

iRAYPLE GigE Line Scan Camera

User's Manual



V3.0.0

Foreword

This manual introduces the installation, functions, and configuration of the GigE 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

L5082MG170, L5022MG141, L5022CG141, L5042MG141, L5042CG141, L5027MG140, L5027CG140, L5047MG140, L5047CG140, L5027MG400, L5027CG300

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 the manual and applicable laws, the laws shall prevail.

Safety Instructions

The following signal words might appear in the manual.

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

Revision History

Version	Revision Content	Release Date
V3.0.0	Updated the manual.	January 2023
V1.0.0	First release.	August 2022

Important Safeguards and Warnings

This section introduces content covering the proper handling of the device, hazard prevention, and prevention of property damage. Read carefully before using the device, and comply with the guidelines when using it.

Transportation Requirements



- Pack the device with packaging provided by its manufacturer or packaging of the same quality before transporting it.
- Avoid heavy stress, violent vibration, or immersion during transportation.
- Transport the device under allowed humidity and temperature conditions. Refer to the technical parameters for requirements on the transporting temperature and humidity of 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.
- Avoid heavy stress, violent vibration, and immersion during storage.

Installation Requirements



- 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 local electrical safety regulations.
- 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.
- Avoid heavy stress, violent vibration, and immersion during installation.



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.
- Prevent the power cord from being trampled or pressed, especially the plug, power socket and the junction from the device.
- For devices that can be powered by multiple supplies, do not connect them to two or more kinds of power supplies; otherwise, the device might be damaged.
- Refer to the specific user's manual for the power requirements of single device.



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

Operation Requirements



A suitable operating environment is the foundation 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 base.
- Do not let any liquid flow into the device to avoid damage to internal components. When liquid flows into the device, immediately disconnect the power supply, unplug all cables connected to it, and contact after-sales service.
- Do not plug or unplug RS-232, RS-485 and other ports with the power on, otherwise, the ports will be easily damaged.
- 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 the device by yourself.
- Use the accessories suggested by the manufacturer. Maintenance must be performed by qualified professionals.

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1 Overview

1.1 Introduction

The device is a highly reliable and cost-effective camera for industrial use. The device uses high-performance photosensitive chip and supports real-time transmission of image data through Gigabit Ethernet. It is compatible with all application development tools (such as Genicam2.0, and GigE Vision 2.1) that comply with GigE Vision and GenICam standards. The max. transmission rate can reach 1000 Mbps, meeting the needs of most industrial applications. It can work stably in various harsh environments. The device transmits images through Gigabit Ethernet and allows you to use images and set camera parameters through the MV client or SDK.

Figure 1-1 Appearance (GigE)



1.2 Features

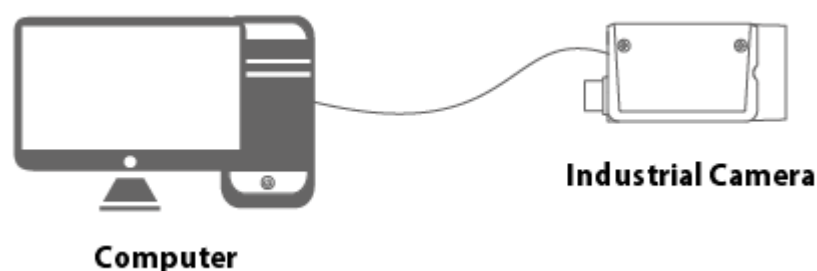
- Simple installation and easy operations.
- Max. transmission distance of 100 m. We recommend you use CAT 5 cables or cables of higher specifications.
- Multiple trigger modes such as external trigger, free-run, multi-frame trigger, and more.
- Multiple image data formats.
- Compatible with Gige protocol and GenICam standard.
- 12-24 VDC wide range voltage.
- Complies with CE and FCC certification standards.
- Bright field uniformity correction and multiple ISP functions.

1.3 Networking

The most typical networking method for industrial cameras is point-to-point connection. One host can also connect multiple industrial cameras through multiple Ethernet ports or switches. After connection, you can configure and use the device for detection through MV Viewer.

Networking of the device: Connect the host and the industrial camera through a network cable.

Figure 1-2 Connection diagram



1.4 Working Environment

- Temperature and humidity
 - ◇ Operating temperature: -30°C to $+50^{\circ}\text{C}$ (-22°F to $+122^{\circ}\text{F}$).
 - ◇ Operating humidity: 20%–80% (non-condensing).
 - ◇ Storage temperature: -30°C to $+80^{\circ}\text{C}$ (-22°F to $+176^{\circ}\text{F}$).
 - ◇ 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 Status Indicators

The following table describes the status indicators of the device.

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.
		High light	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 upgrading.
Abnormal	Red	Solid on	The device is abnormal, such as no bit stream, firmware upgrade failure.
		Flashes slowly	The network is disconnected

1.6 Product and Accessories

1. Camera: The GigE 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). The instantaneous voltage must not exceed 24 V.

6. Cat-6 network cable with an appropriate length.
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2 Installation

2.1 Download Method

Go to the [official website of iRAYPLE](http://download.huaraytech.com/pub/sdk/Ver2.2.5/) or visit <http://download.huaraytech.com/pub/sdk/Ver2.2.5/> to obtain the SDK.

Select a version and an operating system. 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

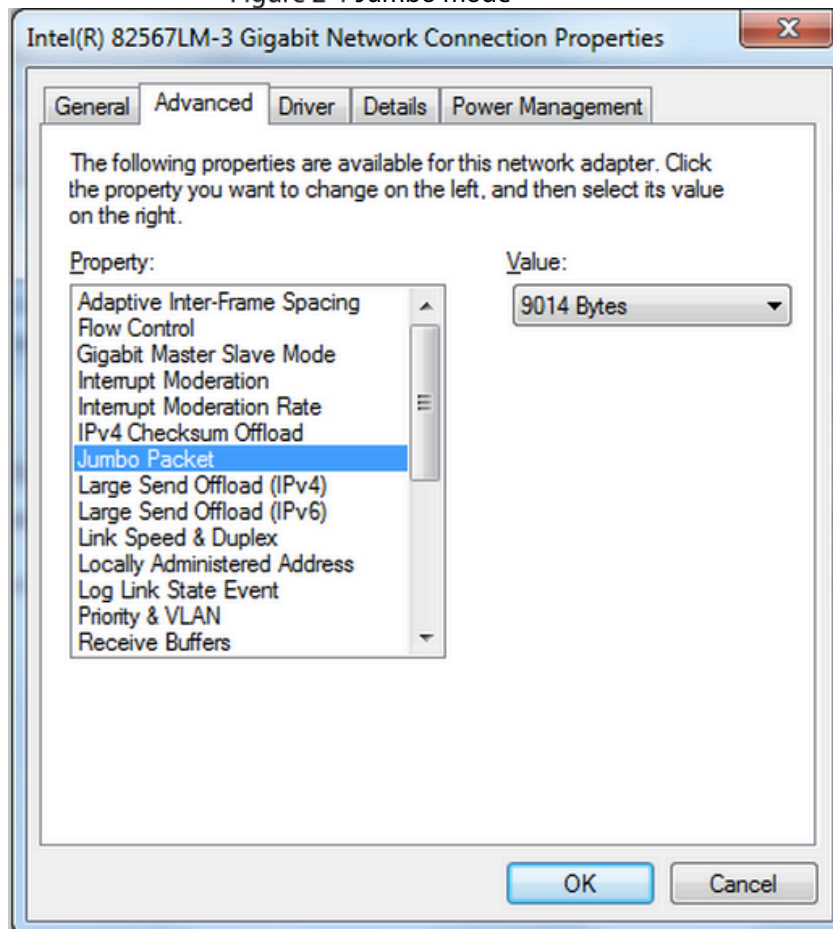
Path to samples

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

2.2 Camera Connection

Step 1 Power on the camera, and connect the camera to your computer, and then open MV Viewer to configure the camera. You must use a Gigabit or higher port for a line scan camera. Go to the control panel of your computer, and then select Hardware and Sound > Device Manager > Network adapter. Right-click a network adapter, select Properties, and then click Advanced. Select Jumbo Packet in the Property section and set Value to 9014 Bytes.

Figure 2-1 Jumbo mode



2.3 Camera Upgrade

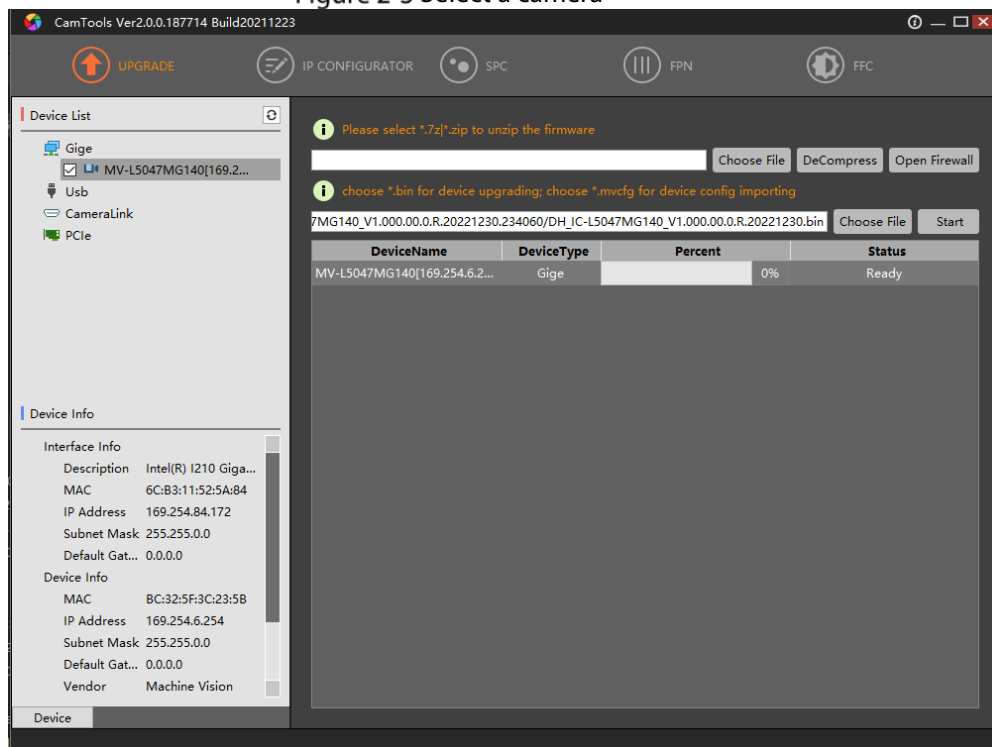
Step 1 Right-click MV Viewer, go to the installation location, and then double-click CamTools.exe.

Figure 2-2 Run CamTools.exe

imageformats	2019/1/28 13:33	文件夹	
platforms	2019/1/28 13:33	文件夹	
Skins	2019/1/28 13:33	文件夹	
CamTools.exe	2018/11/16 11:28	应用程序	1,803 KB
CLAllSerial_MD_VC120_v3_0.dll	2018/11/16 11:09	应用程序扩展	41 KB
CLProtocol_MD_VC120_v3_0.dll	2018/11/16 11:09	应用程序扩展	129 KB
CLSerCOM.dll	2018/11/16 11:09	应用程序扩展	121 KB
DeCompressFile.dll	2017/10/18 20:02	应用程序扩展	123 KB
GCBase_MD_VC120_v3_0.dll	2018/11/16 11:09	应用程序扩展	98 KB
GenApi_MD_VC120_v3_0.dll	2018/11/16 11:09	应用程序扩展	946 KB
GenCP_MD_VC120_v3_0.dll	2018/11/16 11:09	应用程序扩展	78 KB
icudt54.dll	2018/11/16 11:07	应用程序扩展	24,745 KB
icuin54.dll	2018/11/16 11:07	应用程序扩展	2,507 KB
icuuc54.dll	2018/11/16 11:07	应用程序扩展	1,750 KB
ImageConvert.dll	2018/3/23 9:29	应用程序扩展	202 KB
libeay32.dll	2017/10/28 9:55	应用程序扩展	2,042 KB
Log_MD_VC120_v3_0.dll	2018/11/16 11:09	应用程序扩展	47 KB
log4cpp_MD_VC120_v3_0.dll	2018/11/16 11:09	应用程序扩展	230 KB
MathParser_MD_VC120_v3_0.dll	2018/11/16 11:09	应用程序扩展	38 KB
MVlog4cppmd.dll	2018/11/16 13:53	应用程序扩展	163 KB
MVSDKmd.dll	2018/11/16 13:53	应用程序扩展	2,919 KB

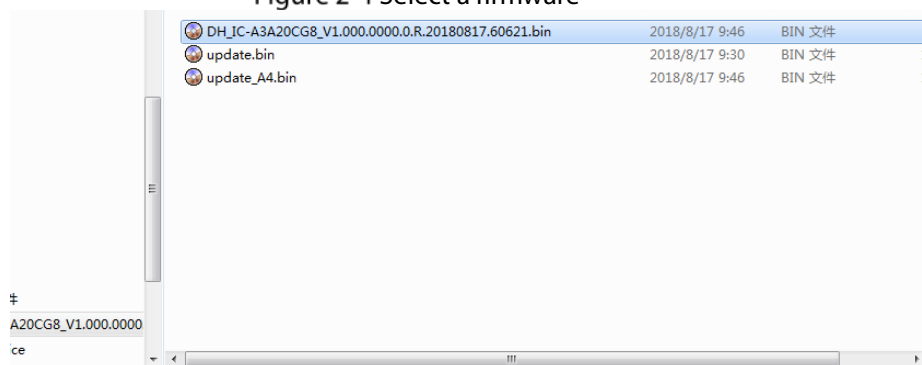
Step 2 Select a camera you want to upgrade.

Figure 2-3 Select a camera



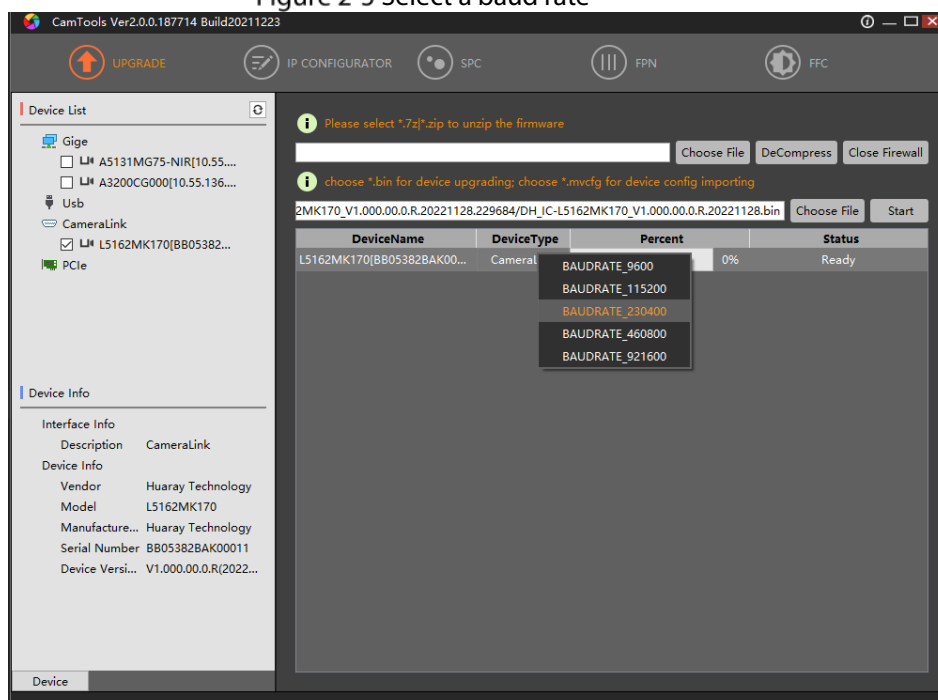
Step 3 Decompress the firmware package, click **Select** to select a firmware, and then double-click the firmware.

Figure 2-4 Select a firmware



Step 4 If you use a CameraLink camera, we recommend you set the baud rate to the max. value supported by the capture card. For Dalsa capture card, select BAUDRATE_921600. For the base mode, set a small baud rate.

Figure 2-5 Select a baud rate



Step 5 Click Start.

Figure 2-6 Start upgrading

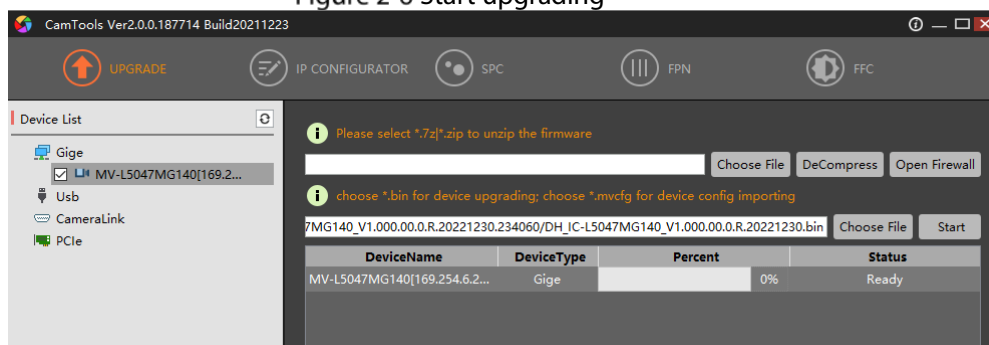
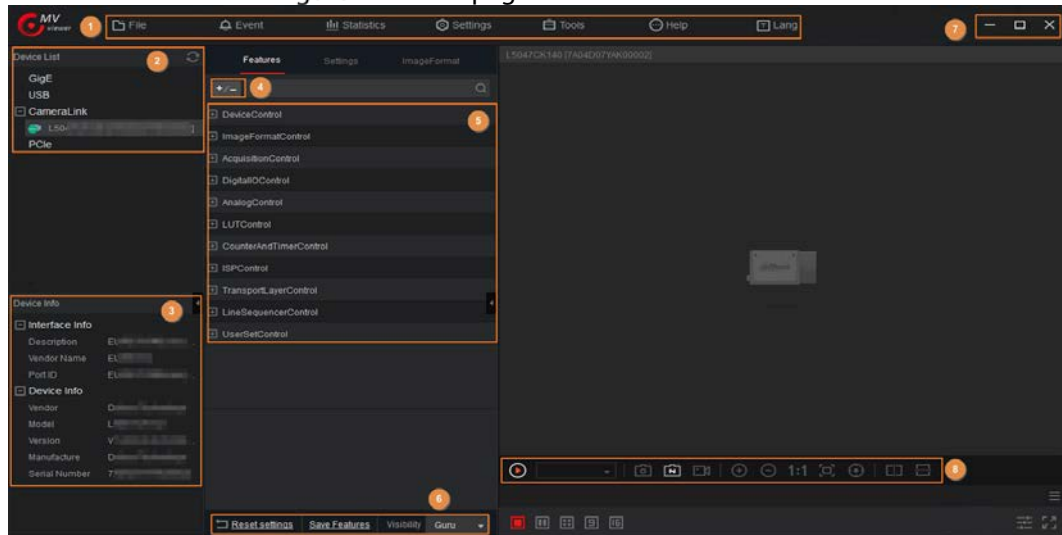


Figure 2-7 Homepage of MV Viewer



Step 6 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 PCIe cameras.
		: Click the icon to refresh online devices.
		: Indicates that the device can be connected. : Indicates that 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 operation menu	/ : Maximize/restore/minimize the image window. : Close MV Viewer.
8	Toolbar (For CameraLink cameras, functions related to image display are unavailable in MV Viewer. You can configure the parameters in the capture card.)	Continuous : Start/stop playback. Click and select a playback mode from continuous, single frame and multiple frames. : You can only select a playback mode when the video is paused.
		: Save single or multiple frames of images.
		: Zoom in or out on images.
		: Displays the image in 1:1 ratio or based on the window size.
		: When the image is zoomed in or out, click to display the image based on the windows size.
		: The mirror of an image in the vertical or horizontal direction.



You can only perform operations on images when video playback is paused or stopped.

Table 2-2 Description of menu parameters

Menu		Description
File	Open file	Select File > Open File , select a file in the pop-up window, and then click Open .
	Open recent file	Select File > Recent . Then, the software displays 10 files that you have recently opened in MV Viewer. Click a file to open it.
	Save	Save changes to the current file.
	Save as	Save the current file with another name to another path.
Event		Event notifications such as parameter modification, event message channel and stream pulling cache.
Statistics		Collect data such as capture frame rate, bandwidth, number of received images, frame loss rate, and number of wrong images.
Settings	General Configuration	Set camera operation level and basic parameters of 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	CamTools	Upgrade the firmware of cameras, configure camera IP addresses, make corrections, and more.
	Driver management tool	Install or uninstall the basic driver of MV Viewer.
	Network adapter configuration tool	Switch between network adapters and configure the parameters of network adapters.
Help		About: View the version information on the software.
Audio	Configure language	Select Chinese or English.

3 Structure

3.1 Naming Rules

GigE 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:

Example: L5022MG141, L5047CG140.

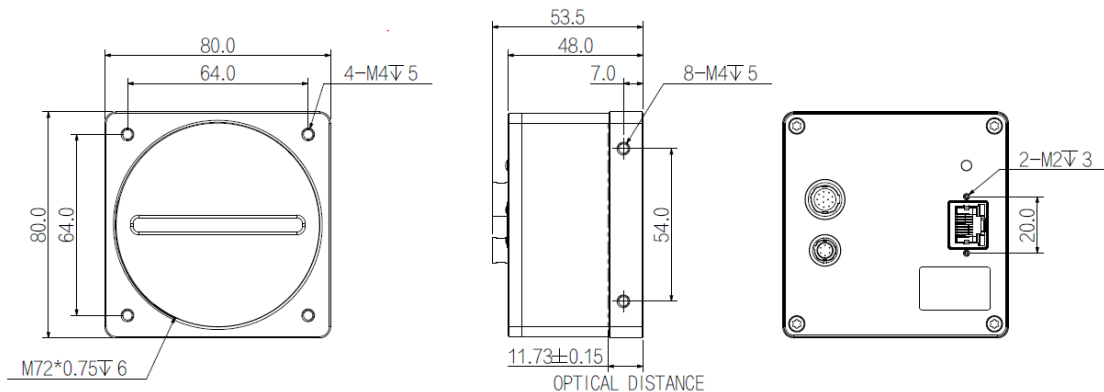
- L stands for Line.
- 5 means the camera belongs to the 5000 series of iRAYPLE cameras. The third number 2 in 5022 means 2 k, and the camera sensor width is 2048. The fourth number 2 in 5022 means that the sensor manufacturer is CMOSIS. If it is 7, the sensor is made by Gpixel.
- The sixth digit C or 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.

3.2 Dimensions

3.2.1 First-generation Line Scan Cameras

First-generation line scan cameras use CMOSIS 8K Ethernet port, and the model is L5082MG170.

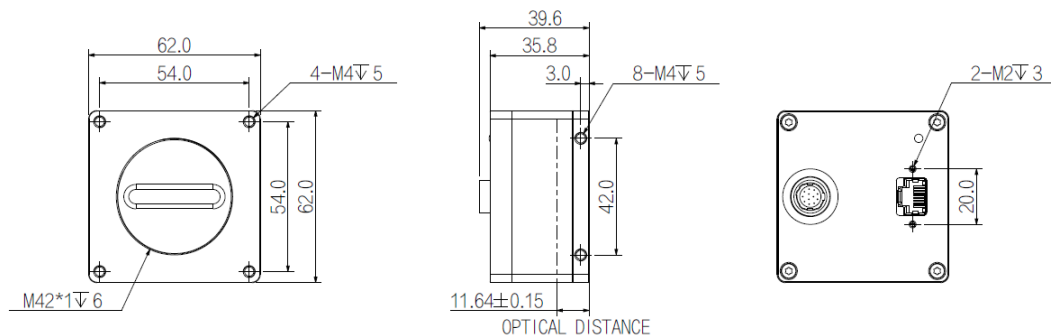
Figure 3-1 L5082MG170 (mm [inch])



3.2.2 Second-generation Line Scan Cameras

Second-generation line scan cameras use CMOSIS 4K Ethernet port, and the models include L5022MG141, L5022CG141, L5042MG141 and L5042CG141. The dimensions of the 4 models are the same.

