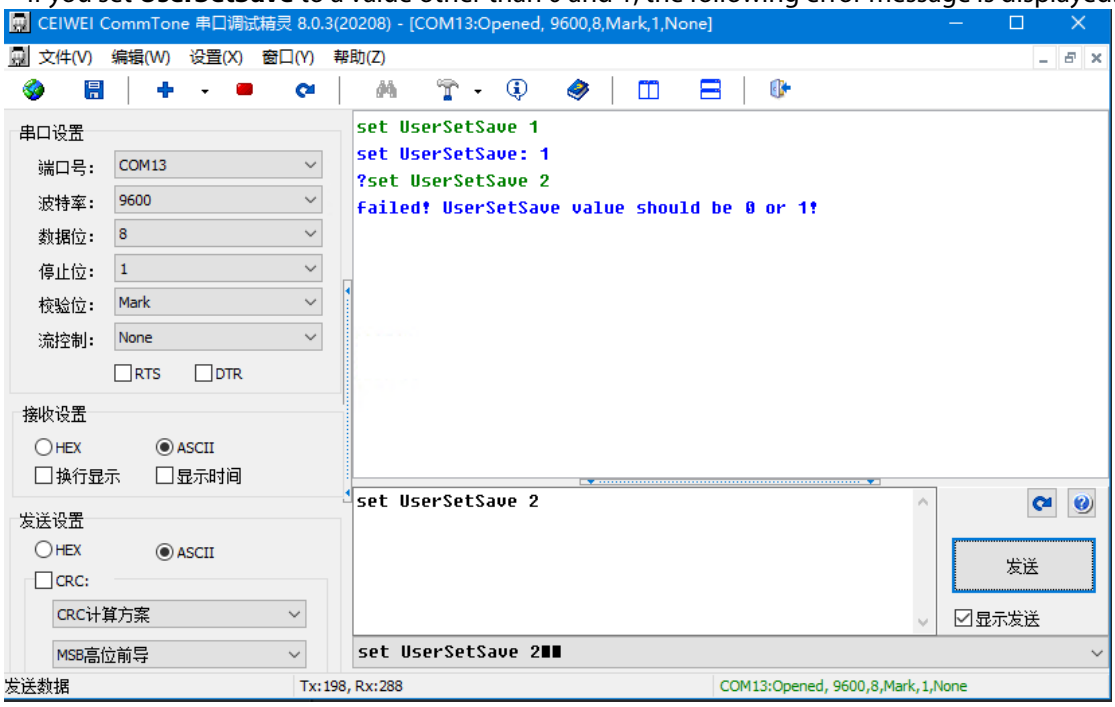


Parameter: UserSetSave

Write: set UserSetSave + value

0: Resets the **UserSetSave** button. 1: After you click **UserSetSave**, save user configurations to selected user group in **UserSetSelector**.

If you set **UserSetSave** to a value other than 0 and 1, the following error message is displayed:

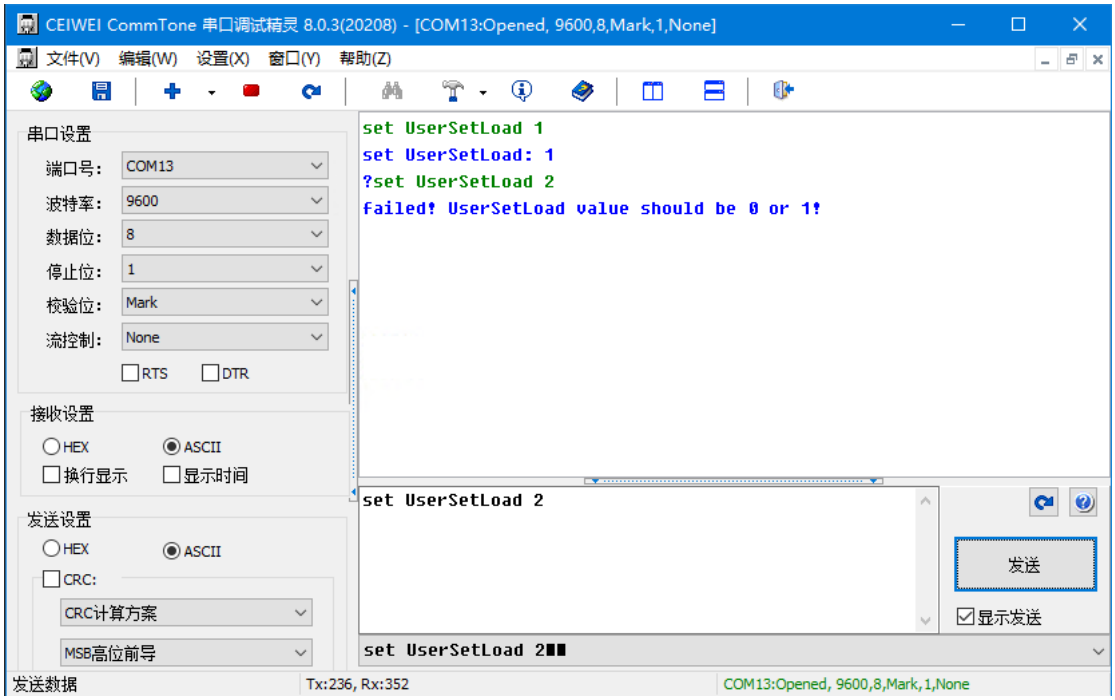


Parameter: UserSetLoad

Write: set UserSetLoad + value

0: Resets the **UserSetLoad** button. 1: After you click **UserSetLoad**, load user configurations of selected user group in **UserSetSelector**.

If you set **UserSetLoad** to a value other than 0 and 1, the following error message is displayed:

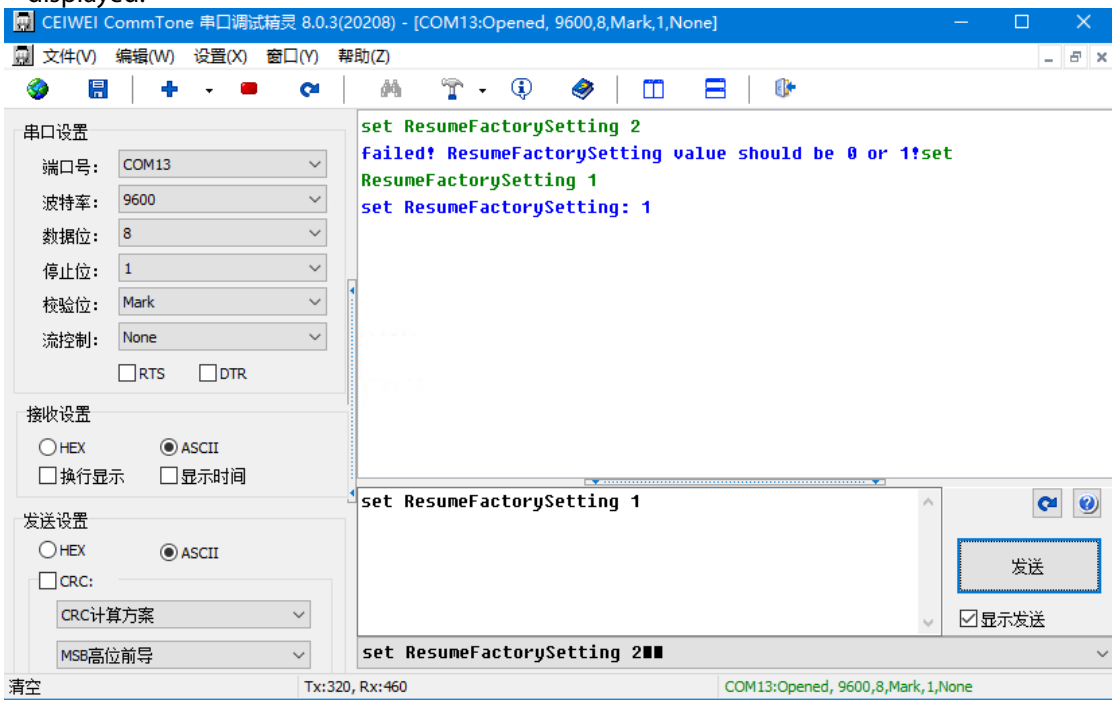


Parameter: ResumeFactorySetting

Write: set ResumeFactorySetting + value

Resets the **ResumeFactorySetting** button. After you click **ResumeFactorySetting**, read configurations selected in **UserSetDefault** and write **UserSetSelector** configurations. Then, set **UserSetLoad** to 1 to load configurations selected in **UserSetSelector**.