Figure 3-2 Second-generation line scan cameras (mm [inch])



3.2.3 Third-generation Line Scan Cameras

Third-generation line scan cameras use GPixel 4K/2K Ethernet port, and the models include L5027MG140, L5027CG140, L5047MG140, L5047CG140, L5027MG400, and L5027CG300. The dimensions of different models are as follows:

Figure 3-3 L5027MG140, L5027CG140, L5047MG140, L5047CG140 (mm [inch])

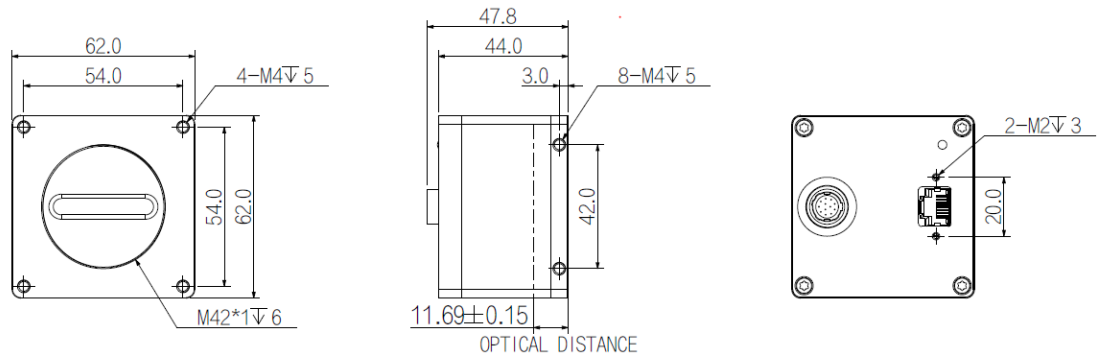
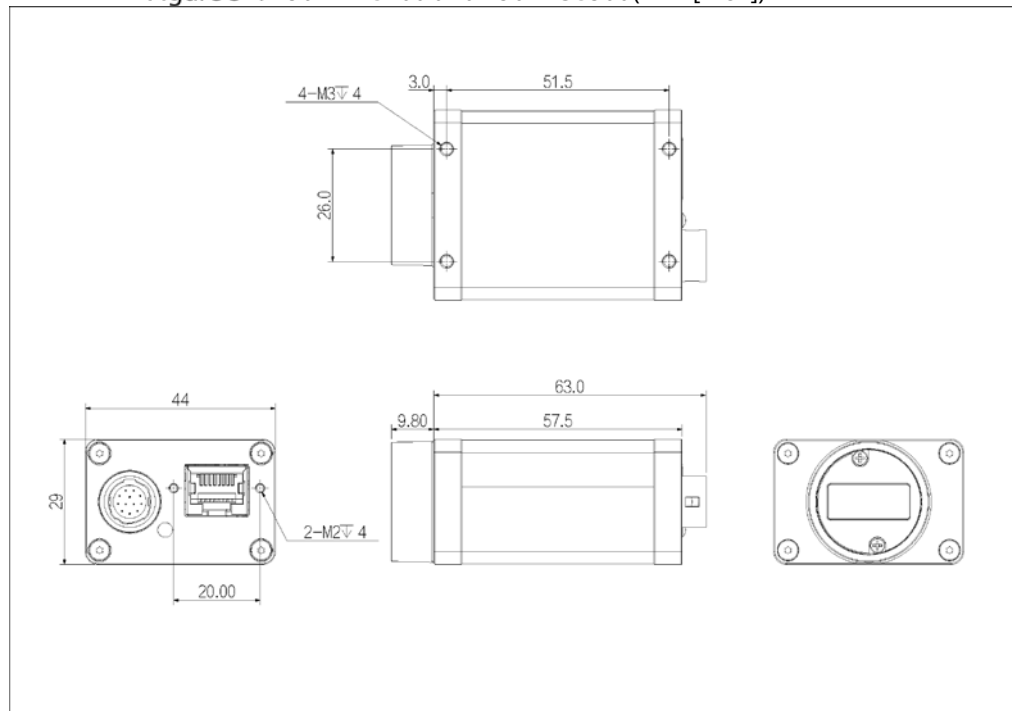


Figure 3-4 L5027MG400 and L5027CG300(mm [inch])



3.3 Camera Parameters

Table 3-1 Description of GigE line scan camera

Model	Sensor	Resolution	Line frequency	Bit depth (bit)	Port	Color	Pixel pitch (μm ²)
L5022MG141	CMOS	2048 x 1	49 KHz	12	GIGE	Mono	14 × 14
L5022CG141		2048x2				Color	
L5027MG140		2048x1				Mono	
L5027CG140		2048x2				Color	
L5047MG140		4096x1	28KHz			Mono	7 × 7
L5047CG140		4096x2				Color	
L5042MG141		4096x1				Mono	
L5042CG141		4096x2				Color	
L5082MG170		8192x1	13KHz			Mono	
L5027MG400		2048x4	59 K			Mono	7X7
L5027CG300		2048x3	59 K			Color	7X7

4 IO Electrical Specifications

4.1 First-generation Line Scan Cameras (CMOSIS 8K Ethernet Port)

First-generation line scan cameras (CMOSIS 8K Ethernet port) are equipped with an Ethernet port, 6-pin power and 12-pin trigger ports. The model is L5082MG170.

Table 4-1 First-generation line scan cameras (CMOSIS 8K Ethernet port)

Parameter	Description
Data output port	Fast Ethernet (100 Mbit/s) or Gigabit Ethernet (1000 Mbit/s).
Sync mode	Hardware triggered, software triggered, or free run.
Exposure time control	Hardware triggered or triggered by camera APIs.
Power supply specification	6-24 VDC, < 1% texture ripple, powered by the Hirose 6-pin connector of the camera. The cable must be at least 26 AWG.
I/O lines	• 2 RS422 inputs, which can be configured as single-end input. • 2 RS422 outputs, which can be configured as single-end output. • 1 RS422 input/output, which can be configured as single-end input/output. • 1 GPIO port, which can be configured as input or output.
Weight	About 230 g.
Lens Mount	M72 Mount
EMS standard	• ESD (GBT17626.2/IEC61000-4-2): 6 KV for contacting with a metal surface. • Surge (IEC61000-4-5): 2 KV in common mode/1 KV in differential mode through the Ethernet port (10/700 μs). • Power port: 2 KV in common mode (1.2/50 μs).
EMC standard	Class A



The power supply must meet SELV and LPS specifications.

Figure 4-1 Ports of first-generation line scan cameras

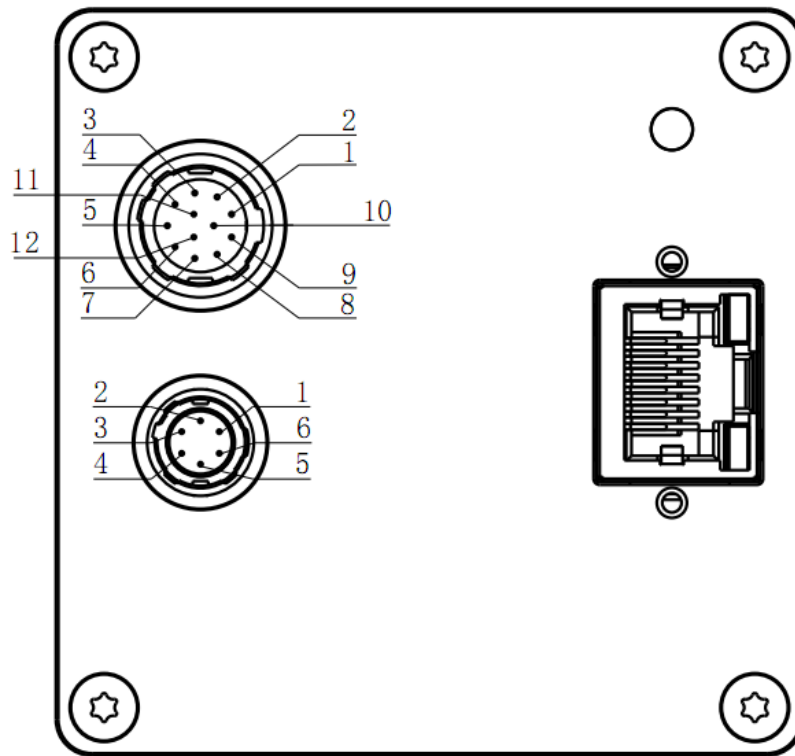


Table 4-2 Definitions of 12-pin signal ports (1)

Color	Pin	Description	Function
Black	1	line1_in-	RS422 input -
Red	2	line1_in+	RS422 input +/-single-end input
White blue	3	line3_inout-	RS422 input/output -
White green	4	line3_inout+	RS422 input/output +/-single-end input/output
Gray	5	signal ground	Signal ground
White	6	Line5_out-	RS422 output -
Brown	7	Line5_out+	RS422 output +/-single-end output
Orange	8	Line2_in-	RS422 input -
Blue	9	Line2_in+	RS422 input +/-single-end input
Green	10	Line4_GPIO	Single-end input/output
Purple	11	Line6_out-	RS422 output -
Yellow	12	Line6_out+	RS422 output +/-single-end output

Table 4-3 Definitions of 6-pin power ports

Color	Pin	Signal	Function
Mono	1	Power	+12 VDC to +24 VDC power supply of the camera
Red	2		
Gray	3		
Mono	4	-	Not connected
Green	5	GND	DC power grounding
Brown	6		



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.

Table 4-4 RS422 input

Input voltage		Description
Vcm	-25 to +25 V	Input common-mode voltage range.
VID	+200 mV	Input differential voltage (A-B). It represents logic 1 when the value is exceeded.
	-200 to +200 mV	The input status reverses and the logic status inside the voltage range is unsure.
	-200 mV	Input differential voltage (A-B). It represents logic 0 when the value is not exceeded.



For products delivered before November 2016, the input common mode voltage ranges from -12 to +12 V.

Figure 4-2 Cable connection of RS422 input

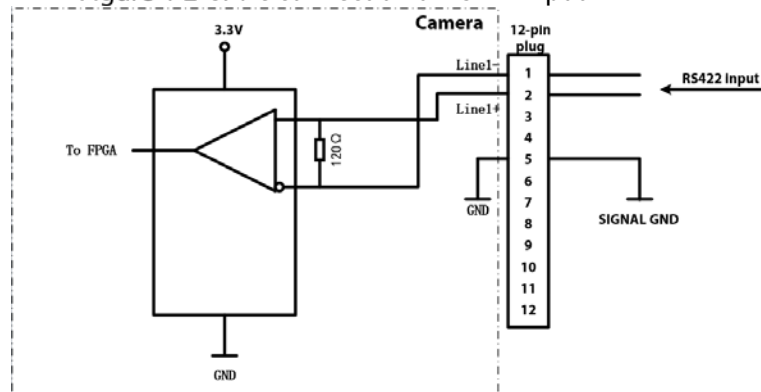


Table 4-5 Single-end input

Input voltage		Description
–	-60.0 to +60.0 V	Max. voltage input, which must be not exceeded. Otherwise, the device might be damaged.
	0-24 V	Safe operating voltage input range
3.3 V TTL input	1.5 V	Determining level for high and low conversion
5 V TTL input	2.5 V	
12 V	6 V	
24 V		



For products delivered before November 2016, the max. voltage is from -15 to +15 V, the safe operating voltage ranges from 0 to 6 V, and only 3.3 V and 5 V are supported for single-end input.

Figure 4-3 Single-end input connection

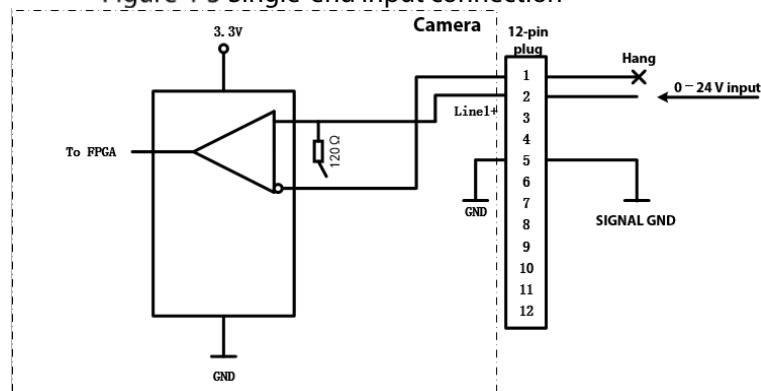


Figure 4-4 Connection for typical application of single-end input (1)

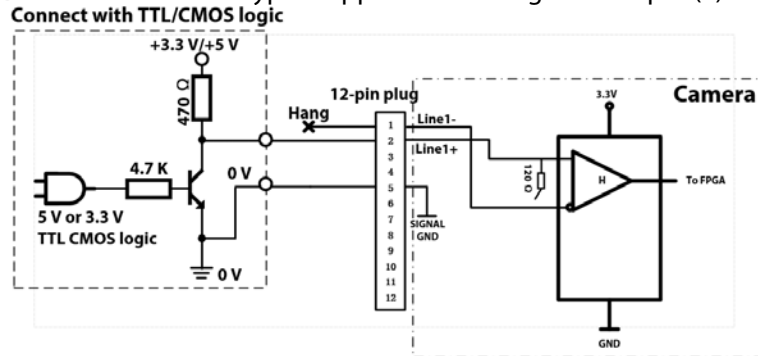


Figure 4-5 Connection for typical application of single-end input (2)

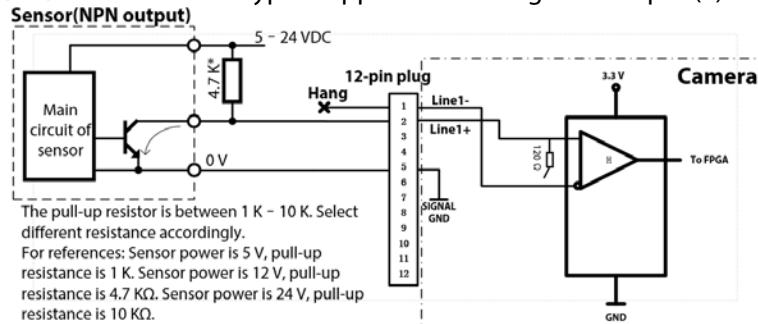


Figure 4-6 Connection for typical application of single-end input (3)

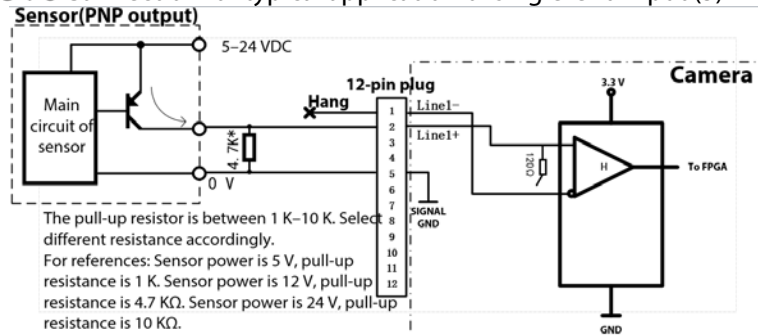


Figure 4-7 Connection for typical application of single-end input (4)

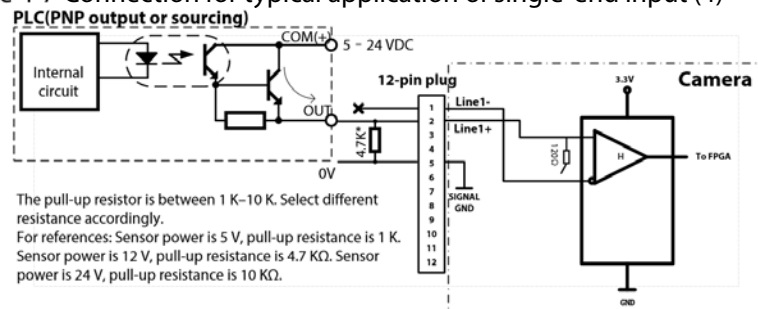


Figure 4-8 Connection for typical application of single-end input (5)

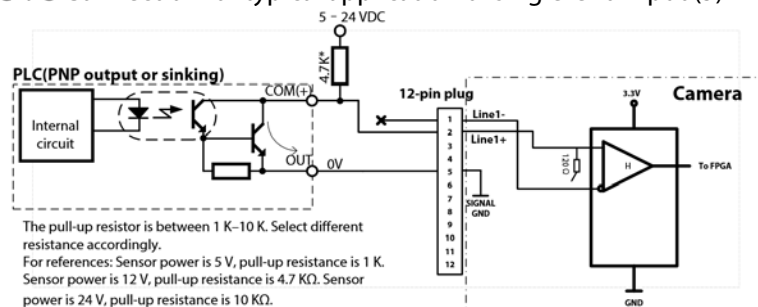


Table 4-6 RS422 output

Output voltage		Description
Voc	+3.0 V	Max. common-mode output voltage.
VOD	+200 mV	Output differential voltage (Y-Z). It represents logic 1 when the value is exceeded.
	-200 to +200 mV	The output status reverses, and the logic status inside the voltage range is unsure.
	-200 mV	Output differential voltage (Y-Z). It represents logic 0 when the value is not exceeded.

Figure 4-9 Cable connection of RS422 output

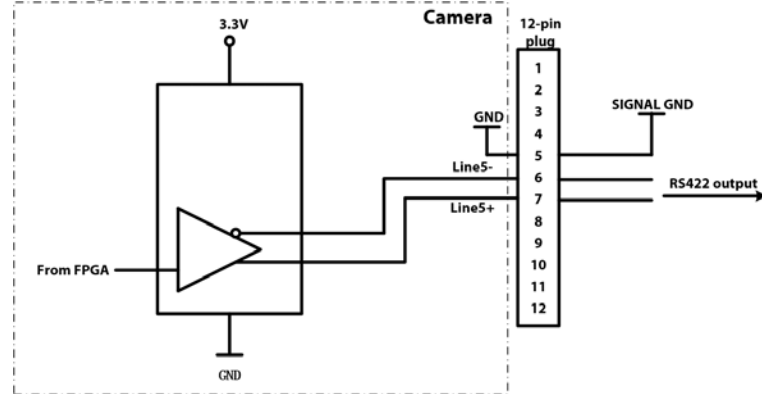


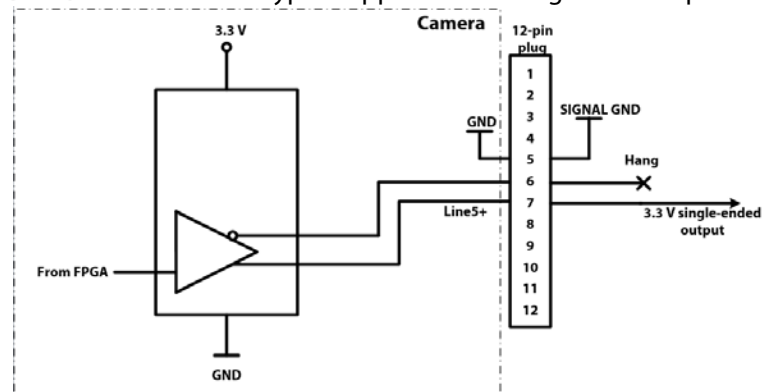
Table 4-7 Single-end output:

Voltage	Description
0 to +3.3 V	3.3 V TTL level
0-0.8 VDC	Logic 0
> 2.0 VDC	Logic 1



Only 3.3 V can be output even when an external pull-up adapter provides a voltage higher than 3.3 V. If an output voltage exceeding 3.3 V is required, a GPIO port is necessary.

Figure 4-10 Connection for typical application of single-end output



The following typical applications support 3.3 V input on the input side. When higher supply voltage is required on the input side, a GPIO port must be used.

Figure 4-11 Connection for typical application of single-end output (1)

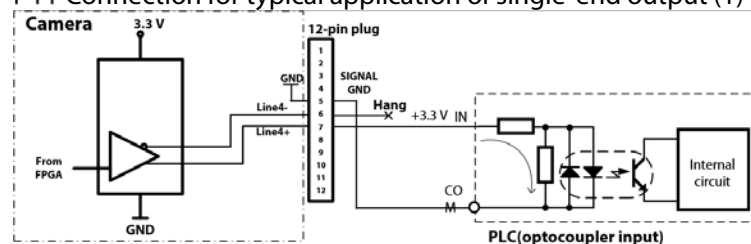


Figure 4-12 Connection for typical application of single-end output (2)

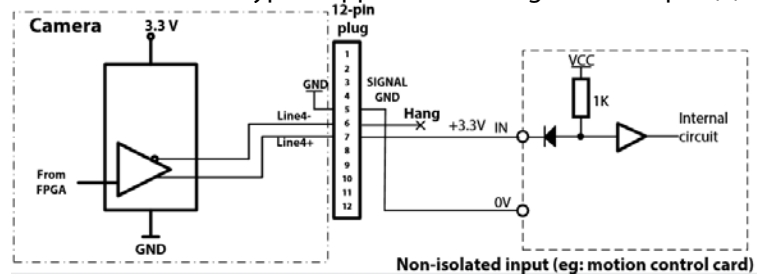


Figure 4-13 Connection for typical application of single-end output (3)

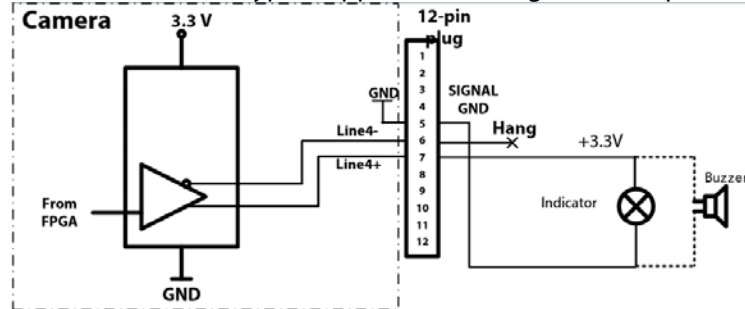
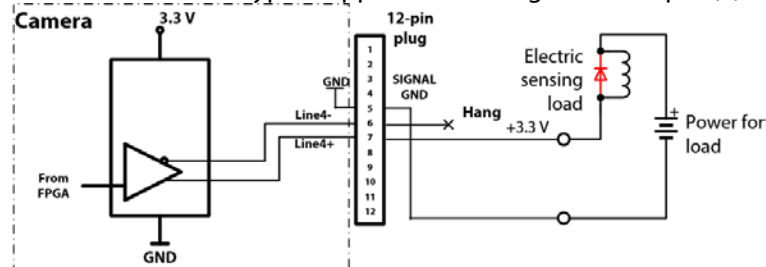


Figure 4-14 Connection for typical application of single-end output (4)



If the output of the camera is connected to an inductive load such as an intermediate relay, the model with a built-in fly-wheel diode must be used (or an external fly-wheel diode, such as 1N4007); otherwise, this may lead to the damage of the output port due to instantaneous overvoltage.

Table 4-8 GPIO input

Voltage	Description
30.0 VDC	Max. voltage. Input voltage cannot exceed the value. Otherwise, the device might be damaged.
0-5.0 VDC	Safe range of operating voltage input (min. 3.3 VDC when an external pull-up adapter exists).
0-0.8 VDC	Logic 0
> 0.8-2.0 VDC	The input status reverses, and the logic status inside the voltage range is unsure.
> 2.0 VDC	Logic 1

The external circuit must be able to input up to 2 mA sink current with voltage less than 0.8 VDC. The sink current must not be greater than 100 μ A at high level input.

Figure 4-15 Connection for GPIO input (1)

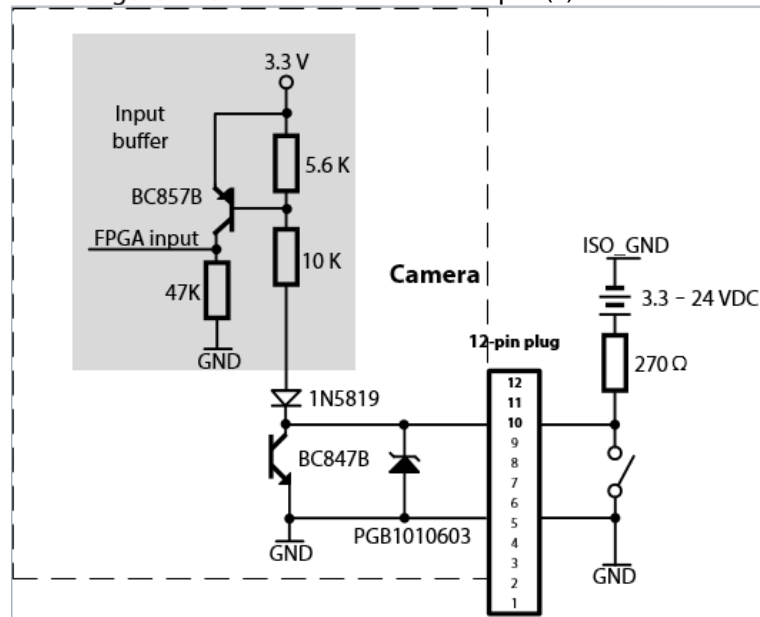


Figure 4-16 5 V TTL logic level input

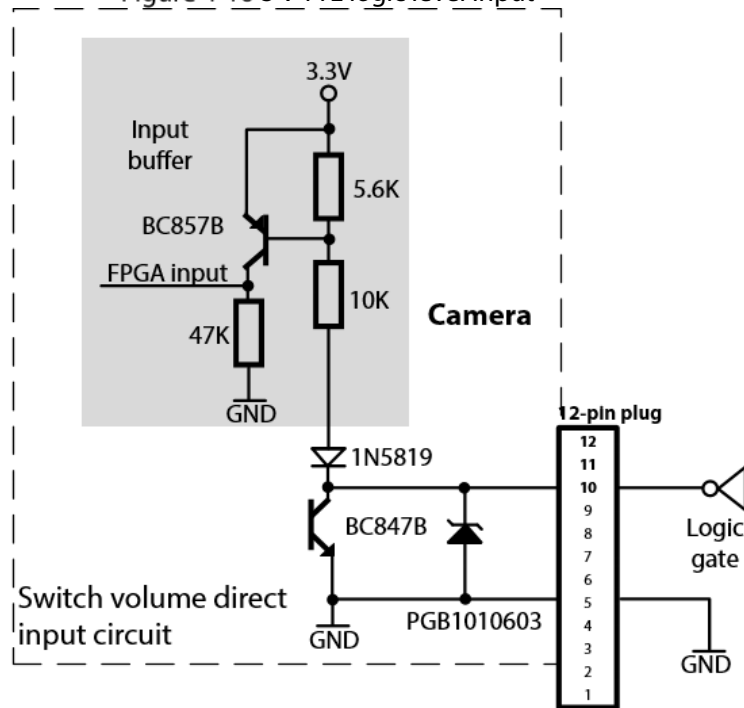


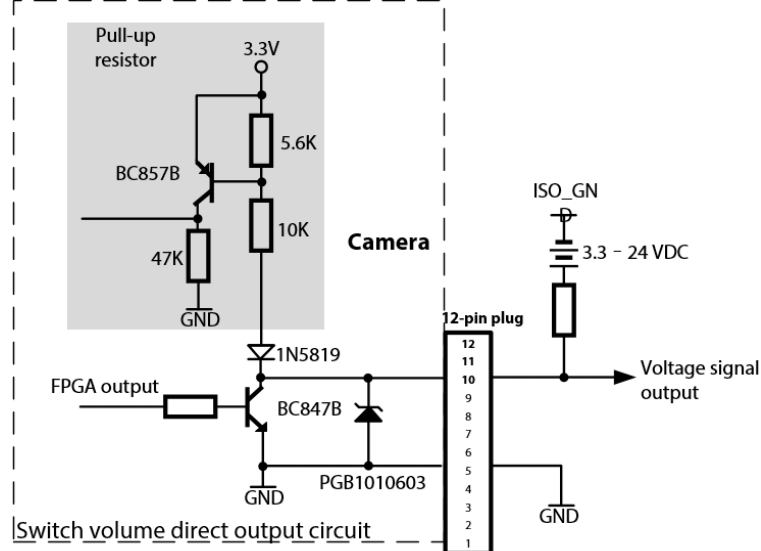
Table 4-9 Connection for GPIO output (2)

Voltage	Description
30.0 VDC	Max. voltage. Output voltage cannot exceed the value. Otherwise, the device might be damaged.
3.3-24 VDC	The security working voltage range when output.
< 3.3 VDC	Possible error on I/O output.



Up to 50 mA sink current when the IO port is used as output.

Figure 4-17 Connection for GPIO output



4.2 Second-generation Line Scan Cameras (CMOSIS 4K Ethernet Port)

Second-generation line scan cameras (CMOSIS 4K Ethernet port) are equipped with an Ethernet port and 12-pin trigger/power ports. The models include L5042 and L5022 series.

Table 4-10 Second-generation line scan camera (CMOSIS 4K Ethernet port)

Parameter	Descriptions
Data output port	Fast Ethernet (100 Mbit/s) or Gigabit Ethernet (1000 Mbit/s)
Sync mode	Hardware triggered, software triggered, or free run
Exposure time control	Hardware triggered or triggered by camera APIs
Power supply specification	9–24 VDC, < 1% texture ripple, powered by the Hirose 12-pin connector of the camera. The cable must be at least 26 AWG.
I/O lines	• 2 differential inputs • 1 differential output • 2 high-speed opto-isolated single-end inputs • 1 GPIO port, which can be configured as input or output
Weight	About 230 g
Lens Mount	M42 Mount
EMS standard	• ESD (GBT17626.2/IEC61000-4-2): 6 KV for contacting with a metal surface • Surge (IEC61000-4-5): 2 KV in common mode/1 KV in differential mode through the Ethernet port (10/700 μs) • Power port: 500 V in common mode (1.2/50 μs)
EMC standard	Class A



The power supply must meet SELV and LPS specifications. Be aware of the difference from the 6-pin and 12-pin camera variants.

Description of external I/O ports of line scan cameras

Figure 4-18 Ports of second-generation line scan cameras

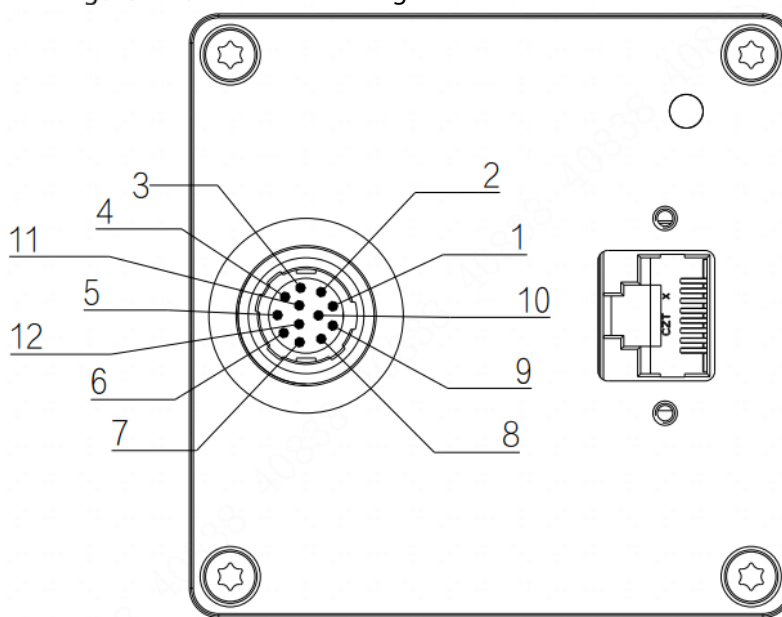


Table 4-11 Definitions of 12-pin signal ports (2)

Color	Pin	Description	Function
Mono	1	Power GND	Camera power supply (signal ground)
Red	2	Camera Power	Camera power
White blue	3	IN Line5+	Input Line5+
White green	4	IN Line5-	Input Line5-
Gray	5	OPT GND	Optocoupler isolated ground
White	6	OPT IN Line1	Optocoupler input 1
Brown	7	OPT IN Line2	Opto-isolated input 2
Orange	8	PDT Line4	Bidirectional GPIO Line4
Blue	9	OUT Line6+	Output Line6+
Green	10	OUT Line6-	Output Line6-
Purple	11	IN Line3+	Input Line3+
Yellow	12	IN Line3-	Input Line3-



An output signal pin not in use must be hanging. Connect an unused input pin to GND (recommended) or leave it hanging, instead of connecting it to the power supply to avoid camera damage.

Table 4-12 Differential input

Input voltage		Description
Vcm	±13 V	Input common-mode voltage range
VID	+200 mV	Input differential voltage (A-B). It represents logic 1 when the voltage exceeds the value.
	-200 to +200 mV	The input status reverses, and the logic status inside the voltage range is unsure.
	-200 mV	Input differential voltage (A-B). It represents logic 0 when the voltage is lower than this value.

There are 2 differential inputs, Line5 and Line3, which can be configured as differential encoder phase A or B on the software respectively.

To ensure good quality of the common-mode signal, connect the input to the signal ground when using. At the same time, for the trigger signal with high common mode voltage input, we recommend you connect the trigger signal to the high-speed opto-isolated input.

Figure 4-19 Connection of differential input

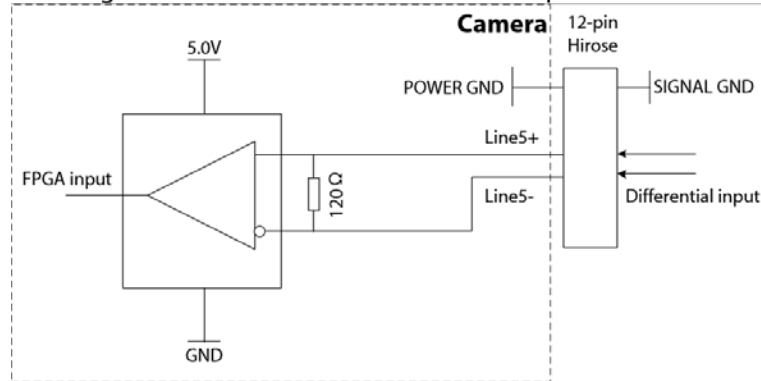


Table 4-13 Differential output

Output voltage		Description
Voc	+3.3 V	Max. common-mode output voltage
VOD	+200 mV	Differential output voltage (A-B). It represents logic 1 when the value is exceeded
	-200 to +200 mV	The output status reverses, and the logic status inside the voltage range is unsure.
	-200 mV	Differential output voltage (A-B). It represents logic 0 when the value is not exceeded.

Figure 4-20 Connection of differential output

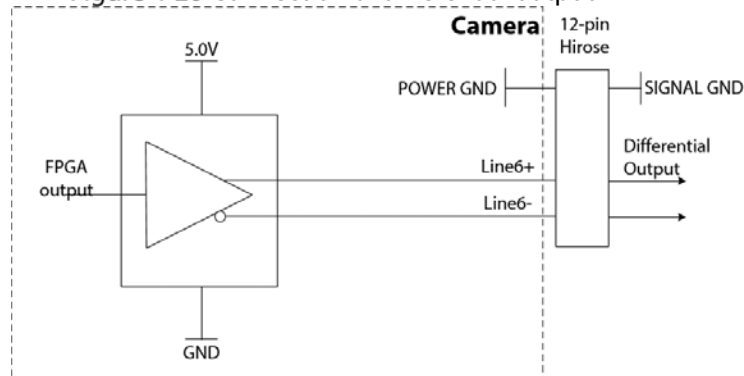


Table 4-14 High-speed opto-isolated input

Input voltage	Description
26.0 VDC	Max. voltage input, which must be not exceeded. Otherwise, the device might be damaged.
0-24 VDC	Safe operating voltage input range
0-1.4 VDC	Logic 0
> 1.4-2.2 VDC	The input status reverses, and the logic status inside the voltage range is unsure.
> +2.2 VDC	Logic 1

- The max. sink current for the opto-isolated input is 20 mA.
- The values above are typical values measured at an ambient temperature of 25 °C, and there are differences between cameras.

Figure 4-21 Relationship between the input signal amplitude and trigger delay

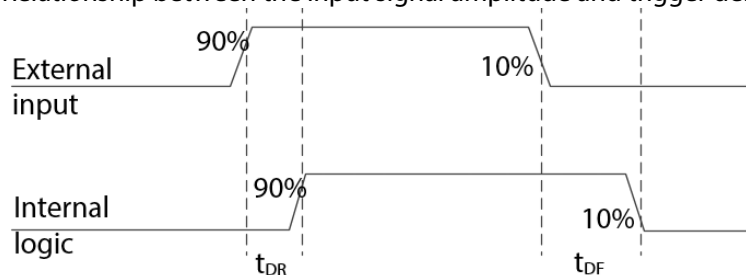


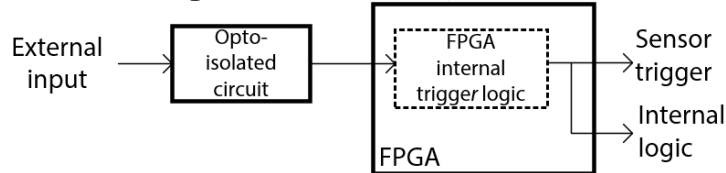
Table 4-15 Relationship between the input signal amplitude and trigger delay

Input signal amplitude (V _p)	Rising edge trigger delay t _{DR} (us)	Falling edge trigger delay t _{DF} (us)
5.00	0.036	0.19



- The trigger delay refers to the delay from the external opto-isolated input to FPGA pin input, without taking into account the internal logic delay of FPGA.
- The values above are measured when the environment temperature is 25°C.

Figure 4-22 Trigger delay



Connection of high-speed opto-isolated input

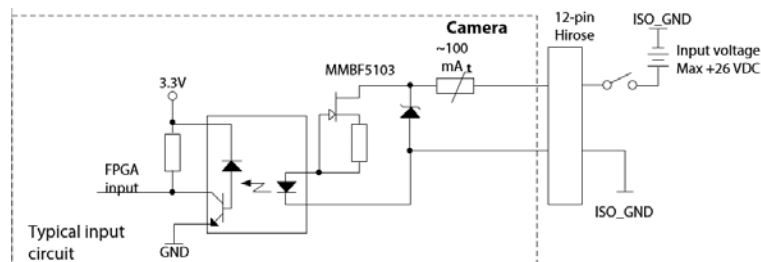


Figure 4-23 Typical application of opto-isolated input (1)
Connect with TTL/CMOS logic

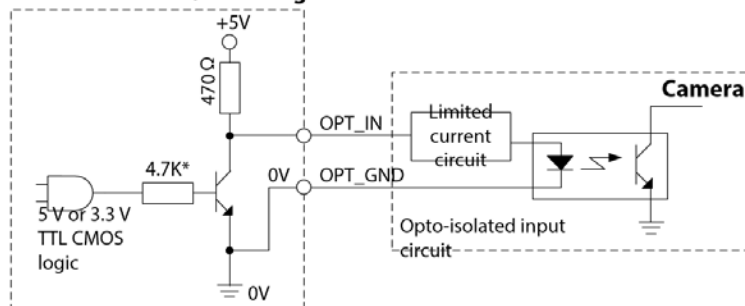
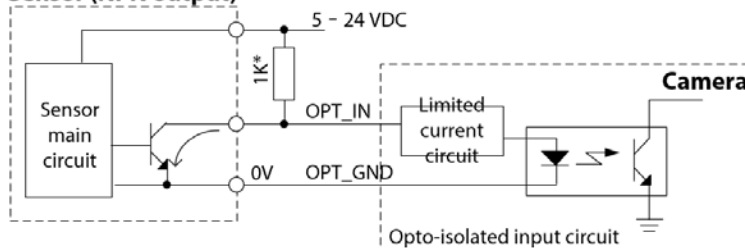


Figure 4-24 Typical application of opto-isolated input (2)
Sensor (NPN output)



For this connection, a pull-up resistor needs to be installed from the sensor output to the power. Select a proper resistance value to ensure that the high and low levels meet the input requirements of the camera opto-isolated port

Figure 4-25 Typical application of opto-isolated input (3)

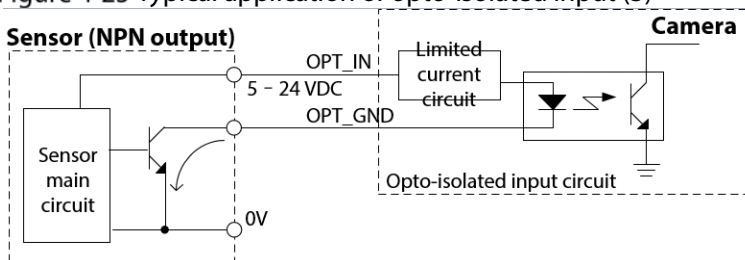


Figure 4-26 Typical application of opto-isolated input (4)
Sensor (PNP output)

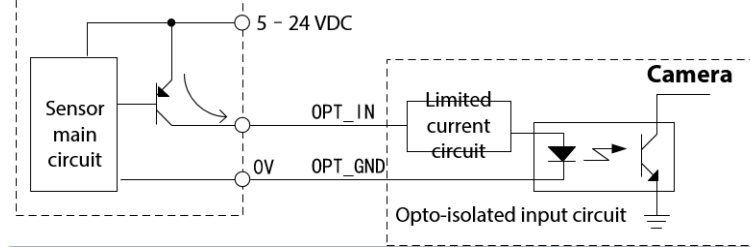
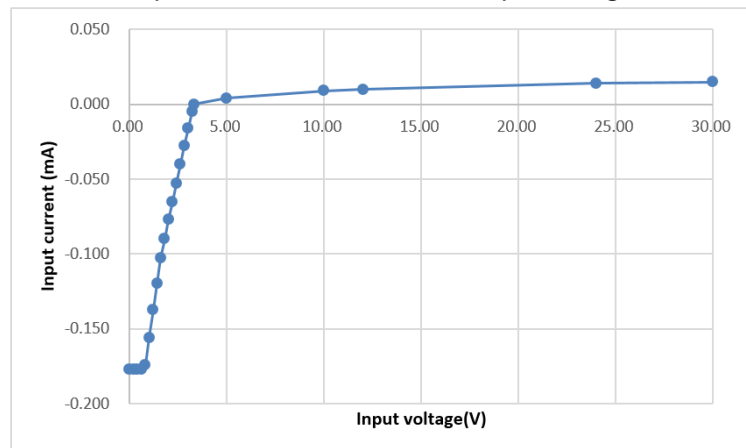


Table 4-16 GPIO input

Voltage	Description
26.0 VDC	Max. voltage input, which must be not exceeded. Otherwise, the device might be damaged.
0-24.0 VDC	Safe operating voltage input range (min. 3.3 VDC when an external pull-up adapter exists)
0-0.8 VDC	Logic 0
> 0.8-2.0 VDC	The input status reverses, and the logic status inside the voltage range is unsure.
> 2.0 VDC	Logic 1

When GPIO is used as an input port, the sink current from an external circuit must not be lower than 2 mA at low input level. In this case, the voltage must not be greater than 0.8 VDC. The sink current must not be greater than 100 μ A at high input level.

Figure 4-27 Relationship between sink current and input voltage of GPIO_IN



- The max. input sink current of GPIO is 15 μ A.
- The values above are measured when the environment temperature is 25°C.

Table 4-17 Relationship between the input signal amplitude and trigger delay

Input signal amplitude (Vp-p)	Rising edge trigger delay tDR (us)	Falling edge trigger delay tDF (us)
3.00	6.783	0.339
5.00	6.563	0.200
9.00	6.164	0.106
10.00	6.416	0.960



- The trigger delay refers to the delay from the external opto-isolated input to FPGA pin input, without taking into account the internal logic delay of FPGA.
- The GPIO input port supports the shortest input positive pulse of 20 μ s (typical value) and the shortest input negative pulse of 2 μ s (typical value).

Figure 4-28 Connection for GPIO input (2)

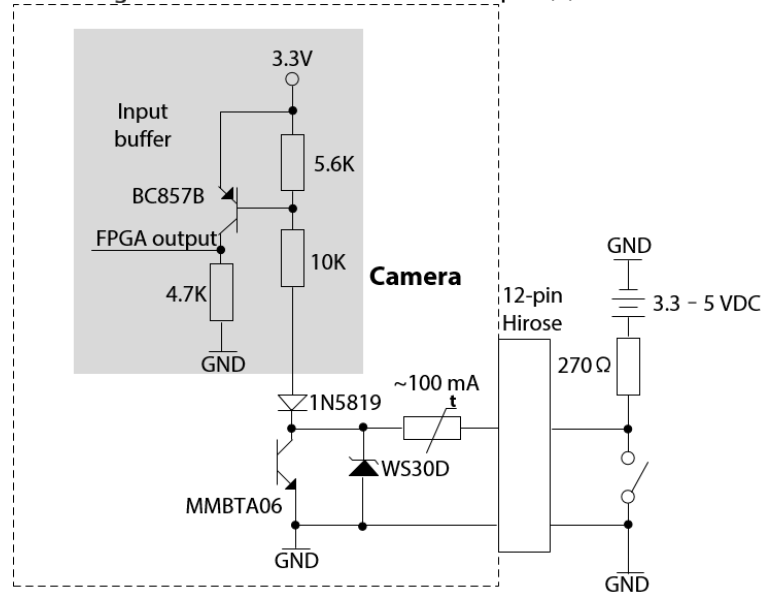


Figure 4-29 5 V TTL logic level input

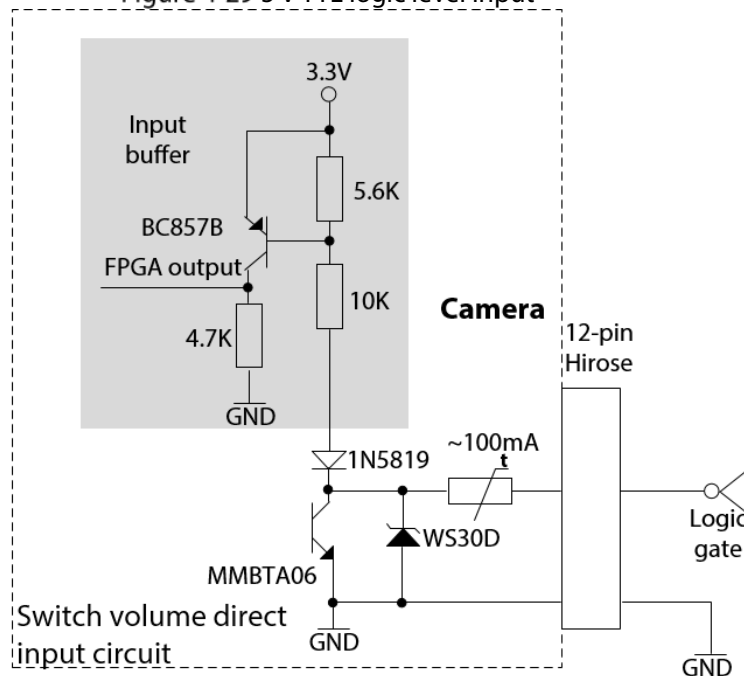


Table 4-18 Connection for GPIO output (2)

Voltage	Description
30.0 VDC	Max. voltage. Output voltage cannot exceed the value. Otherwise, the device might be damaged.
3.3-24 VDC	Safe operating voltage output range
< 3.3 VDC	I/O output might be incorrect



Up to 100 mA sink current when the IO port is used as output.

Figure 4-30 On/off direct output circuit (1)

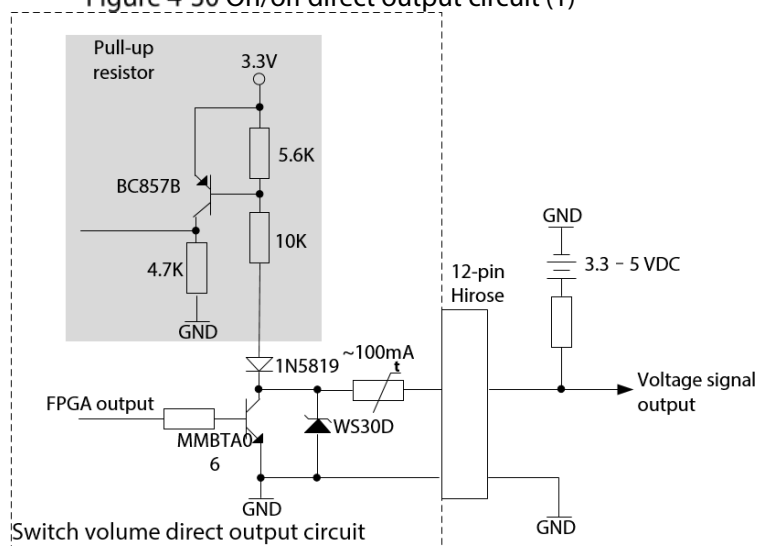
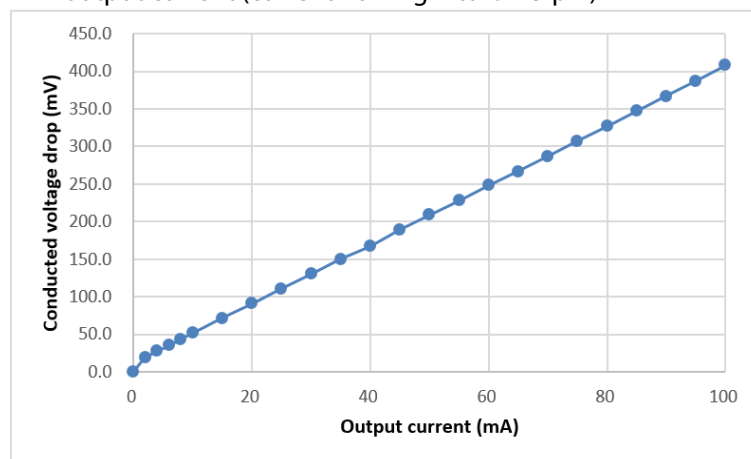
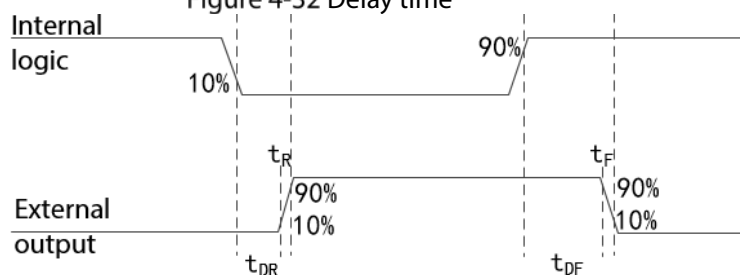


Figure 4-31 Relationship between the GPIO output voltage drop (voltage drop between GPIO and GND) and output current (current flowing into GPIO pin)



- The max. voltage drop at GPIO output port is about 0.41 V (measured at the max. output current of 100 mA).
- The values above are typical values measured at an ambient temperature of 25 °C, and there are differences between cameras.