If you set **ResumeFactorySetting** to a value other than 0 and 1, the following error message is displayed:



Appendix 2 Cybersecurity Recommendations

Mandatory actions to be taken for basic device network security:

1. **Use a strong passcode**
   Refer to the following recommendations for setting up the passcode:
   - The length should not be less than 8 characters
   - A strong passcode is comprised of at least two of these three character types: letters in upper and lower cases, numbers, and special characters.
   - Do not contain the username in its forward or reverse sequence.
   - Do not use continuous characters, such as 123 and abc.
   - Do not use repeated characters, such as 111 and aaa.
2. **Timely update firmware and client software**
   - According to the standard procedure in Tech-industry, we recommend you keep device (such as NVR, DVR, and IP camera) firmware up-to-date to ensure the system is equipped with the latest security patches and fixes. When the device is connected to the Internet, we recommend you enable the "auto-check for updates" function to obtain timely information of firmware updates released by the manufacturer.
   - You are recommended to download and use the latest client software.

Recommended measures to improve network security:

1. **Physical protection**
   We recommend you perform physical protection to device, especially storage devices. For example, place the device in a special computer room and cabinet, and implement well-done access control permission and key management to prevent unauthorized personnel from carrying out physical contacts such as damaging hardware, unauthorized connection of removable device (such as USB flash drive and serial port).
2. **Change Passwords Regularly**
   We recommend you change passwords regularly to reduce the risk of being guessed or cracked.
3. **Timely set up and update password resetting information**
   This device supports password reset. To reduce prevent this function from being attacked by hackers, we recommend you timely set up password resetting information, including reserved phone number/email and security questions. If any of such information changes, update password resetting information in time. When setting up security questions, set up an answer that is difficult for others to guess.
4. **Enable account lock-down**
   Account lock-down is enabled by default. To keep your Account safe, it is recommended to keep this setting. After hackers fail multiple attempts to hack passwords, the corresponding Account and source IPs are locked.
5. **Change HTTP and other default service ports**
   We recommend you change the default port of HTTP and other services into any set of numbers between 1024-65535, preventing hackers from gussing the ports you are using.
6. **Enable HTTPS**
   We recommend you enable HTTPS. This way, you can visit Web service through a secure communication channel.
7. **Bind MAC address**
   Bind the IP and MAC address of the gateway device to reduce the risk of ARP deception.
8. **Reasonably allocate account and permission**
   According to business and management requirements, reasonably add users and grant a minimum set of permissions to them.
9. **Turn off unnecessary services and use safe modes**
   If not needed, SNMP, SMTP and UPnP can be turned off to reduce the risks for the device.
   If necessary, it is strongly recommended to use safe modes, including but not limited to:
   - SNMP: Select SNMP v3 and set a stronger encryption passcode and authentication passcode.
   - SMTP: Select TLS to access to the email server.
   - FTP: Select SFTP and set a strong passcode.
   - AP hotspot: Select WPA2-PSK encryption mode and set a strong passcode.

10. **Audio and Video Encrypted Transmission**
    If your audio/video data includes important or sensitive contents, use encrypted transmission to make it more difficult for someone to steal your data.
11. **Security audit**
    - online users: Do this from time to time to find out illegal login, if any.
    - Review device log: This gives you the IP data of a device trying to login and the critical operation information of users already in the login status.
12. **Network log**
    Due to the limited storage capacity of the device, the stored log is limited. If you need to save the log for a long time, we recommend you enable the network log function to ensure that the critical logs are synchronized to the network log server for tracing.
13. **Building safe network environment**
    To keep the device safer and reduce network risks, we recommend you:
    - off the port mapping of the router to prevent external networks from directly accessing services of router intranet devices.
    - into different partitions as needed: If two subnetworks do not have to establish communications, use VLAN or gatekeeper for network division.
    - 802.1x access authentication to reduce the risk of illegal terminals connecting with your private networks.
    - Enable the IP/MAC address filtering function to limit the range of hosts allowed to access the device.