Figure 4-32 Delay time



The following table describes the rising and falling time, and delay time of rising and falling edge when using a 470 Ω pull-up resistor.

Table 4-19 Output delay time

External power supply voltage (V)	Rising time t_R (μ s)	Falling time t_F (μ s)	Rising edge trigger delay t_{DR} (us)	Falling edge trigger delay t_{DF} (us)
—	—	—	5.43	0.35
5	0.16	0.02	1.80	39
12	0.22	0.04	2.37	71



- The output delay refers to the delay from the FPGA pin output to GPIO pin, without taking into account the internal logic delay of FPGA.
- When no external pull-up resistor exists, the shortest output positive pulse is 11 μ s and the shortest output negative pulse is 1 μ s.

4.3 Third-generation Line Scan Cameras (GPixel 4K Ethernet Port)

Third-generation line scan cameras (GPixel 2K/4K Ethernet port) are equipped with an Ethernet port and 12-pin trigger/power ports. The models include L5027 and L5047 series.

Table 4-20 Third-generation line scan camera (GPixel 2K/4K Ethernet port)

Parameter	Description
Data output port	Fast Ethernet (100 Mbit/s) or Gigabit Ethernet (1000 Mbit/s)
Sync mode	Hardware triggered, software triggered, or free run
Exposure time control	Hardware triggered or triggered by camera APIs
Power supply specification	9–24 VDC, < 1% texture ripple, powered by the Hirose 12-pin connector of the camera. The cable must be at least 26 AWG.
I/O lines	• 3 differential inputs (among them, Line1/2 can be configured as differential or single-end input, and Line3 can only be configured as differential input). • 1 differential output (Line3 can be configured as differential input or output). • 1 high-speed opto-isolated single-end input (Line5, isolated input). • 1 GPIO (Line4 can be configured as input or output)
Weight	About 230 g
Lens Mount	M42 Mount
EMS standard	• ESD (GBT17626.2/IEC61000-4-2): 6 KV for contacting with a metal surface • Surge (IEC61000-4-5): 2 KV in common mode/1 KV in differential mode through the Ethernet port (10/700 μs) • Power port: 500 V in common mode (1.2/50 μs)
EMC standard	Class A

Figure 4-33 Ports of third-generation line scan cameras

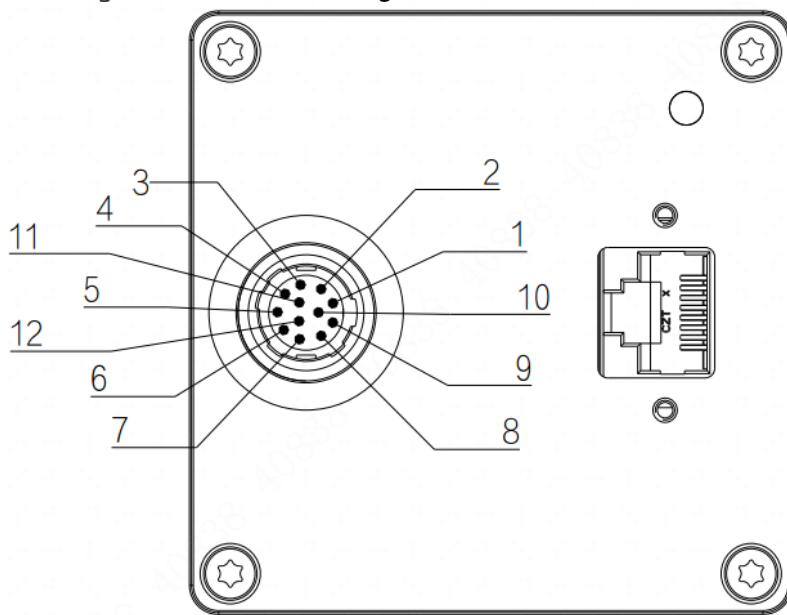


Table 4-21 Definitions of 12-pin signal ports (3)

Color	Pin	Description	Function
Mono	1	Power GND	Camera power ground
Red	2	Camera Power	Camera power
White blue	3	IN Line1+	Input Line1+
White green	4	IN Line1-	Input Line1-
Gray	5	Signal GND	Signal ground
White	6	IN Line2+	Input Line2+
Brown	7	IN Line2-	Input Line2-
Orange	8	IN Line4	Bidirectional GPIO Line4
Blue	9	IN/OUT Line3+	Input/output Line3+
Green	10	IN/OUT Line3-	Input/output Line3-
Purple	11	OPT_IN Line5	Optocoupler input Line5
Yellow	12	OPT GND	Opto-isolated ground



An output signal pin not in use must be hangged. Connect an unused input pin to Signal ground (recommended) or leave it hanging, instead of connecting it to the power supply to avoid camera damage.

Table 4-22 Differential input

Input voltage		Description
Vcm	± 25.0 V	Input common-mode voltage range
VID	200 mV	Input differential voltage (A-B). It represents logic 1 when the value is exceeded.
	-200 to +200 mV	The input status reverses, and the logic status inside the voltage range is unsure.
	-200 mV	Input differential voltage (A-B). It represents logic 0 when the value is not exceeded.

- There are 2 differential inputs, i.e. Line1/Line2/Line3, which can be configured as differential encoder phase A or B by software, respectively, among which Line1/Line2 can only be configured as trigger input, while Line3 can not only be configured as input but also output.
- When Line1/Line2/Line3 is configured as input, the terminal resistor is disabled by default. Instead, it is enabled when the RS422 mode is selected. To ensure good quality of the common-mode signal, connect the input to the signal ground when using.

Figure 4-34 Connection of differential input

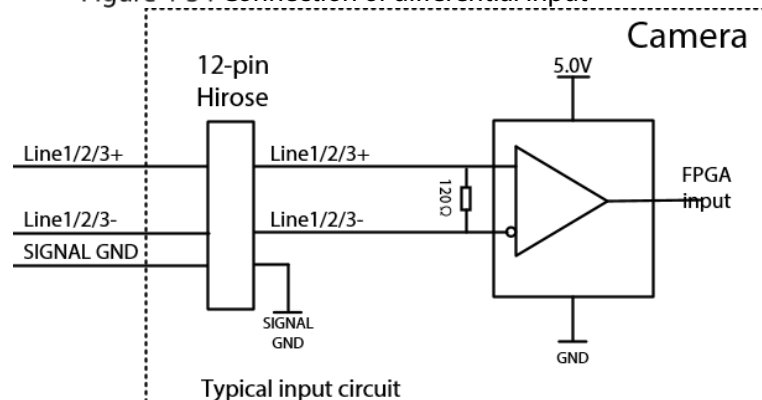


Table 4-23 Single-end input

+ input voltage	- reference voltage	Description
0-24 V	—	Safe operating voltage input range
< 2.23 V	0 V	Do not meet the min. level for trigger logic
3.3 V TTL input	1.5 V	Determining level for high and low conversion
5 V TTL input	2.5 V	

+ input voltage	- reference voltage	Description
12 V	5 V	
24 V	8.4 V	
> 25 V	—	Max. voltage input, which must be not exceeded. Otherwise, the device might be damaged.

For GEN.3 linear array cameras, only Line1/Line2 can be configured as single-end input, and Line3 can only be configured as differential input or output. For single-end input, the trigger level must not be lower than 2.32 V and the shortest trigger pulse must not be lower than 50 ns. Otherwise, the trigger might fail.

Figure 4-35 Typical input circuit

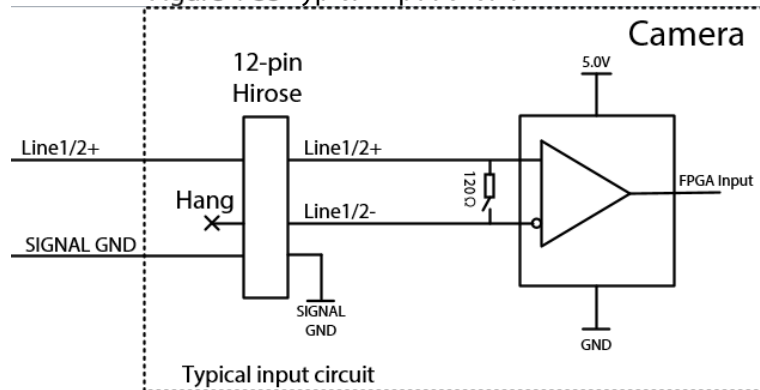


Figure 4-36 Output delay time

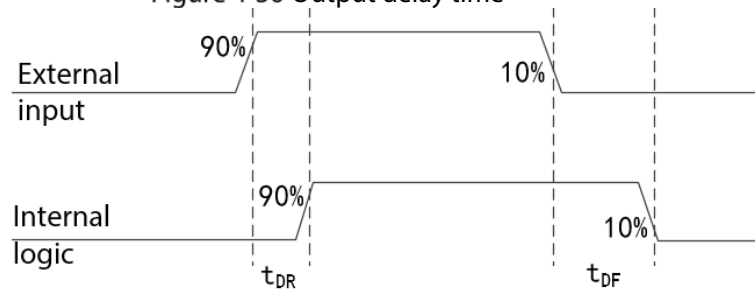


Table 4-24 Output delay time

External power supply voltage (V)	Rising time tR (ns)	Falling time tR (ns)	Rising edge trigger delay tDR (us)	Falling edge trigger delay tDF (us)
3.3	< 3.4	< 4	< 15	< 34.5
5.0				< 31
12			< 13	< 41.2

Figure 4-37 Connection of typical application when differential mode is configured as single-end input (1)

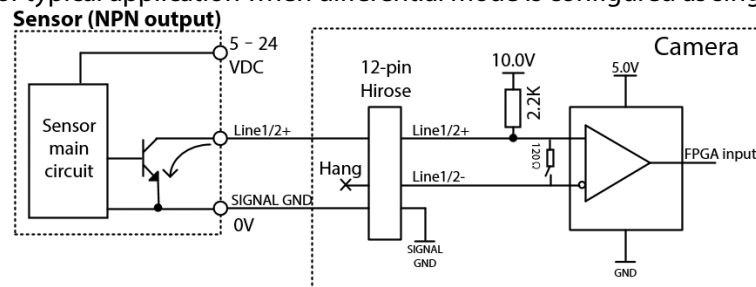


Figure 4-38 Connection of typical application when differential mode is configured as single-end input (2)

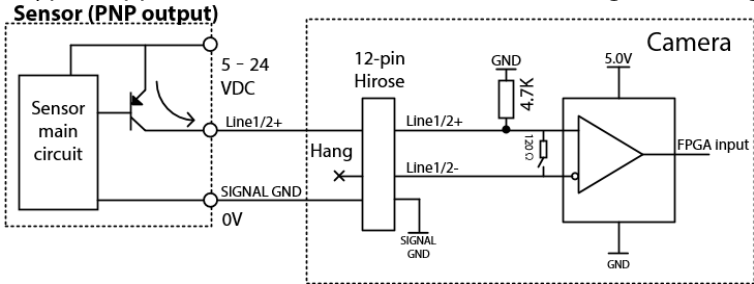


Figure 4-39 Connection of typical application when differential mode is configured as single-end input (3)

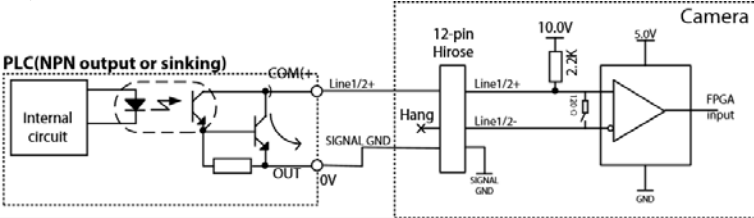


Figure 4-40 Connection of typical application when differential mode is configured as single-end input (4)

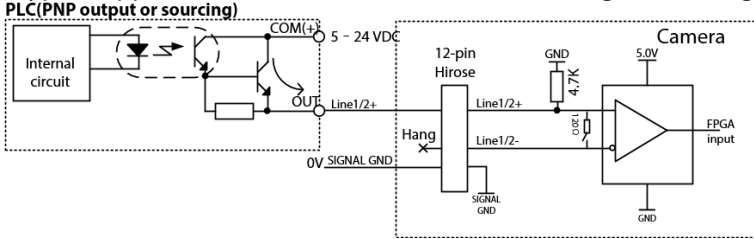


Table 4-25 Differential output

Output voltage		Description
Voc	±3.0 V	Max. output voltage
VOD	+200 mV	Differential output voltage (A-B). It represents logic 1 when the value is exceeded.
	-200 to +200 mV	The output status reverses, and the logic status inside the voltage range is unsure.
	-200 mV	Differential output voltage (A-B). It represents logic 0 when the value is not exceeded

For GEN.3 linear array cameras, the differential output contains only Line3.

Figure 4-41 Connection of differential output

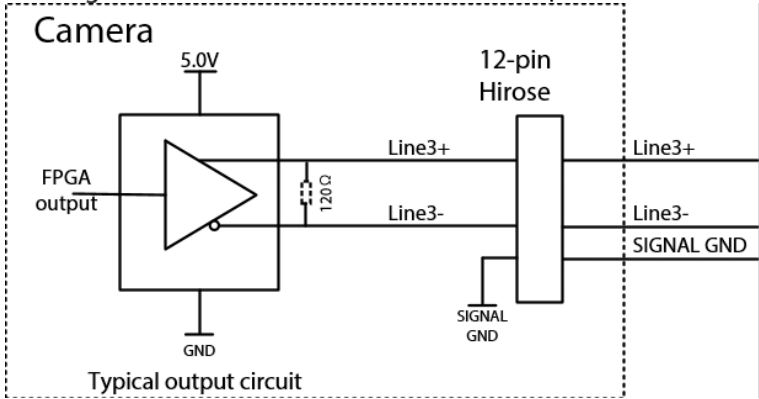


Table 4-26 Out delay when empty

Rising time tR (ns)	Falling time tR (ns)	Rising edge trigger delay tDR (us)	Falling edge trigger delay tDF (us)
< 4.5	< 5.4	< 27.5	< 26.4

Figure 4-42 Special use of a differential output as a single-end output

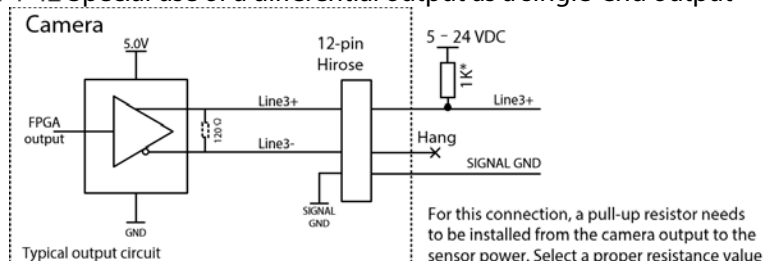
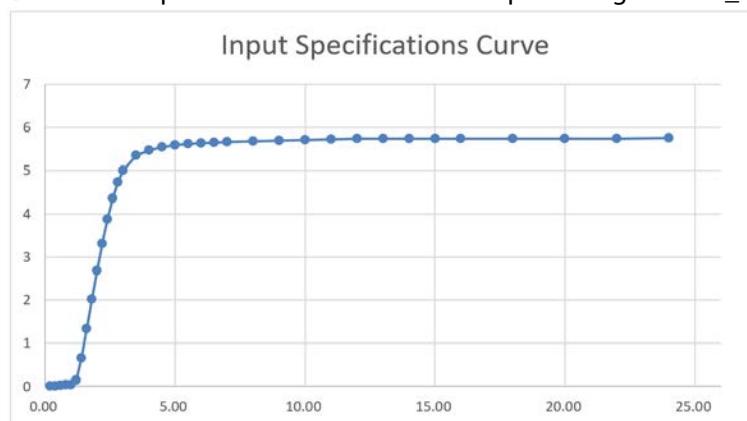


Table 4-27 Opto-isolated Input

Input voltage	Description
26.0 VDC	Max. voltage input, which must be not exceeded. Otherwise, the device might be damaged.
0-24 VDC	Safe operating voltage input range
0-1.4 VDC	Logic 0
> 1.4-2.2 VDC	The input status reverses, and the logic status inside the voltage range is unsure.
> 2.2 VDC	Logic 1

Figure 4-43 Relationship between sink current and input voltage of OPT_IN



- The max. sink current for the opto-isolator input is 6 mA.
- The values above are typical values measured at an ambient temperature of 25 °C, and there are differences between cameras.

Table 4-28 Relationship between the input signal amplitude and trigger delay

Input signal amplitude (Vp-p)	Rising edge trigger delay tDR (us)	Falling edge trigger delay tDF (us)
3.3	28	90
5.0	14	94
9.0	4	94
12	4	98



- The trigger delay refers to the delay from the external opto-isolated input to FPGA pin input, without taking into account the internal logic delay of FPGA.
- The values above are measured when the environment temperature is 25°C.

Figure 4-44 Opto-isolated trigger delay

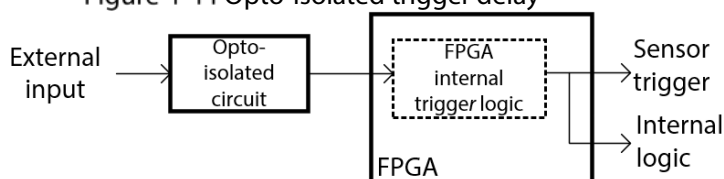


Figure 4-45 Typical input circuit

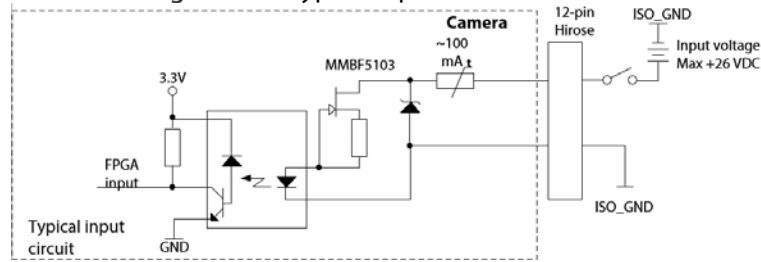


Figure 4-46 Typical application of opto-isolated input (1)
Connect with TTL/CMOS logic

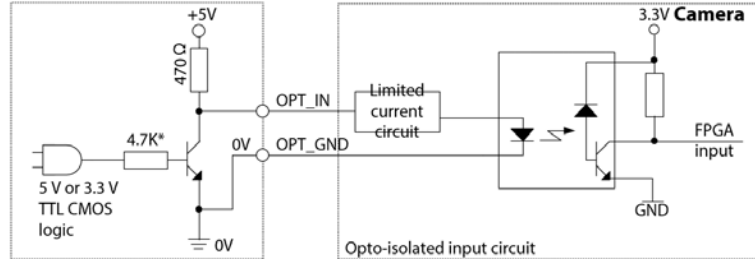


Figure 4-47 Typical application of opto-isolated input (2)
Sensor (NPN output)

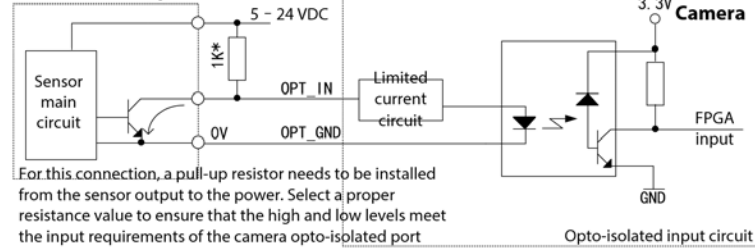


Figure 4-48 Typical application of opto-isolated input (3)

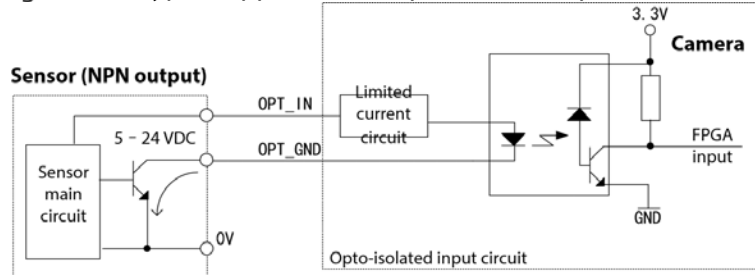


Figure 4-49 Typical application of opto-isolated input (4)
Sensor (PNP output)

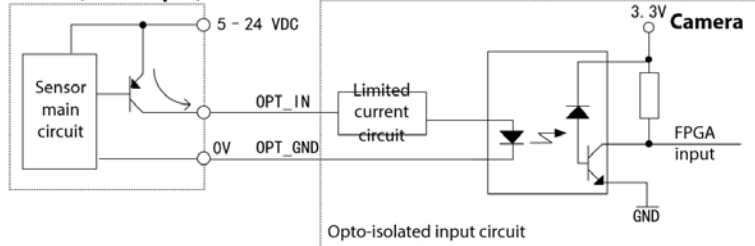


Figure 4-50 Typical application of opto-isolated input (5)
PLC(PNP output or sourcing)

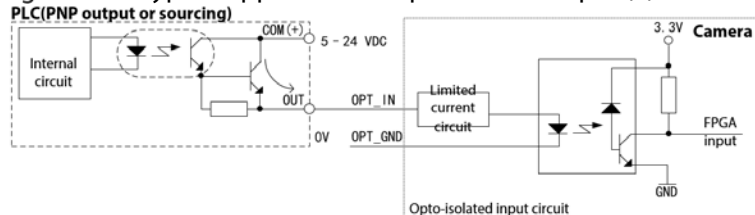


Figure 4-51 Typical application of opto-isolated input (6)

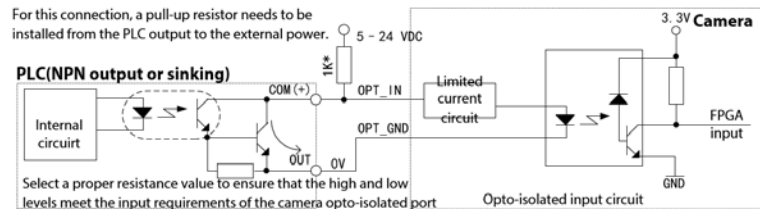
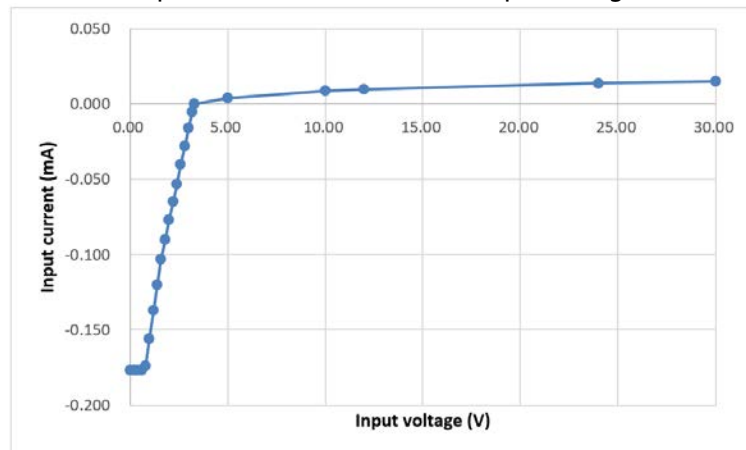


Table 4-29 GPIO input

Voltage	Description
26.0 VDC	Max. voltage input, which must be not exceeded. Otherwise, the device might be damaged.
0-24.0 VDC	Safe operating voltage input range (min. 3.3 VDC when an external pull-up adapter exists)
0-0.8 VDC	Logic 0
> 0.8-2.0 VDC	The input status reverses, and the logic status inside the voltage range is unsure.
> 2.0 VDC	Logic 1

When GPIO is used as an input port, the sink current from an external circuit must not be lower than 2 mA at low input level. In this case, the voltage must not be greater than 0.8 VDC. The sink current must not be greater than 100 μ A at high input level.

Figure 4-52 Relationship between sink current and input voltage of GPIO_IN



- The max. input sink current of GPIO is 15 μ A.
- The values mentioned above are measured when the environment temperature is 25°C.

Table 4-30 Relationship between the input signal amplitude and trigger delay

Input signal amplitude (Vp-p)	Rising edge trigger delay tDR (us)	Falling edge trigger delay tDF (us)
3.00	6.783	0.339
5.00	6.563	0.200
9.00	6.164	0.106
10.00	6.416	0.960



- The trigger delay refers to the delay from the external opto-isolated input to FPGA pin input, without taking into account the internal logic delay of FPGA.
- The GPIO input port supports the shortest input positive pulse of 20 μ s (typical value) and the shortest input negative pulse of 2 μ s (typical value).

Figure 4-53 GPIO input (3)

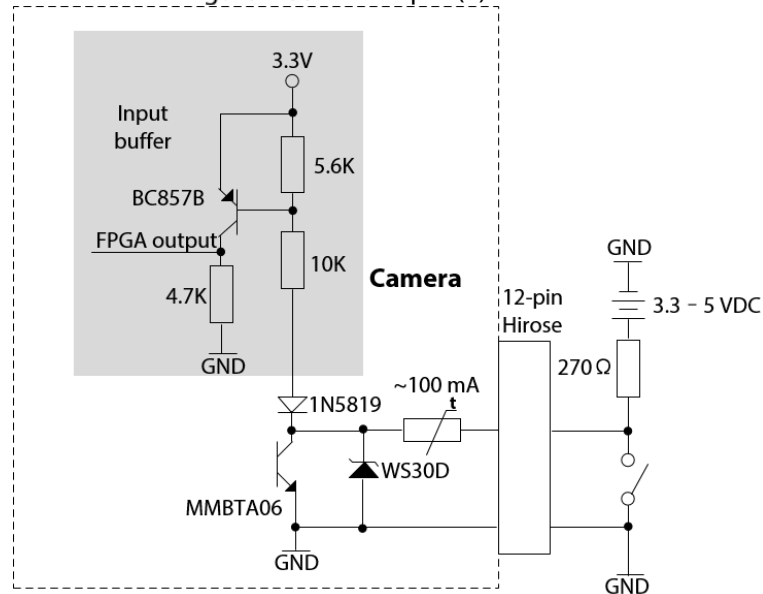


Figure 4-54 5 V TTL logic level input (3)

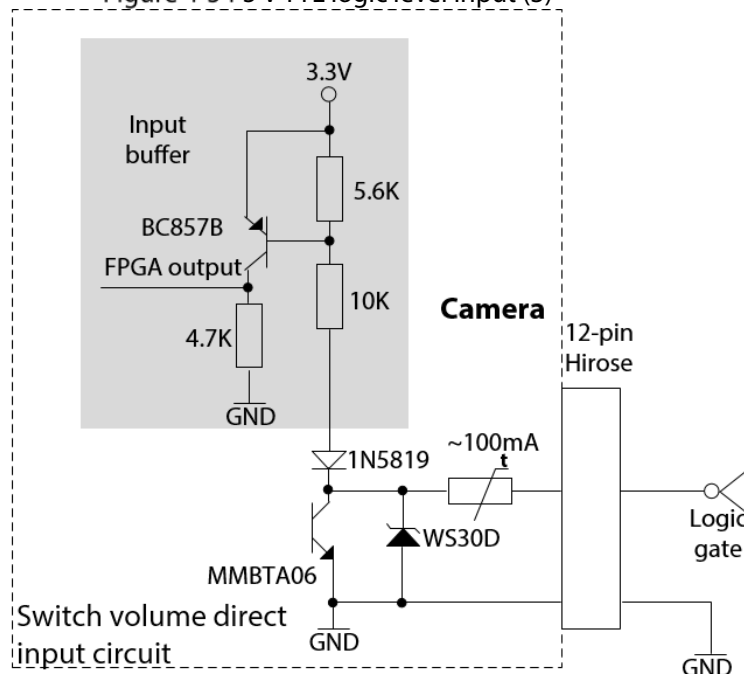


Table 4-31 Connection for GPIO output (3)

Voltage	Description
+30.0 VDC	Max. voltage. Output voltage cannot exceed the value. Otherwise, the device might be damaged.
3.3-24 VDC	Safe operating voltage output range
< 3.3 VDC	I/O output may be incorrect



Up to 100mA sink current when the IO port is used as output.

Figure 4-55 On/off direct output circuit (2)

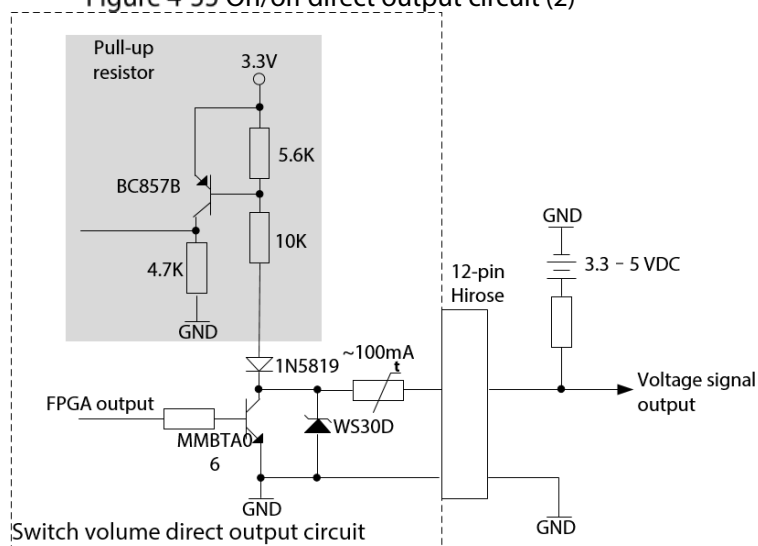
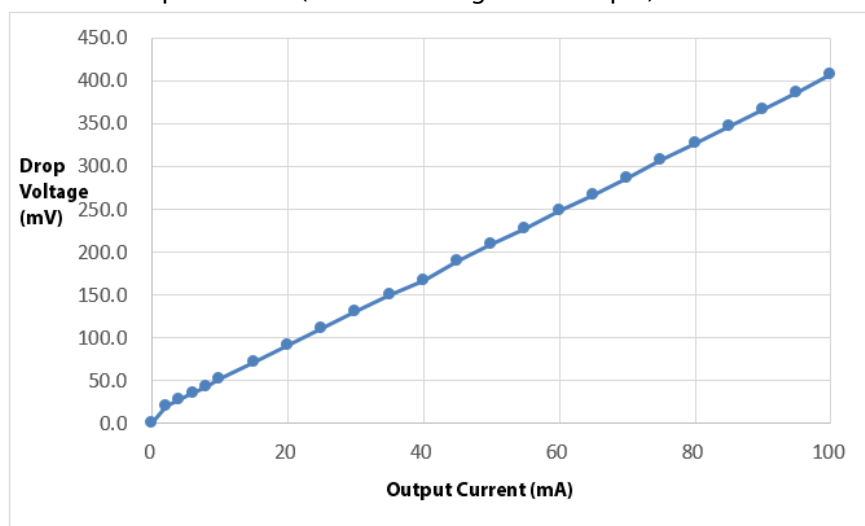


Figure 4-56 Relationship between the GPIO output voltage drop (voltage drop between GPIO and GND) and output current (current flowing into GPIO pin)



- The max. voltage drop at GPIO output port is about 0.41 V (measured at the max. output current of 100 mA).
- The values above are typical values measured at an ambient temperature of 25 °C, and there are differences between cameras.

Figure 4-57 Logic delay

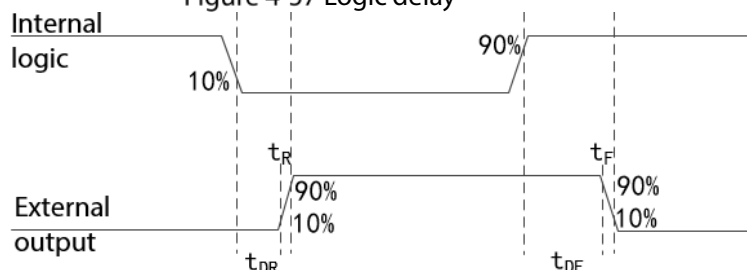


Table 4-32 Output delay when using 470 Ω pull-up resistor

External power supply voltage (V)	Rising time t_R (μs)	Falling time t_F (μs)	Rising edge trigger delay t_{DR} (us)	Falling edge trigger delay t_{DF} (us)
—	—	—	5.43	0.35
5	0.16	0.02	1.80	39
12	0.22	0.04	2.37	71



- The output delay refers to the delay from the FPGA pin output to GPIO pin, without taking into account the internal logic delay of FPGA.
- When no external pull-up resistor exists, the shortest output positive pulse is 11 μs and the shortest output negative pulse is 1 μs .

4.4 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. For max. safe voltage of input signal, see the IO electrical introduction in the previous section. 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.

4.4.1 Avoiding EMI and ESD

In an industrial environment, some devices might generate EMI (electromagnetic interference). Cameras are susceptible to ESD (electrostatic discharge). Significant EMI and ESD lead to issues such as false trigger and sudden stop of stream acquiring. EMI and ESD also reduce the imaging quality of cameras and the reliability of data transmission between cameras and computers.

In order to avoid issues caused by EMI and ESD, we recommend you take the following measures:

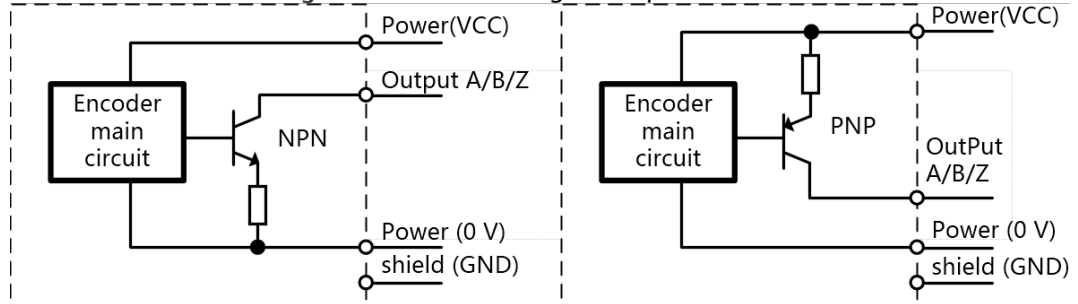
- Use a high-quality cable with the shielding function, which shields cameras from EMI and ESD.
- Use a cable with an appropriate length. If the cable is excessively long, bend it back and forth instead of making it a coil.
- Make the power cord of the camera in parallel with the data cable.
- Do not 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 prevents a ground loop from occupying a large area, which is the main cause of EMI.
- 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.
- You can take the following measures 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.

4.4.2 FAQs on Rotary Encoders

What is the difference among voltage output, collector signal output, and differential output encoders?

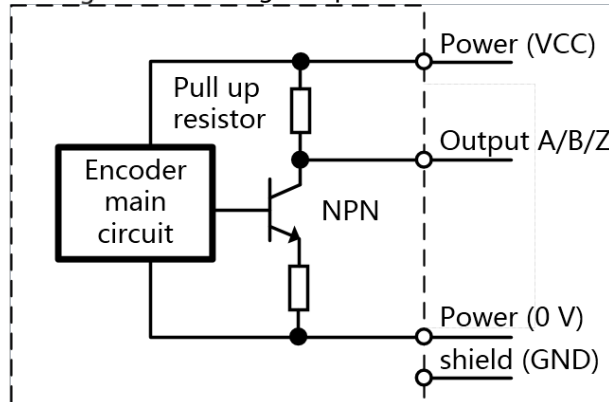
- The collector signal output uses the transistor emitter of the output circuit as the common end, and the collector is suspended in the output circuit. Generally, the collector signal output is divided into NPN open collector output and PNP open collector output.

Figure 4-58 Collector signal output



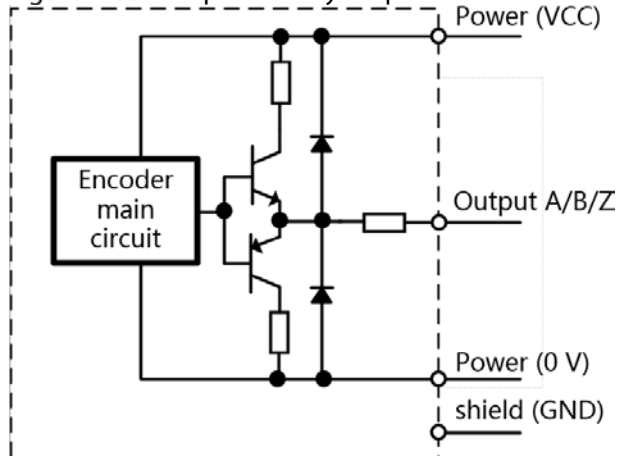
- Voltage output is based on an open-collector output circuit. A pull-up resistor is connected between the power supply and the collector, so that stable voltage can be provided between the collector and the power supply.

Figure 4-59 Voltage output circuit

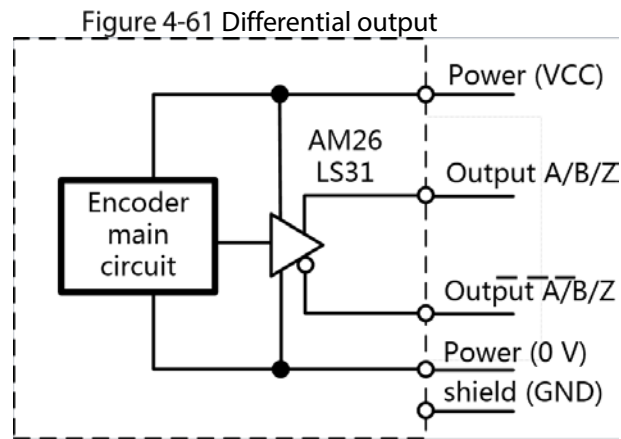


- Output circuit with NPN and PNP transistors for complementary output. According to the strength of the output signal, the 2 output transistors switch alternately. This allows longer transmission distance than the open-collector output circuit.

Figure 4-60 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 uses a dedicated IC (called RS422 transceiver) to receive the signal sent by the encoder.



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

After power failure, incremental encoders do 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°. iRAYPLE line scan cameras only support incremental encoders.

What causes missing pulses of rotary encoders?

Possible causes:

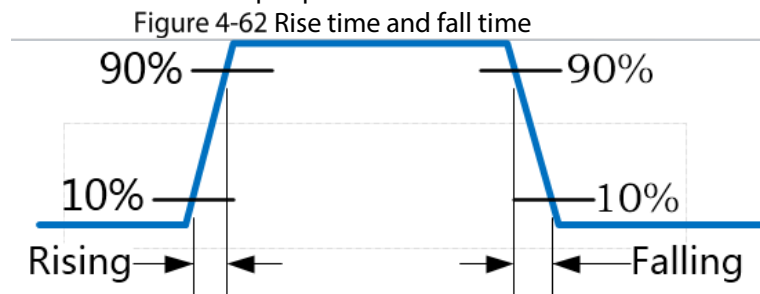
- The encoder rotated too fast, exceeded the response frequency of the encoder or subsequent device.
- The wire is extended too long and the signal is attenuated.
- There is hardware failure of encoders.
- There is jitter or interference on site, such as jitter of mechanical transmission devices and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

How do I judge 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%.



What are max. response frequency and max. allowed speed?

- The max. response frequency is the max. electrical response frequency of the encoder. The unit is Hz. If the encoder is used when max. response frequency is exceeded, its internal circuit will not be able to respond, resulting in pulse leakage of the encoder.
- The max. 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 you use 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.

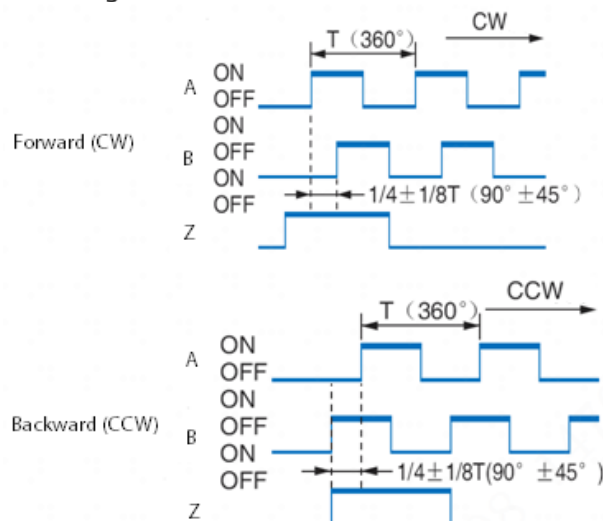
How do I avoid encoder interference?

- 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 4-63 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.

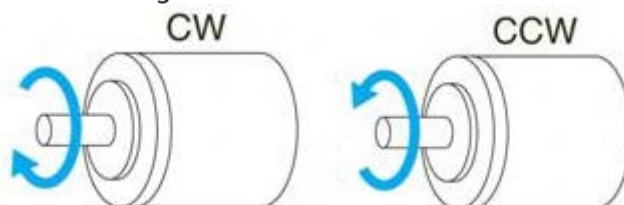
What is the output phase?

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.

Figure 4-64 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.

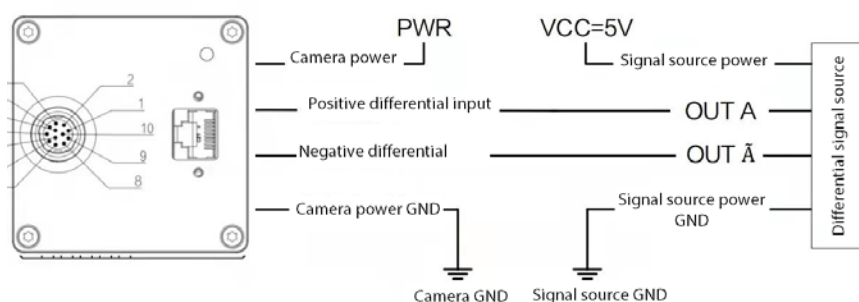
4.5 Camera IO Trigger Solution

4.5.1 Frame trigger

Typical scenario: Use a photoelectric switch to provide frame signals. This requires the object to move at a constant speed during the actual operation, and the direction does not change. Then, use the line scan camera to scan the object. Set a photoelectric switch in the passage, and the object moves at a constant speed after passing through the photoelectric switch. After the photoelectric switch senses the object, it provides the camera a frame signal to start scanning.

In actual use, you need to adjust the focal length, angle, exposure value and line frequency of the camera to make the final image meet the requirements.

Figure 4-65 Frame trigger

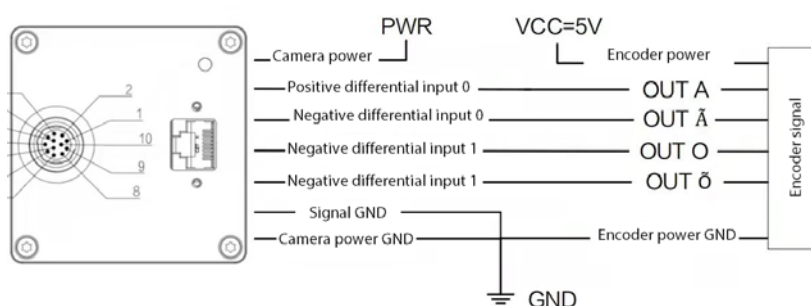


4.5.2 Line Trigger

Typical scenario: The object is transported by the roller, and its speed changes constantly due to processing or other operations. If you use a line scan camera to capture in freerun mode, it easily leads to excessive stretching or compression of the image, so it is necessary to use line trigger performed by the encoder signal to control the camera to capture images, so that the exposure and data acquisition logics of the camera conform to the motion law of the object. When there is no slippage between the belt and the roller, the frequency of the belt speed matches the frequency of the line signal given by the encoder, so that the line frequency and the movement speed of the object match. The final imaging effect meets the requirements.

When the line signal is not lost, and there are no other issues in the environment, such as roller slippage, but the image is still stretched or compressed, you can use division and multiplication to control the final imaging effect.

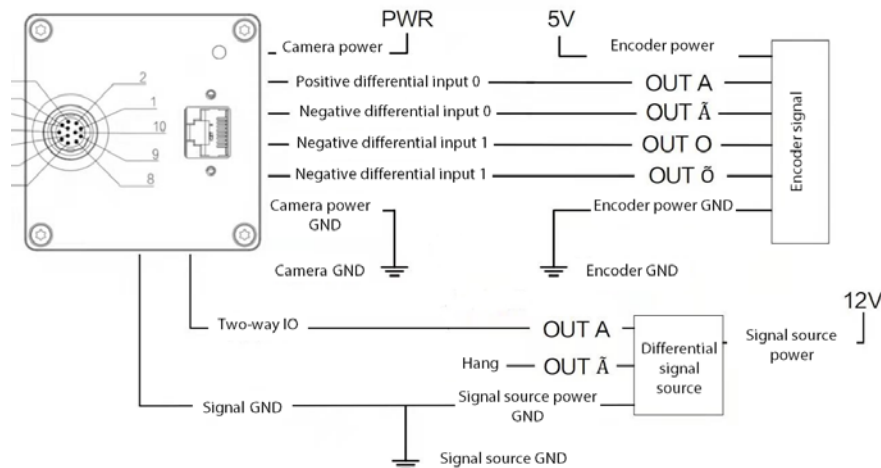
Figure 4-66 Line trigger



4.5.3 Line Trigger and Frame Trigger

When there are multiple trigger signals, you can enable frame trigger and line trigger at the same time, so that the images fit the application environment and the law of object motion.

Figure 4-67 Line trigger and frame trigger



In actual use, you can also use the IO output of the camera:

- **ExposureActive:** Outputs signal when exposure starts.
- **LightTrigger:** The light source controls the signal output.
- **FrameActive:** Frames output signals to control the light source.



Encoder signals can also control light sources.

Conclusion of the external ports of line scan cameras

Table 4-33 First-generation line scan cameras (CMOSIS 8K Ethernet port)

Pin	Description	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 -	Reserved
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 -	Reserved
12	Line6_out+	RS422 output +/-single-end output	

Table 4-34 Second-generation line scan camera (CMOSIS 4K Ethernet port)

Pin	Description	Function	Suggestion
1	Power GND	Camera power supply (signal ground)	Camera power supply ground (0 V)
2	Camera Power	Camera power	Camera power VCC
3	IN Line5+	Input Line5+	

Pin	Description	Function	Suggestion
4	IN Line5-	Input Line5-	Connects the encoder (line trigger)
5	OPT GND	Opto-isolated ground	—
6	OPT IN Line1	Optocoupler input 1	Connects the photoelectric switch (frame trigger)
7	OPT IN Line2	Opto-isolated input 2	
8	PDT Line4	Bidirectional GPIO Line4	—
9	OUT Line6+	Output Line6+	Reserved
10	OUT Line6-	Output Line6-	
11	IN Line3+	Input Line3+	Connects the encoder (line trigger)
12	IN Line3-	Input Line3-	

Table 4-35 Third-generation line scan camera (GPixel 4K/2K Ethernet port and Gpixel 8K Ethernet port)

Pin	Description	Function	Suggestion
1	Power GND	Camera power ground	Camera power supply ground (0 V)
2	Camera Power	Camera power	Camera power VCC
3	IN Line1+	Input Line1+	Connects the encoder (line trigger)
4	IN Line1-	Input Line1-	
5	Signal GND	Signal ground (SGND)	Signal ground
6	IN Line2+	Input Line2+	Connects the encoder (line trigger)
7	IN Line2-	Input Line2-	
8	IN Line4	Bidirectional GPIO Line4	—
9	IN/OUT Line3+	Input/output Line3+	
10	IN/OUT Line3-	Input/output Line3-	
11	OPT_IN Line5	Optocoupler input Line5	Connects the photoelectric switch (frame trigger)
12	OPT GND	Optocoupler isolated ground	—



- Use RS-422 input to connect to the encoder, and provide line trigger signal.
- Use optocoupler input to connect photoelectric switch or PLC output to provide frame trigger signal. If there is no optocoupler input, use GPIO input instead.

5 Function Parameters

This section takes on the functions of the industrial camera.



- 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.

5.1 DeviceControl

In DeviceControl, you can view the device information and change the device name.

Figure 5-1 DeviceControl

DeviceType	Transmitter
DeviceScanType	Linescan
DeviceVendorName	Machine Vision
DeviceModelName	L5042CG141_109
DeviceManufacturer...	Machine Vision
DeviceVersion	V1.000.00.0.R(20211119.)
DeviceFirmwareVer...	20211112,141027,00800000,2
DeviceSerialNumber	6K08B44YAK00002
DeviceUserID	LA
DeviceTLType	GigEVision
DeviceTLVersionMajor	2
DeviceTLVersionMinor	0
DeviceMaxThroughput	1,000.00000 Mbps
DeviceCharacterSet	UTF8
DeviceReset	{Command}
DeviceTemperature...	Mainboard
DeviceTemperature	19.68750 C
DeviceRegistersIs...	True
DeviceTLVersionSe...	Version_2_0
DeviceUpTime	1,066
DeviceDevelopData	

Table 5-1 Description of parameters in DeviceControl

Parameter	Description
DeviceType	The device type defined by GigE Vision.
DeviceScanType	The scanning type of the sensor, such as area scan and line scan.
DeviceVendorName	The vendor of the device.
DeviceModeName	The model of the device.
DeviceManufacturerInfo	The manufacturer of the device.

Parameter	Description
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.
DeviceTLType	The protocol type used by the device in the transmission layer. Supports GigE Vision, CameraLink, CameraLinkHD, CoaXPress, and USB3 Vision. The preceding figure indicates that the device uses the GigE protocol. The software automatically recognizes the protocol of the device and the protocol cannot be modified.
DeviceTLVersionMajor	The main version of the transmission layer protocol that is compatible with the device.
DeviceTLVersionMinor	The sub version of the transmission layer protocol that is compatible with the device.
DeviceMaxThroughput	The max. transmission speed of the device.
DeviceCharacterSet	The character set used by the index register. The default character set is UTF-8.
DeviceReset	The restart button of the device. You can also an API to restart the device.
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.
DeviceRegisterIsBigEndian	Displays the big end or small end of the device register. The big end is supported by default.
DeviceTLVersionSelector	The compatible version of the transmission layer protocol. GigE cameras support switching between V2.0 and V1.0.
DeviceUpTime	The total running time of the device. The unit is s.
DeviceDevelopData	The parameter is reserved for debugging.

5.2 ImageFormatControl

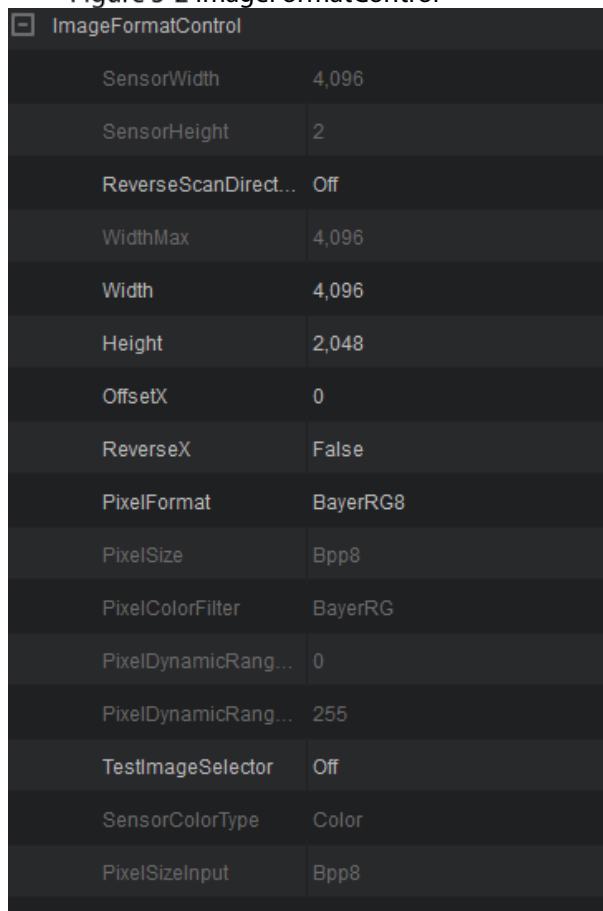
In ImageFormatControl, you can modify image properties such as image size, image pixel format, and test image mode.



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

Image format

Figure 5-2 ImageFormatControl



SensorWidth	4,096
SensorHeight	2
ReverseScanDirect...	Off
WidthMax	4,096
Width	4,096
Height	2,048
OffsetX	0
ReverseX	False
PixelFormat	BayerRG8
PixelSize	Bpp8
PixelColorFilter	BayerRG
PixelDynamicRang...	0
PixelDynamicRang...	255
TestImageSelector	Off
SensorColorType	Color
PixelSizeInput	Bpp8

Table 5-2 Description of parameters in ImageFormatControl

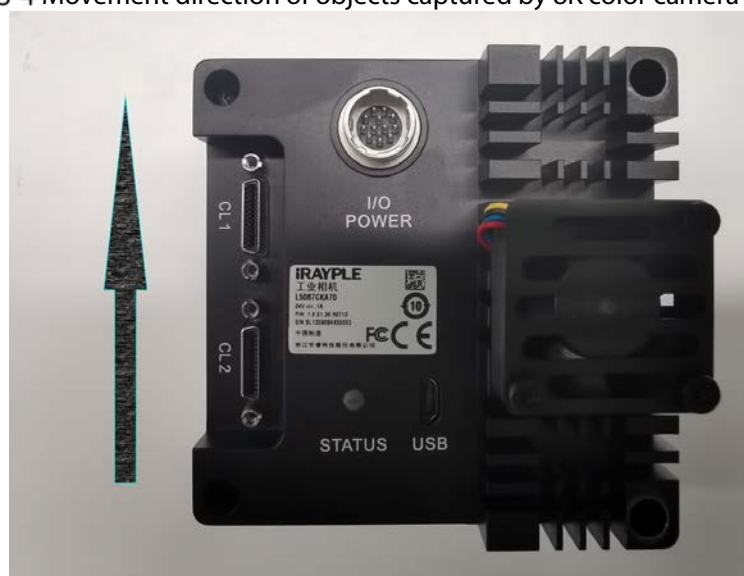
Parameter	Descriptions
SensorWidth	The original image width of the sensor, in pixels.
SensorHeight	The original image height of the sensor, in pixels.
ReverseScanDirection	If the moving direction of the object captured by the color line scan camera is not perpendicular to the direction of the camera 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.
WidthMax	The max. image width, in pixels.
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.
Height	The actual height of output images, in pixels. Each camera has max. height, you can set a height as instructed.
OffsetX	The horizontal offset of the image, starting from the upper-left corner. The max. value is determined by the value of Width .
ReverseX	The horizontal flipping of images. The flip is based on the original size of the sensor, not images after the ROI.
PixelFormat	The format of output images. The supported formats differ depending on the models.
PixelSize	The number of bits that a pixel occupies in different image formats.
PixelColorFilter	The filter model used during image processing in the current image output format.
PixelDynamicRangeMin	The min. value of pixel brightness.

Parameter	Descriptions
PixelDynamicRangeMax	The max. value of pixel brightness.
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.
SensorColorType	The color type of the sensor: Color or Mono (black and white).
PixelSizeInput	The bit depth of the images output by the sensor.

Figure 5-3 Movement direction of objects captured by 4K color camera



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



Testimage (Test Mode)

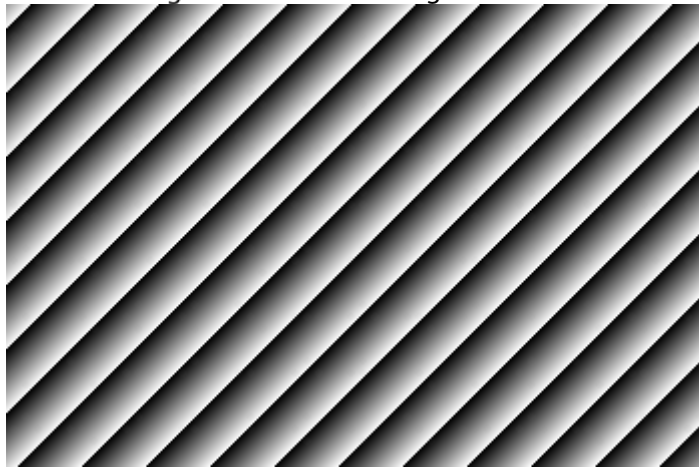
The camera supports test mode. When the camera is in test mode, the camera does not output real-time images, but images generated by the internal program. When real-time images are abnormal, you can determine the cause by checking whether images in test mode have similar issues. This function is disabled by default. In this case, images output by the camera are data collected in real time.

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

Figure 5-5 Gradient image from black to white



Figure 5-6 Rhombic image



Supported test images varies with different models.

5.3 AcquisitionControl

5.3.1 Parameters in AcquisitionControl

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

Figure 5-7 AcquisitionControl

AcquisitionMode	Continuous
AcquisitionStart	{Not Available}
AcquisitionStop	{Not Available}
FrameTimeout	{Not Available}
AcquisitionFrameC...	1
AcquisitionLineRate	10,000.00000 Hz
AcquisitionLineRat...	False
AcquisitionStatusS...	FrameTriggerWait
AcquisitionStatus	False
TriggerSelector	FrameActive
TriggerMode	Off
TriggerFrameCount	{Not Available}
TriggerSoftware	{Not Available}
TriggerSource	Line2
SyncSource	Disable
TriggerActivation	{Not Available}
TriggerDelay	0.00000
TriggerDelaySource	InternalClock
TriggerPostDelay	0.00000 us
ExposureMode	Timed
ExposureTime	80.00000 us
ExposureAuto	Off
ExposureTargetBrig...	50
ResultingLineRate...	12,091.89844 Hz

Table 5-3 Description of parameters in AcquisitionControl

Parameter	Description
AcquisitionMode	- SingleFrame: The camera captures a frame at a time and stops pulling stream after capture. - MultiFrame: The camera captures multiple frames specified by AcquisitionFrameCount and stops pulling stream after capture. - Continue: The camera keeps capturing until AcquisitionStop is called.
AcquisitionStart	The SDK starts or stops pulling stream.
AcquisitionStop	
FrameTimeout	Under the frame and line trigger, set a period, when the frame signal comes, if not enough lines are acquired within the period, the camera fills in the remaining lines as black and outputs a whole image.
AcquisitionFrameCount	The number of images captured at a time.  The parameter is available only when you set AcquisitionMode to MultiFrame.
AcquisitionFrameRate	The frame rate of images. The parameter is available when you set AcquisitionFrameRateEnable to True .
AcquisitionFrameRateEnable	
AcquisitionStatusSelector	Select a trigger state to view.

Parameter	Description
AcquisitionStatus	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	The type of the trigger. Select FrameStart or FrameActive from TriggerSelector , working with LineStart , and then select On or Off from TriggerMode to enable or disable the trigger mode. TriggerFramesCount: The upper limit of captured images.  Burst means that the camera can capture multiple images after a single signal is triggered.
TriggerMode	
TriggerFramesCount	
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, FallingEdge or AnyEdge (available on select models), 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	
TriggerActivation	
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.
TriggerDelaySource	The source of trigger delay. LightTriggerDelay is used to set the delay time from when the camera receives the trigger signal to when LightTrigger outputs the conduction of the optocoupler. The conduction time of the optocoupler is from the start of LightTrigger to the end of the exposure.  During the delay, the camera cannot receive new triggers. Otherwise, the camera needs to stop and acquire the stream again to return to normal.
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	The exposure time.
ExposureAuto	The automatic exposure, including Off , Once , and Continuous . You can set a target value of brightness, and then apply exposure once or continuously to increase it. The value ranges from 0–100.
ExposureTargetBrightness	
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.

5.3.2 LineFrequency

Line scan cameras have the following 2 working modes in terms of line frequency.

- Freerun
 - ◇ Exposure: The shorter the exposure time, the higher the horizontal scan rate.
 - ◇ Pixel format: In the same conditions, the more bytes the pixel format occupies, the lower the horizontal scan rate.
 - ◇ Bandwidth: The larger the bandwidth of the Ethernet card, the more data can be transmitted per second.
 - ◇ Lossless compression: When the camera is used with the best SDK, image data is transmitted to the computer in different image transmission modes, and the computer parses the original image data through the SDK, which further improves the line frequency.
- Line trigger
 - ◇ When the line signal frequency is less than the theoretical line frequency, the line frequency is the line signal frequency.
 - ◇ When the line signal frequency is instantaneously or continuously greater than the theoretical line frequency, the line frequency is the theoretical line frequency, and line signals might lose.



The image lossless compression functions supported by different cameras are different. In addition, contact local technical support to obtain the lossless compressed version firmware.

Theoretical line frequency: The max. line frequency calculated under the current environment of the camera and its own parameter configuration, namely **ResultingLineRateAbs**. For details, see Table 5-3.

- Enable line frequency
Set **AcquisitionLineRateEnable** to set a value as line frequency. It is the upper limit of the line frequency of the camera. When the camera is limited by the trigger signal or exposure value, the real-time line frequency might be less than the specific value.

Figure 5-8 Enable line frequency

AcquisitionLineRate	10,000.00000 Hz
AcquisitionLineRate...	False
AcquisitionStatusSe...	False
AcquisitionStatus	True
TriggerSelector	FrameStart
TriggerMode	Off
TriggerFrameCount	{Not Available}
TriggerSoftware	{Command}
TriggerSource	Software
TriggerActivation	{Not Available}
TriggerDelay	0.00000
TriggerDelaySource	InternalClock
ExposureMode	Timed
ExposureTime	80.00000 us
ResultingLineRateAbs	12,091.89844 Hz
DigitalIOControl	
LineSelector	Line1
LineMode	Input
Acquisition Line Rate Enable Enables setting the camera's acquisition line rate to a specified value Feature Name: AcquisitionLineRateEnable	

Step 1 Connect to the camera through MV, display all parameters, and then find **AcquisitionControl**.

Step 2 Adjust line frequency by setting AcquisitionLineRate. You can also view the max. and min. line frequency.

You can view the theoretical line frequency when the camera acquires stream through **ResultingLineRateAbs**.



- If the max. line frequency of the camera is lower than the defined value, the camera captures images based on the actual frequency.
- If the max. line frequency of the camera is greater than the defined value, the camera captures images based on the set value.

Figure 5-9 Capture frequency

AcquisitionControl	
AcquisitionMode	Continuous
AcquisitionStart	(Not Available)
AcquisitionStop	(Not Available)
FrameTimeout	(Not Available)
AcquisitionFrameC...	1
AcquisitionLineRate	10,000.00000 Hz
AcquisitionLineRate...	True
AcquisitionStatusSe...	FrameTriggerWait
AcquisitionStatus	False
TriggerSelector	FrameStart
TriggerMode	Off
Acquisition Line Rate Controls the acquisition rate (in Hertz) at which the lines are captured. Min: 100.00000 Max: 28000.00000 Feature Name: AcquisitionLineRate	

Figure 5-10 View stream acquiring frequency

+ / -	Q
TriggerSoftware	{Command}
TriggerSource	Software
TriggerActivation	(Not Available)
TriggerDelay	0.00000
TriggerDelaySource	InternalClock
ExposureMode	Timed
ExposureTime	80.00000 us
ResultingLineRateAbs	12,091.89844 Hz

Figure 5-11 View real-time frame rate

L5023MG51_087 [169.254,174.45]	接收: 18 Images	4.88 FPS	63.82 Mbps	显示: 5 FPS
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Step 3 View the real-time frame rate of the line scan camera in the upper-right corner of MV, and calculate the real-time line frequency by multiplying the frame rate by the line height.

5.3.3 FrameTimeout

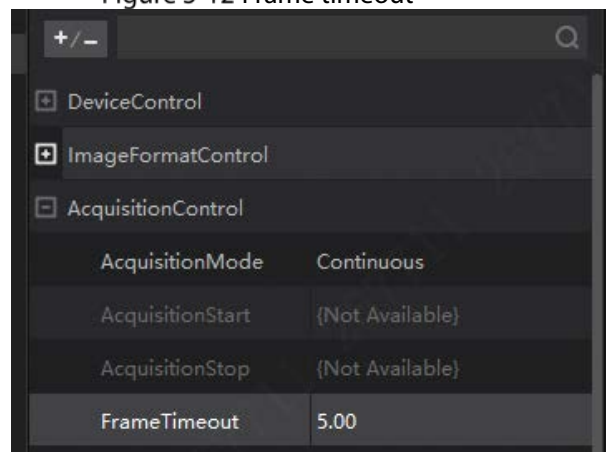
In the frame + line trigger mode, when the number of frame signals reach the set line height, but the subsequent line signals does not, the image will only be output after the line signal reaches the set line height. If a slight error occurs in the roller, the roller might have made one turn, but the image is not displayed. This affects the production rate.

In special circumstances, if the line signal does not reach the defined line height, the camera will wait for the subsequent line signal. At this time, the frame signal will be filtered out and frame loss will occur.

To avoid the above exceptions, turn on frame timeout, set the max. duration of one frame. If there are no enough line signals within this time, the camera will blacken the remaining lines and output a frame of image.

For details, see **AcquisitionControl**. Set **FrameTimeout**, and then start acquiring stream.

Figure 5-12 Frame timeout



To use the function, you must enable frame trigger and line trigger at the same time.

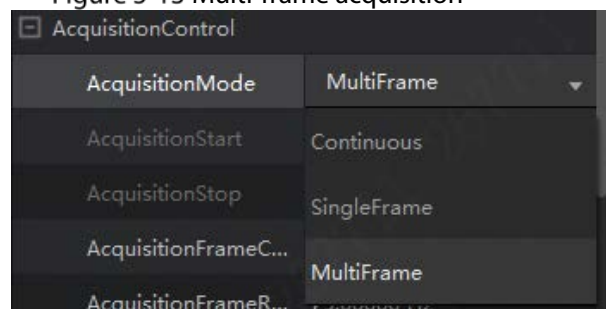
5.3.4 AcquisitionMode

3 acquisition modes are available: Continuous acquisition, single-frame acquisition, and multi-frame acquisition.

Step 1 Click **AcquisitionMode** to select a mode.

- Continuous: Continuous acquisition.
- MultiFrame: Multi-frame acquisition. The camera stops acquisition when the set number of frames are acquired.

Figure 5-13 Multi-frame acquisition



Step 2 Set **AcquisitionFrameCount**.

Figure 5-14 Number of acquisition frames

AcquisitionControl	
AcquisitionMode	MultiFrame
AcquisitionStart	{Not Available}
AcquisitionStop	{Not Available}
AcquisitionFrameC...	4

Table 5-4 Description of acquisition mode parameters

Parameter	Description
SingleFrame	The camera starts capturing and stops after one capture.
Continuous	- The camera starts and keeps capturing. - When the number of acquired lines reaches the height of the image, one image will be output, and then the camera keeps outputting images in this mode.
MultiFrame	Configure the frame rate (1–255) in AcquisitionFrameCount. - The camera starts and keeps capturing. - When the number of acquisition lines reaches the height of the image, one image will be generated, and then the images will be continuously generated in this mode, until the generated images reaches the value defined in AcquisitionFrameCount.

5.3.5 TriggerMode

Trigger modes of a line scan camera include line trigger, frame trigger and line + frame trigger. The trigger mode is determined by **TriggerSelector** and **TriggerMode** in **AcquisitionControl**.

Trigger Type

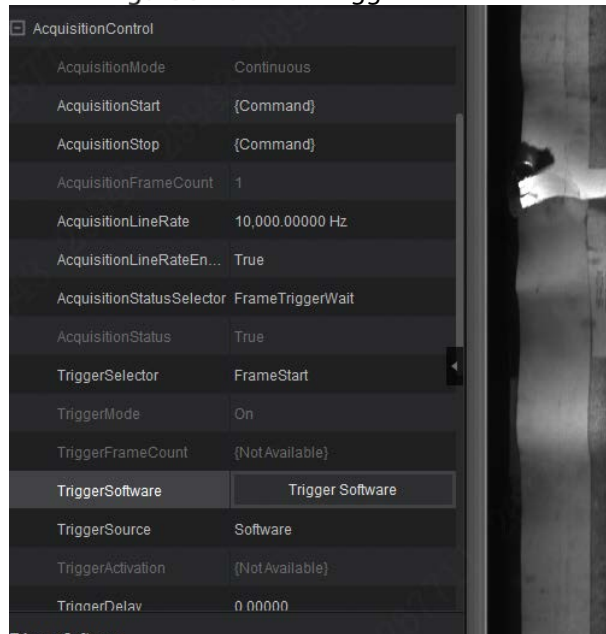
- Line trigger (LineStart): Outputs one line after receiving a trigger signal, and outputs a frame of image when the received signals meet the defined image height. The trigger condition of the trigger signal can be set as rising edge, falling edge or transition edge (includes rising edge and falling edge, only available on select models).

Figure 5-15 Line trigger

AcquisitionFrameCount	1
AcquisitionLineRate	10,000.00000 Hz
AcquisitionLineRateEn...	True
AcquisitionStatusSelector	FrameTriggerWait
AcquisitionStatus	False
TriggerSelector	LineStart
TriggerMode	On
TriggerFrameCount	{Not Available}
TriggerSoftware	{Not Available}
TriggerSource	Line2
TriggerActivation	FallingEdge
TriggerDelay	0.00000
TriggerDelaySource	InternalClock
ExposureMode	Timed
ExposureTime	80.00000 us
ResultingLineRateAbs	10,000.00000 Hz

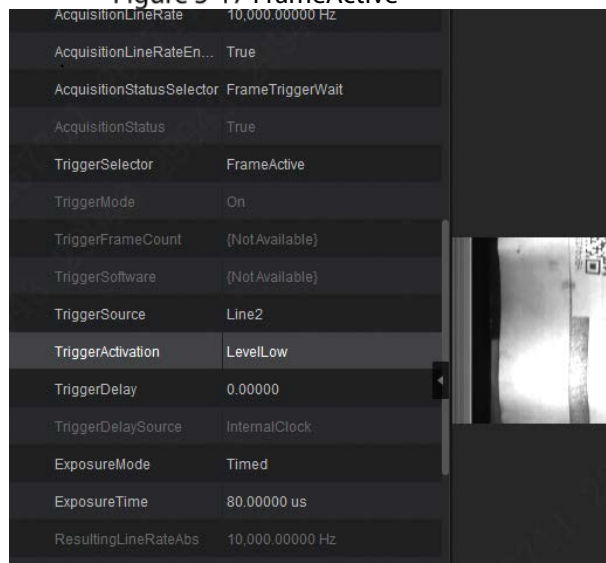
- Frame trigger (FrameStart): Outputs a frame of image after receiving a trigger signal (rising edge or falling edge).

Figure 5-16 Frame trigger



- **FrameActive:** After receiving a high level (low level) signal, multiple lines are collected within the effective range of the signal pulse width. After the number of lines collected meets the set line height, the image is output. If the signal pulse width is too short or the line trigger is enabled, a sufficient number of lines are not collected within the valid range of the signal pulse width, the image will be output according to the actual line height.

Figure 5-17 FrameActive

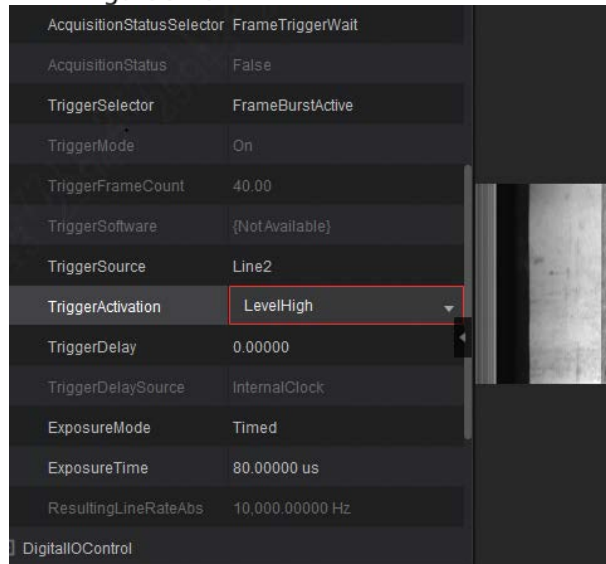


- **FrameBurstActive:** When a high level (low level) signal is received, multiple lines are collected within the effective range of the signal pulse width. Different from **FrameActive**, **FrameBurstActive** always collect images within the effective range of the signal pulse width, and can output all the collected image data according to the set line height. Details of the output logic is as follows:



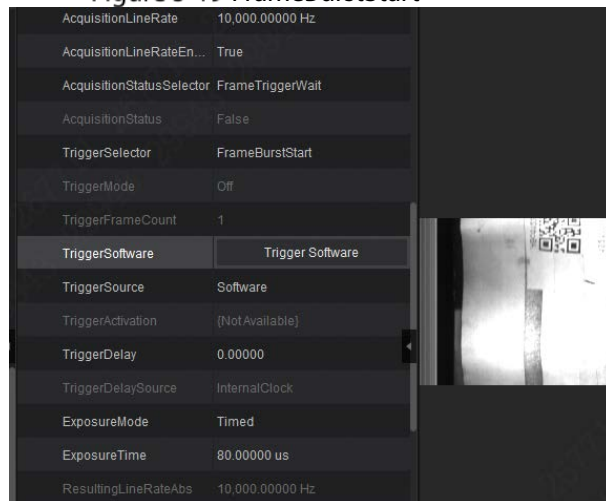
The adaptive line height is the max. number of line heights that can be continuously collected in the effective area of the high level (low level) of the signal pulse width in **FrameBurstActive** mode.

Figure 5-18 FrameBurstActive



- **FrameBurstStart:** Multi-frame mode of frame trigger mode. Outputs multiple images according to the define line height after receiving a trigger signal rising edge (falling edge) upon receiving a rising edge (falling edge). The number of images depends on the value defined in **TriggerFrameCount**.

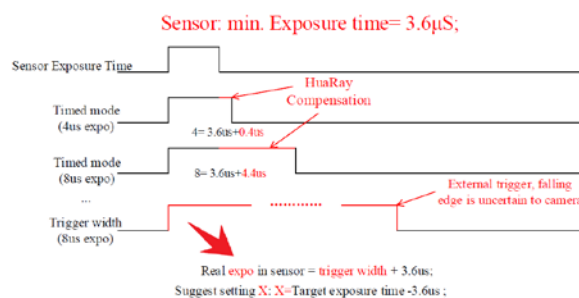
Figure 5-19 FrameBurstStart



5.3.6 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 minimum value of the camera to reach the set exposure. For example, the min. exposure value of the sensor is 3.6 μ s, and if you set the exposure to 4 μ s, the multiple calculated by the sensor is 0.4 μ s, allowing 3.6 μ s + 0.4 μ s = 4 μ s.

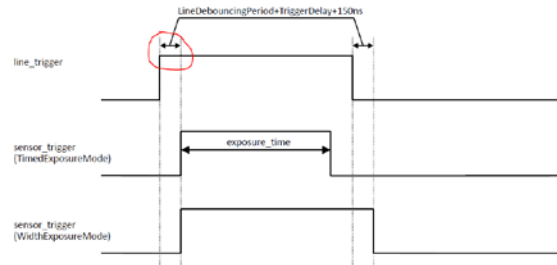
Figure 5-20 Sensor exposure logic



The relationship between the sensor and the line trigger signal is as follows:

- First signal: 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.

Figure 5-21 Sensor and trigger logics



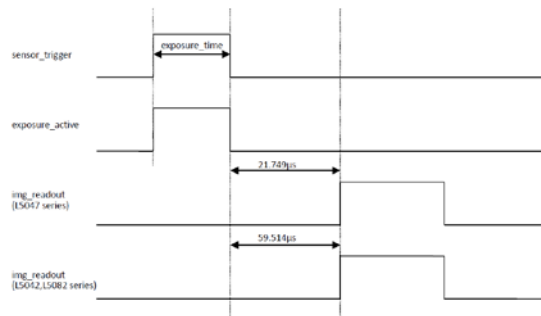
The relationship between the actual exposure and stream acquiring is as follows:

- The first signal is the actual exposure signal of the sensor.
- The second signal is the exposureactive signal output by the camera.
- The third and fourth signals are the signals of actual stream acquiring of the camera.



L5042 is the same as L5022, and L5027 is the same as L5047.

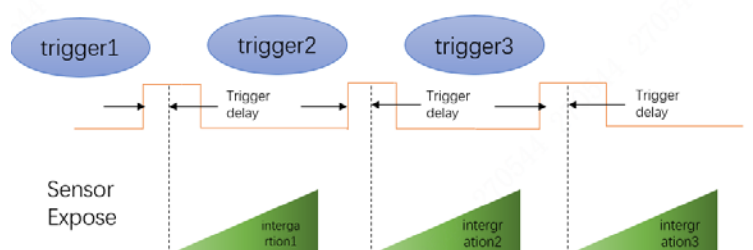
Figure 5-22 Logics of sensor and actual stream acquiring.



5.3.7 TriggerDelay

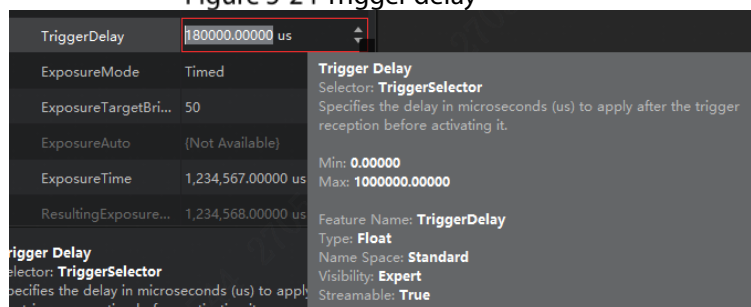
You can set a delay time between the camera receives and responds to the trigger signal to start image acquisition, and the camera will capture the image after this time.

Figure 5-23 Working principle of trigger delay



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

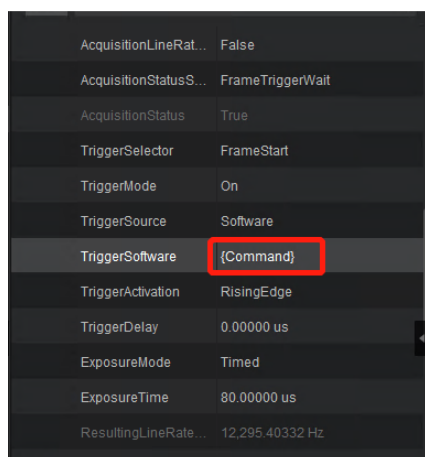
Figure 5-24 Trigger delay



5.3.8 TriggerSource

- Software trigger: Select **Trigger Software** from **AcquisitionControl** > **TriggerSoftware** to send trigger signals through the software.

Figure 5-25 Software trigger



- I/O trigger: The trigger signal enters the camera from external devices through the I/O interface. For the specific wiring of the camera I/O interface, see "4 IO Electrical Specifications". Based on the actual cable connection, set **TriggerSelector** to **FrameBurstActive**, **TriggerMode** to **On**, **TriggerSource** to **line2** and **TriggerActivation** to **LevelHigh**. After completing the configuration, wire line 2 according to the cable specifications. After that, images can be generated after receiving signals.

Figure 5-26 Frame trigger configuration of the camera

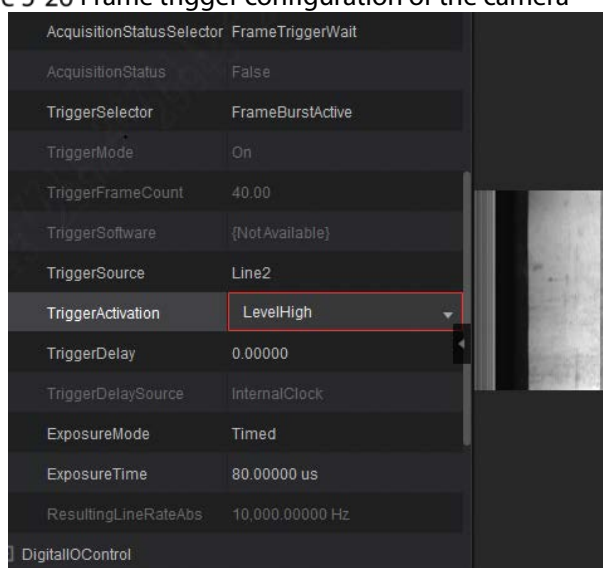
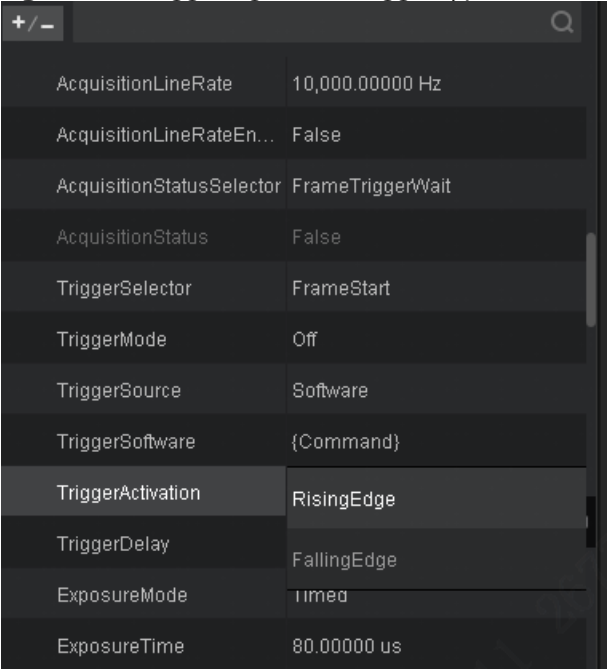


Figure 5-27 Trigger signal and trigger type



AcquisitionLineRate	10,000.00000 Hz
AcquisitionLineRateEn...	False
AcquisitionStatusSelector	FrameTriggerWait
AcquisitionStatus	False
TriggerSelector	FrameStart
TriggerMode	Off
TriggerSource	Software
TriggerSoftware	{Command}
TriggerActivation	RisingEdge
TriggerDelay	FallingEdge
ExposureMode	imed
ExposureTime	80.00000 us

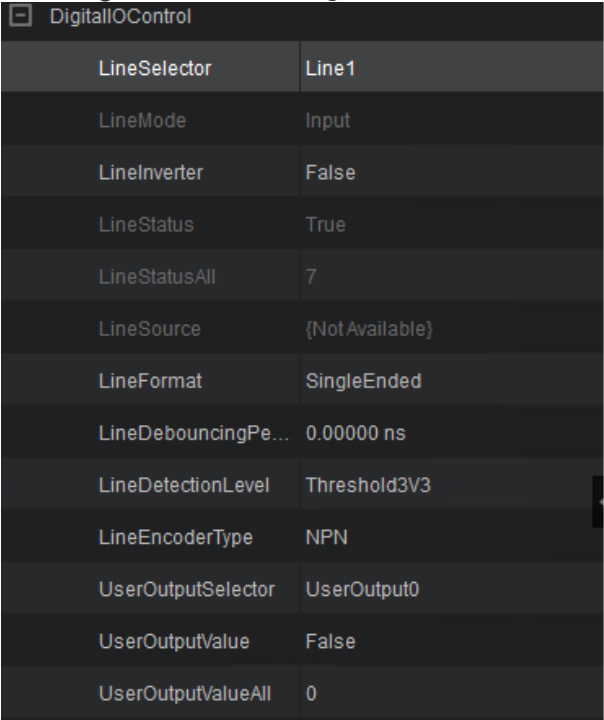
5.4 DigitalIOControl

In DigitalIOControl, you can manage different I/O input or output signals. The output signal triggered by the camera can be used to control external devices such as alarm light, light source and PLC. The trigger output signal can be realized in two ways: Level inversion and Output 2.

IOControl settings

Configure parameters in **DigitalIOControl**.

Figure 5-28 I/O management



DigitalIOControl	
LineSelector	Line1
LineMode	Input
LineInverter	False
LineStatus	True
LineStatusAll	7
LineSource	{Not Available}
LineFormat	SingleEnded
LineDebouncingPe...	0.00000 ns
LineDetectionLevel	Threshold3V3
LineEncoderType	NPN
UserOutputSelector	UserOutput0
UserOutputValue	False
UserOutputValueAll	0

Table 5-5 Description of parameters in DigitalIOControl

Parameter	Descriptions
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. ● FrameActive: Signals of starting frame output.  1 means the opto-coupler is connected, and 0 means disconnected.
LineFormat	The trigger type of the selected IO cable. For differences between differential and single-end cable connection, see IO electrical specifications.
LineDebouncingPeriod	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.
LineEncoderType	The signal type, including Pnp , Npn , and NoPull .
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.

Singal Debouncing

LineDebouncingPeriod: 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. This significantly shields the environment from signal clutters.

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

Figure 5-29 Configure filter value

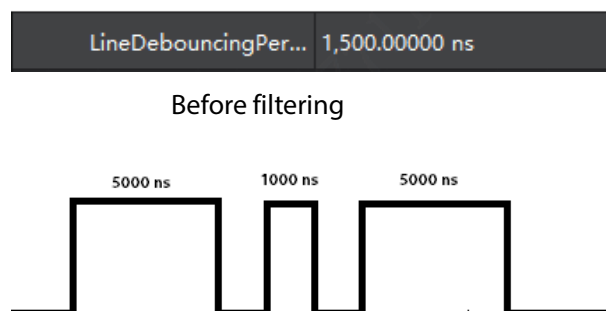


Figure 5-30 After filtering



When the value of **LineDebouncerPeriod** is greater than the value of the level signal, as shown in the example above, if the filtering level is greater than 5000 ns, the camera will not generate streams. Therefore, when setting **LineDebouncerPeriod**, make sure that its value is smaller than the high or low level.

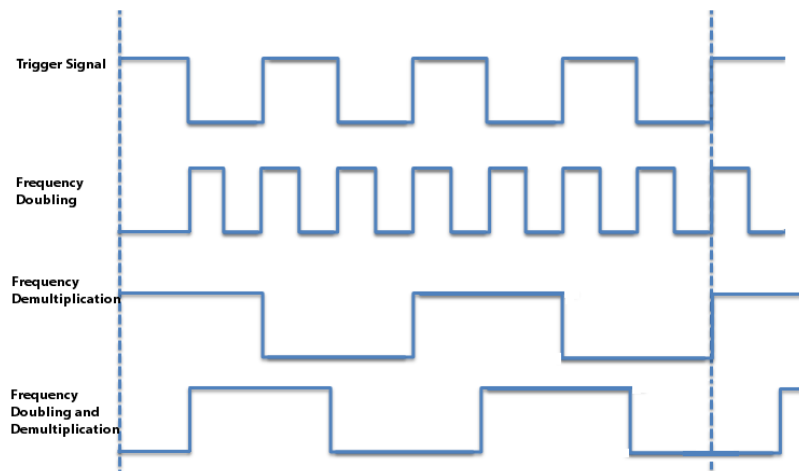
5.5 FrequencyConverterControl

Speed up or slow down the specific signals. When external signals trigger the camera to start working, the image quality might be poor, for example, severely stretched or compressed. The frequency division and multiplication function can be used to adjust signal frequency to increase or decrease line scan rate.



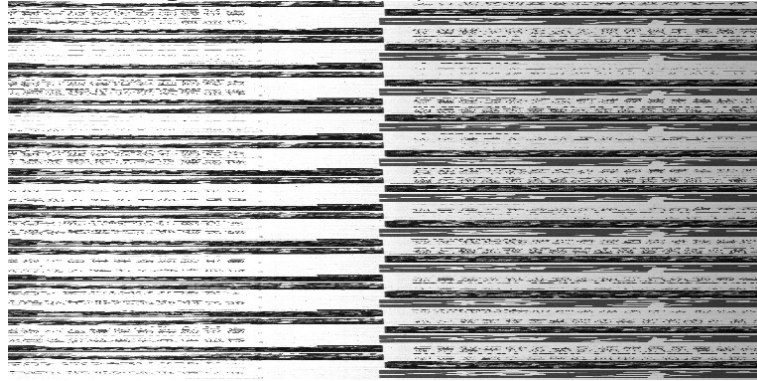
- The frequency converter is only available when line trigger is enabled.
- Frequency division and multiplication is to adjust the aspect ratio, so when adjusting this function, it is necessary to confirm that the image is not stretched and compressed due to external signal interference.

Figure 5-31 Frequency converter



For example, 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 5-32 Image compression



- Step 1** Select frequency controller from **FrequencyConverterSelector**.
- Step 2** Set the signal source in **InputSource**.
- Step 3** Select **Divider** or **Multiplier** to set the divider or multiplier index.
Set **Multiplier** to 13, so that the line frequency is increased to $2048 \times 13 = 26624$. You can use divider for adjustment when the image is stretched. Set **Multiplier** and **Divider** to 3 and 2 respectively to get the 1.5 multiplication effect.

Figure 5-33 Frequency division and multiplication adjustment

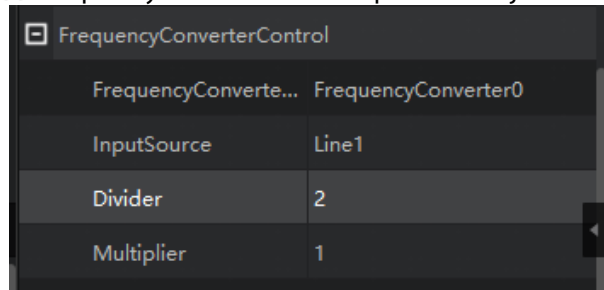


Figure 5-34 Adjustment results



Table 5-6 Description of parameters in FrequencyConverterControl

Parameter	Description
FrequencyConverterSelector	The frequency converter.
InputSource	The input signal source for the frequency converter to process.
Divider	The divider index.
Multiplier	The multiplier index.

5.6 RotaryEncoderControl

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** Click **RotaryEncoderSelector** to select an encoder.
- Step 2** Click **RotaryEncoderLineSelector** to select the encoder phase.
- Step 3** Select line of rotary encoder. You can select from PhaseA and PhaseB, which influences the forward and reverse direction of the movement platform.
- Step 4** Click **RotaryEncoderMode** to set the direction of the encoder.

The trigger mode of rotary encoding is divided into 2 modes: **ForwardOnly** and **AnyDirection**. When the platform translation trigger signal reaches the set line height, a frame will be triggered.

- **ForwardOnly:** Images are output when the encoder rotates in a forward direction. During rotation in a reverse direction, **RotaryEncoderReverseCounter** will record the number of reversed signals. 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.



The value of **RotaryEncoderReverseCounterMax** must be greater than the max. reverse signals. Otherwise, debouncing will fail.

- **AnyDirection:** Images will be generated when the encoder rotates in any direction.

Figure 5-35 Encoder trigger mode

RotaryEncoderControl	
RotaryEncoderSele...	RotaryEncoder0
RotaryEncoderLine...	PhaseA
RotaryEncoderLine...	Line1
RotaryEncoderMode	ForwardOnly
RotaryEncoderCou...	FollowDirection
RotaryEncoderCou...	0
RotaryEncoderCou...	1,000
RotaryEncoderCou...	{Command}
RotaryEncoderRev...	0
RotaryEncoderRev...	1,000
RotaryEncoderRev...	{Command}

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 application environment, set **RotaryEncoderMode** to **ForwardOnly** to eliminate the image impact caused by jitter.

Table 5-7 Description of encoder parameters

Parameter	Descriptions
RotaryEncoderSelector	The rotary encoder.
RotaryEncoderLineSelector	The encoder phase.
RotaryEncoderLineSource	The signal source of the rotary encoder phase.
RotaryEncoderMode	The frame output mode of the encoder.
RotaryEncoderCounterMode	The counting mode of the encoder.
RotaryEncoderCounter	The current value of the rotary encoder.
RotaryEncoderCounterMax	Specifies that counting restarts when the counter cleared.

Parameter	Descriptions
RotaryEncoderCounterReset	Clear the counter.
RotaryEncoderReverseCounter	The number recorded by the reverse counter.
RotaryEncoderReverseCounterMax	Specifies that counting restarts when the reverse counter cleared.
RotaryEncoderReverseCounterReset	Clear the reverse counter.

5.7 EventControl

In EventControl, you can enable event notification and select the type of events that trigger notifications.

Figure 5-36 EventControl

EventControl	
EventSelector	FrameTrigger
EventNotification	Off

Table 5-8 Description of parameters in EventControl

Parameter	Description
EventSelector	The type of events that can trigger notifications. ● FrameTrigger: Sends frame trigger signals to the sensor. ● FrameStart: Receives frame trigger. ● AcquisitionStart: Starts image acquisition. ● ReadOut: The current frame ends trigger.
EventNotification	Specifies whether to notify upper-level software after the preceding event types are selected. ON: yes. OFF: no.

5.8 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 5-37 AnalogControl

AnalogControl	
GainSelector	All
GainRaw	1.00000
BlackLevelSelector	All
BlackLevel	0
BalanceRatioSelector	Red
BalanceRatio	1.00000
BalanceWhiteAuto	Off
Gamma	0.80000

Table 5-9 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. 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. - Off: Set BlackLevel to the black level calculated by the algorithm. - Once: The algorithm sets BlackLevel for once according to the return value of the sensor, and then BlackLevelAuto changes to Off. - Continues: The algorithm continuously sets BlackLevel according to 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.
BlackLevel	
BlackLevelAuto	
BalanceRatioSelector	Select the Red, Green or Blue channel to set the white balance.
BalanceRatio	Adjust the image color by setting R, G and B to make the image more vivid.
BalanceWhiteAuto	- If BalanceWhiteAuto is set to Off, and you can set the value of Red, Green and Blue channels. - If BalanceWhiteAuto is set to Once, the camera performs auto white balance for a period and then stops it 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.
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. 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.

5.8.2 BlackLevel

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 5-38 Black level settings

BlackLevelAuto	Off
BlackLevelSelector	All
BlackLevel	50

5.8.3 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.
- Digital gain can amplify the electrical signal of the image after FPGA conversion. The higher the parameter value, the stronger the gain, the higher the brightness, and the more the noise.

Analog Gain

Gain parameter settings include **Off**, **Once** and **Continuous**. Gain value ranges from 1–32. A large value is not recommended. During FPN, when the analog gain value is the actual analog gain level of the 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 L5082MG170, 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 level to 7 after FPN correction.

Table 5-10 Analog gain levels of the camera

Camera model	Analog gain number	Analog gain level
L5022CG141	1	
L5022MG141		
L5027CG140	5	1 1.4 1.6 2.4 3.2
L5027MG140		
L5042CG141	2	1 4
L5042MG141	1	
L5047CG140	5	1 1.4 1.6 2.4 3.2
L5047MG140		
L5082MG170	2	1 3.5

Figure 5-39 GainAuto

GainSelector	All
GainAuto	Off
GainRaw	Off
	Once
	Continuous

Table 5-11 Description of GainAuto

Analog gain mode	Parameter	Description
Manual	Off	Adjust the analog gain according to the value set in GainRaw . Most cameras only support setting a specific target value.
Automatic once	Once	Automatically run analog gain for a period of time according to the scenario. When reaching the set target, the camera stops running analog gain.

Analog gain mode	Parameter	Description
Continuous	Continuous	Automatically and continuously adjust the analog gain according to the scenario.



Only select models support **GainAuto**. For details, refer to the corresponding product specifications.

Digital Gain

Set **DigitalShift** under **ISPControl** (ranges from 0–4). The higher the value, the stronger the gain, the higher the brightness, and the more the noise.

Figure 5-40 DigitalShift



5.8.4 WhiteBalance

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.

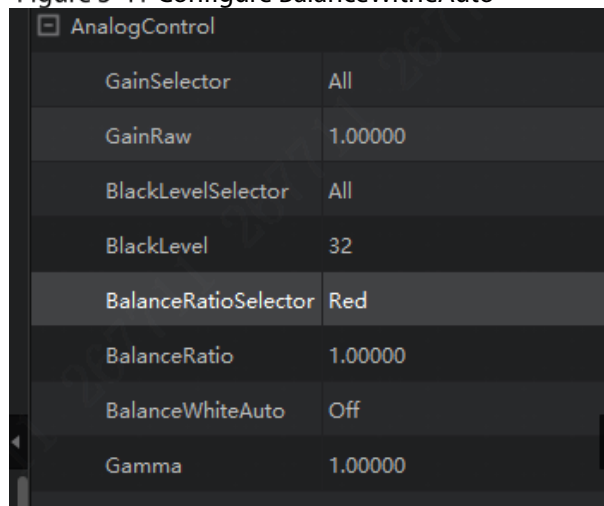
Table 5-12 Configure white balance.

WB Mode	Working Mode
Manual	You can manually set the value of Red, Green and Blue channels under 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.

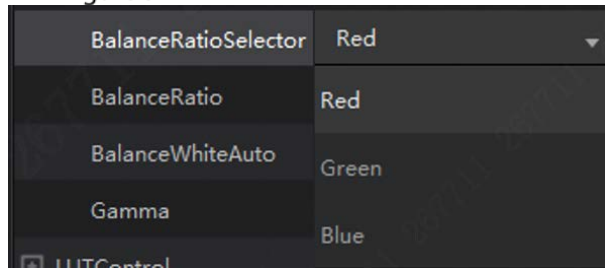
Step 1 Set **BalanceWhiteAuto** to **Off**.

Figure 5-41 Configure BalanceWhiteAuto



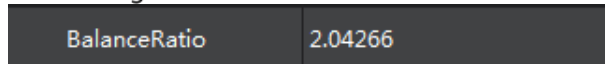
Step 2 Select R/G/B channels to be adjusted under **BlackRatioSelector**.

Figure 5-42 BalanceRatioSelector



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

Figure 5-43 BalanceRatio

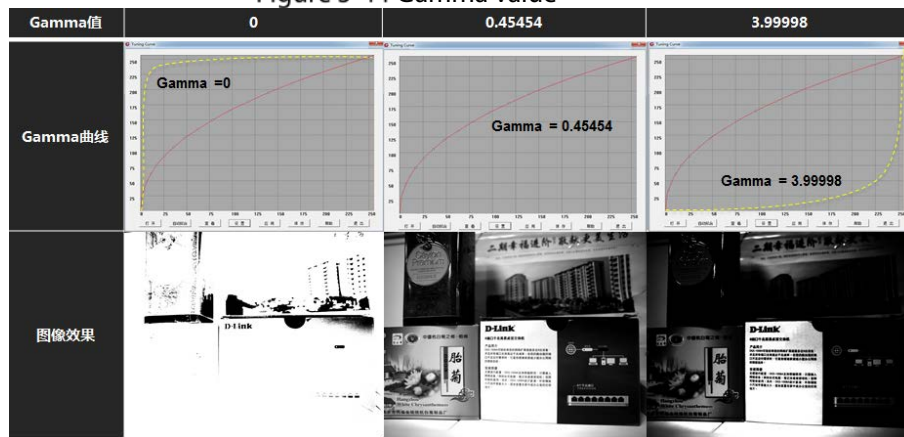


- Save the parameters after correction to avoid repeated configuration in case of unexpected occasions.
- When the light source and the color temperature of the camera location change, you need to calibrate the white balance again.

5.8.5 Gamma

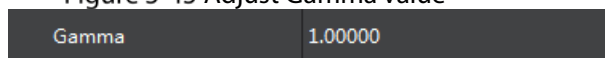
Gamma is a non-linear correction of the image data due to non-linear response of the display. The larger the Gamma value, the darker the image. Gamma coefficient ranges from 0 to 3.99998.

Figure 5-44 Gamma value



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

Figure 5-45 Adjust Gamma value



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

5.9 LUTControl

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



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

Figure 5-46 LUTControl

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

Table 5-13 Description of parameters in LUTControl

Parameter	Descriptions
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.

5.10 TransportLayerControl

Figure 5-47 TransportLayerControl (1)

TransportLayerControl	
PayloadSize	8,388,608
GevActiveLinkCount	1
GevInterfaceSelector	0
GevLinkSpeed	1,000
GevMACAddress	
GevSupportedOptionSelector	SingleLink
GevSupportedOption	True
GevCurrentIPConfigurationLLA	True
GevCurrentIPConfigurationDHCP	False
GevCurrentIPConfigurationPersistentIP	False
GevCurrentIPAddress	
GevCurrentSubnetMask	
GevCurrentDefaultGateway	0.0.0.0
GevIPConfigurationStatus	LLA
GevFirstURL	Lo
GevSecondURL	
GevNumberOfInterfaces	1
GevPersistentIPAddress	0.0.0.0
GevPersistentSubnetMask	0.0.0.0
GevPersistentDefaultGateway	0.0.0.0
GevMessageChannelCount	1
GevStreamChannelCount	1
GevHeartbeatTimeout	3,000
GevTimestampTickFrequency	125,000,000
GevTimestampControlLatch	{Command}
GevTimestampControlReset	{Command}
GevTimestampValue	0

Figure 5-48 TransportLayerControl (2)

GevGVCPExtendedStatusCodesSelector	Version1_1
GevGVCPExtendedStatusCodes	False
GevGVCPPendingAck	False
GevGVCPHeartbeatDisable	False
GevGVCPPendingTimeout	200
GevGVSPExtendedIDMode	Off
GevCCP	ControlAccess
GevPrimaryApplicationSocket	63,849
GevPrimaryApplicationIPAddress	
GevMCPHostPort	63,848
GevMCDA	
GevMCTT	300
GevMCRC	3
GevMCSP	1,024
GevStreamChannelSelector	0
GevSCPIInterfaceIndex	0
GevSCPHostPort	63,857
GevSCPSFireTestPacket	False
GevSCPSDoNotFragment	True
GevSCSPPacketSize	6,380
GevSCPD	0
GevSCDA	
GevSCSP	20,202
FrameTriggerCount	0
FrameTriggerLostCount	0
LineTriggerCount	1
LineTriggerLostCount	0
StatTriggerCountReset	(Command)

Table 5-14 Description of parameters in TransportLayerControl

Parameter	Description
PayloadSize	The length of each message.
GevActiveLinkCount	The number of logical channels currently connected.
GevInterfaceSelector	The number of Ethernet ports. It is 0 by default.
GevLinkSpeed	The negotiated rate of the current Ethernet port.
GevMACAddress	Device MAC address.
GevCurrentIPconfigurationLLA	Enable LLA function. When setting GevCurrentIPconfigurationLLA to True , you can set the IP address in LLA mode after the device is powered on.
GevCurrentIPconfigurationDHCP	Enable DHCP function. When setting GevCurrentIPconfigurationDHCP to True , you can set the IP address in DHCP mode. In this case, the IP address can be automatically obtained.
GevCurrentIPconfigurationPersistentIP	Static IP function. When setting GevCurrentIPconfigurationPersistentIP to True , you can set the IP address in static mode after the device is powered on.  Priority level of 3 IP configurations is static IP > DHCP > LLA.
GevCurrentIPAddress	The IP address of the device.

Parameter	Description
GevCurrentSubnetMask	Subnet mask of the current device.
GevCurrentDefaultGateway	Gateway of the current device.
GevIPConfigurationStatus	Displays the assigning method of the current IP address, including LLA, DHCP and static IP.
GevFirstURL	Acquires the first URL address of GenICam XML.
GevSecondURL	Acquires the second URL address of GenICam XML.
GevNumberOfInterface	Displays the number of logic channels that the device supports.
GevPersistentIPAddress	Static IP address of the device.
GevPersistentSubnetMask	Subnet mask of device static IP.
GevPersistentDefaultGateway	Gateway of device static IP.
GevMessageChannelCount	Displays the number of message channels that the device supports.
GevStreamChannelCount	Displays the number of streaming channels that the device supports.
GevHeartbeatTimeout	Heartbeat timeout period.
GevTimestampTickFrequency	Frequency of timestamp.
GevTimestampControlLatch	Latch the current timestamp into GevTimestampValue .
GevTimestampControlReset	Used to reset the internal timestamp.
GevTimestampValue	Used to store the latched timestamp.
GevGVCPExtendStatusCodesSelector	The version of GigE Vision for extended status code output.
GevGVCPExtendStatusCodes	Outputs extended status code or not.
GevGVCPPendingAck	Reports to Pending_ACK or not when command timed out.
GevGVCPHeartbeatDisable	Disable heartbeat detection of GVCP.
GevGVCPPendingTimeout	Timeout period of GVCP command execution.
GevGVSPExtendedIDMode	Enable GVSP extended ID code.
GevCCP	Controls the permissions of applications to access the camera. ● ExclusiveAccess: The application that connected to the camera can modify the register. ● ControlAccess: The application that connected to the camera can read the register, but cannot modify it.
GevPrimaryApplicationSocket	Displays the UDP source port of the application that connected to the camera.
GevPrimaryApplicationIPAddress	Displays the IP address of the application that connected to the camera.
GevMCPHostPort	The destination port of the camera message channel.
GevMCDA	The destination address of the camera message channel.
GevMCTT	Timeout period of message channel.
GevMCRC	The max. number of message channel retransmissions.
GevMCSP	Displays the source port of message channel.
GevStreamChannelSelector	Select the streaming channel number if the camera supports multiple streaming channels.
GevSCPInterfaceIndex	Displays the logic channel of device.
GevSCPHostPort	The port number used by the streaming channel of the camera.
GevSCPSFireTestPacket	Sends a test message.
GevSCPSDoNotFragment	If the message is too long, whether to send the message in fragments and add fragmentation position 1 in the IP header.
GevSCSPPacketSize	The message length of the streaming channel.
GevSCPD	The interval between messages.  Changing the value can reduce the pressure on the NIC, but the max. bandwidth will be affected and the time to get a single frame will be prolonged.
GevSCDA	The destination address of the streaming channel.

Parameter	Description
GevSCSP	The destination port of the streaming channel.

5.11 UserSetControl

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

Figure 5-49 UserSetControl

UserSetControl	
UserSetSelector	UserSet1
UserSetLoad	{Command}
UserSetSave	{Command}
UserSetDefault	UserSet1
UserSetLoadLastUserSet	UserSet1
UserSetLoadStatus	Success

Table 5-15 Description of parameters in UserSetControl

Parameter	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.

5.12 ChunkDataControl

In ChunkDataControl, you can change image color.



Only color cameras support **ChunkDataControl**.

Figure 5-50 ChunkDataControl

ChunkDataControl	
ChunkModeActive	(Not Available)
ChunkSelector	(Not Available)
ChunkEnable	(Not Available)
ChunkCounter0Value	(Not Available)
ChunkCounter1Value	(Not Available)

Table 5-16 Description of parameters in ChunkDataControl

Parameter	Description
ChunkModeActive	Activates the chunk data in images.
ChunkSelector	Select the chunk data function.
ChunkEnable	Specifies whether to enable chunk data.
ChunkCounter0Value	Returns the value of PLC controller 0.
ChunkCounter1Value	Returns the value of PLC controller 1.

5.13 ColorTransformationControl

In ColorTransformationControl, you can change image color.



Only color cameras support **ColorTransformationControl**.

Figure 5-51 ColorTransformationControl

ColorTransformationControl	
ColorTransformationSelector	RGBtoRGB
ColorTransformationEnable	True
ColorTransformationValueSelector	Gain00
ColorTransformationValue	1.53120

Table 5-17 Description of parameters in ColorTransformationControl

Parameter	Description
ColorTransformationSelector	Select a color transformation module to configure. RGBtoRGB and RGBtoYUV are supported.
ColorTransformationEnable	Specifies whether to enable the color transformation module. You can set RGBtoRGB and RGBtoYUV separately.
ColorTransformationValueSelect or	The type of the enhancement factor.
ColorTransformationValue	The value of the enhancement factor.

5.14 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 **TriggerSource**.

Figure 5-52 CounterAndTimerControl

CounterAndTimerControl	
CounterSelector	Counter0
CounterResetSource	Off
CounterEventSource	ChunkFrameTrigger
CounterReset	{Not Available}
CounterValue	{Not Available}
TimerSelector	Timer0
TimerTriggerSource	ExposureStart
TimerTriggerActivation	RisingEdge
TimerDelay	1,024
TimerDuration	4,096

Table 5-18 Description of parameters in CounterAndTimerControl

Parameter	Description
CounterSelector	- 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.

5.15 ISPControl

In ISPControl, you can adjust the sharpness, brightness, saturation and contrast of images.



Hue and saturation are only available for color cameras.

Figure 5-53 ISPControl

Hue	50
Saturation	50
DigitalShift	0
FPNCalibrationStatus	True
FPNRoiCount	1
FPNRoiSetSelector	First
FPNRoiStart	0
FPNRoiWidth	4,096
FPNEnable	On
FPNBlackCalibration	[Not Available]
FPNBrightCalibration	[Not Available]
FPNCalibrationModel	Maximum
FPNTargetValue	[Not Available]

Table 5-19 Description of parameters in ISPControl

Parameter	Description
Hue	Adjusts the chrominance component in HSV color space, the default value is 50.
Saturation	Adjusts the saturation component in HSV color space, the default value is 50. The higher the value, the higher the saturation and the more flamboyant the color.
DigitalShift	Increase the value of DigitalShift by one, and the image brightness is doubled.
FPNCalibrationStatus	The status of the FPN calibration. True means the image has been corrected, false means not.
FPNRoiCount	The number of effective FPN areas.
FPNRoiSetSelector	Switch effective FPN areas.
FPNRoiStart	The start point of effective FPN areas.
FPNRoiWidth	The end point of effective FPN areas.
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 5.8.2 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.)
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.

5.16 FPNCalibration

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

Step 1 Enable **FPNEnable**.

Step 2 (Optional) Cover the camera with the lens cap, and then click **FPNBlackCalibration**.



Generally, leave **FPNBlackCalibration** as default.

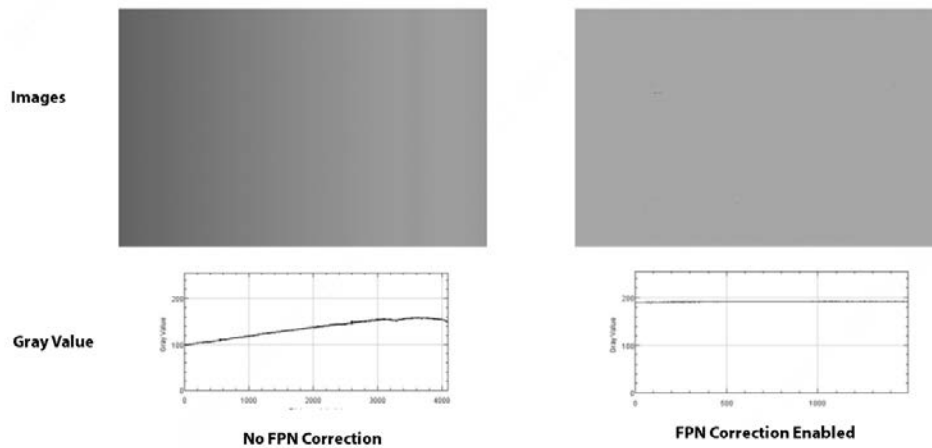
Step 3 Remove the lens cap, place an even plate to cover your field of view (use a piece of white paper instead if plate is unavailable), and adjust the exposure so that the gray value of the image is between 160 and 200. If the vertical lines of the image under **FPNBrightCalibration**

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 5-54 Correction effect



5.17 LineShadingCorrection

Figure 5-55 LineShadingCorrection

☒ LineShadingCorrection	
LSCEnable	On
LSCDataSelector	Data1
LSCCalibration	{Command}
LSCCalibrationModel	Maximum

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.

6 FAQs

6.1 No Cameras Detected

Reason:

- The camera is not started as expected.
- Abnormal network cable connection.
- The camera and the client are not on the same network segment.

Solution: Restart the camera. Check whether the network connection is correct and indicator status is normal. Make sure that the camera and the client are on the same network segment.

6.2 Cameras Detected but Failed to Connect

Reason:

- The camera is not started as expected.
- The camera and the client are not on the same network segment.
- The camera is connected to other clients.

Solution: Restart the camera, try modifying IP to make it in the same LAN with the client. You can also try disconnect other connected clients and connect the current client again.

6.3 Black Live View

Reason:

- The lens aperture is closed.
- The camera is working abnormally.

Solution: Open the aperture or restart the camera.

6.4 Unavailable External Trigger

Reason:

- Incorrect cable connection of external trigger.
- The trigger mode is not set to external trigger.

Solution: Select a right trigger mode and make sure that the external cable connection is correct.

6.5 Images Are Upside Down

Reason: The installation direction of the camera is wrong.

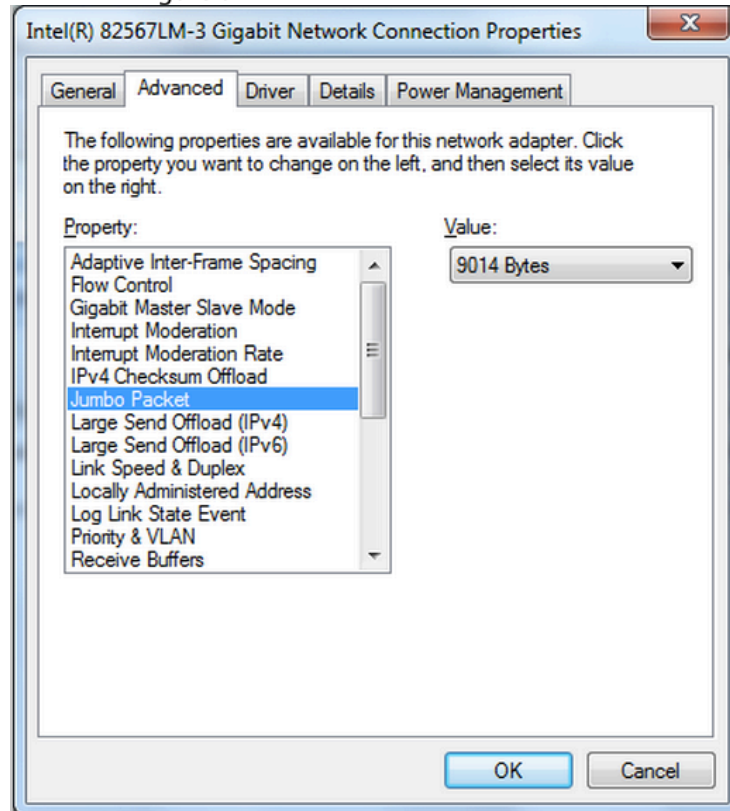
Solution: Go to **Settings > ImageFormatControl > ReverseX** in the client to correct images.

6.6 Issues Related to Image Acquiring

6.6.1 FailedStream Acquiring

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

Figure 6-1 Network connection

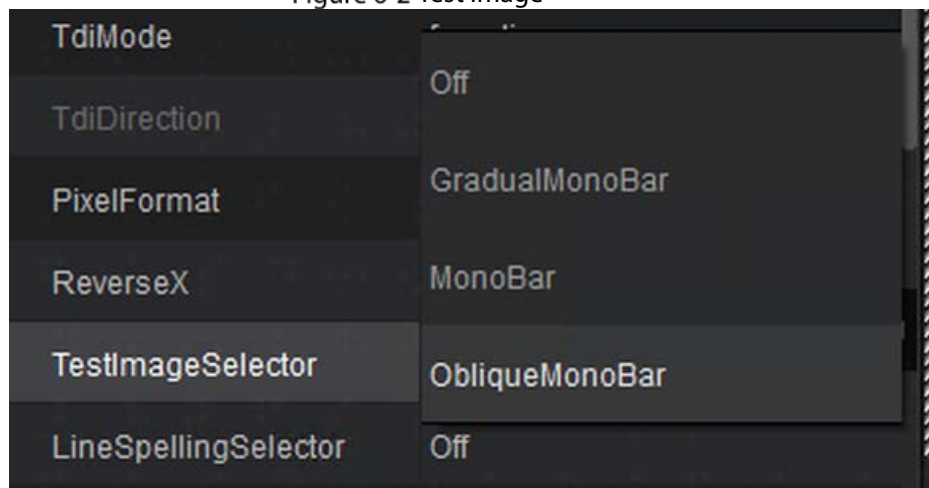


6.6.2 Test Image

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 6-2 Test image



6.6.3 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

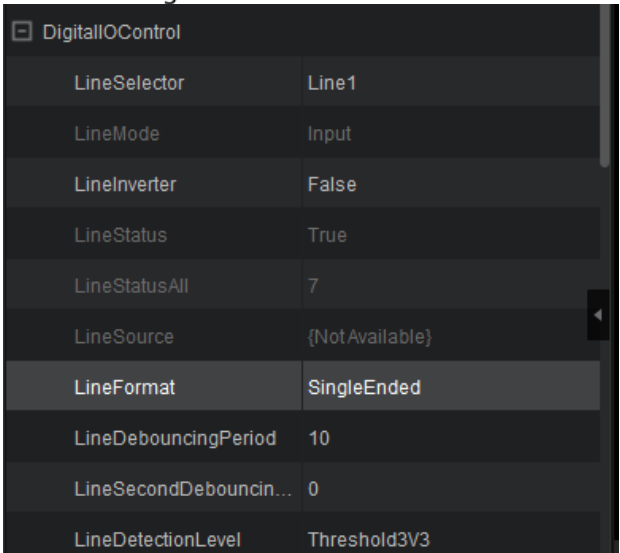
Line frequency: $K=V/(S/X)$

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

6.7 Invalid Trigger

- IO issues**
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.

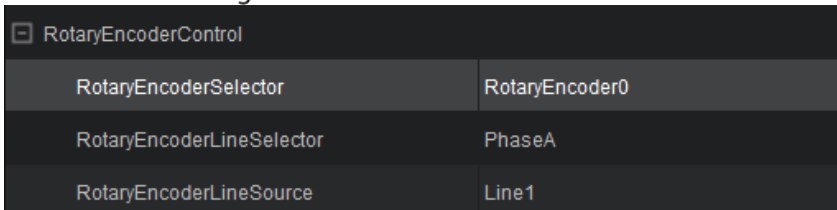
Figure 6-3 IO issues



LineSelector	Line1
LineMode	Input
LineInverter	False
LineStatus	True
LineStatusAll	7
LineSource	{Not Available}
LineFormat	SingleEnded
LineDebouncingPeriod	10
LineSecondDebouncin...	0
LineDetectionLevel	Threshold3V3

- Encoder issues**
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:
 - Perform frame trigger for 2 lines of the encoder to check whether there is signal output.
 - Check whether the cable connection of the encoder is A+ A- B+ B-, and select lines based on Phase and PhaseB.

Figure 6-4 Encoder issues



RotaryEncoderSelector	RotaryEncoder0
RotaryEncoderLineSelector	PhaseA
RotaryEncoderLineSource	Line1

- 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 6-5 Check the encoder

RotaryEncoderControl	
RotaryEncoderSelector	RotaryEncoder0
RotaryEncoderLineSelector	PhaseA
RotaryEncoderLineSource	Line1
RotaryEncoderMode	ForwardOnly
RotaryEncoderCounterMode	FollowDirection
RotaryEncoderCounter	0
RotaryEncoderCounterMax	1,000
RotaryEncoderCounterReset	{Command}
RotaryEncoderReverseCounter	0
RotaryEncoderReverseCounterMax	1,000
RotaryEncoderReverseCounterReset	{Command}

6.8 Issue Related to Camera Upgrade and Version

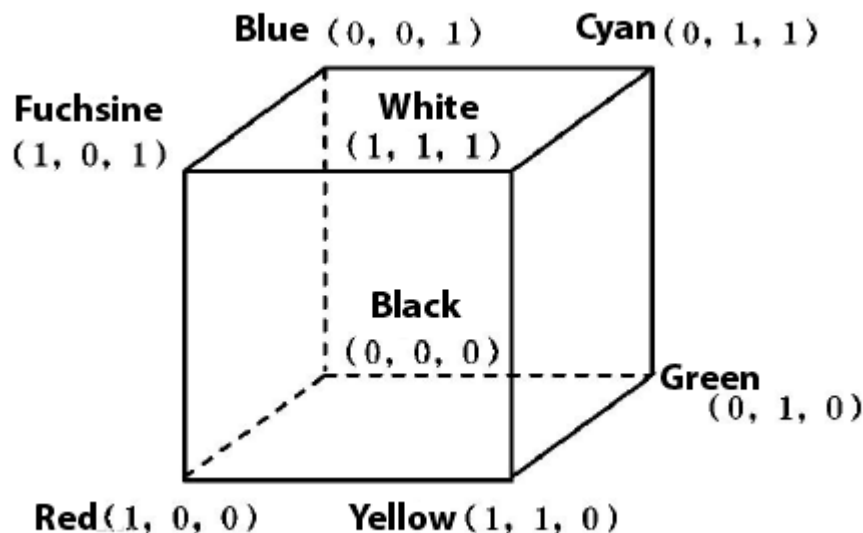
You do not need to take actions if the camera is offline during upgrade. Because the upgrade requires disconnection between MV (or capture card) and the camera. If the upgrade fails, check whether the firmware matches with the internal model of the camera. For details, contact technical support. Do not power off the camera to stop upgrade. Instead, you can close Camtool to stop upgrade.

6.9 Issues Related to White Balance and FPN

6.9.1 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 6-6 RGB

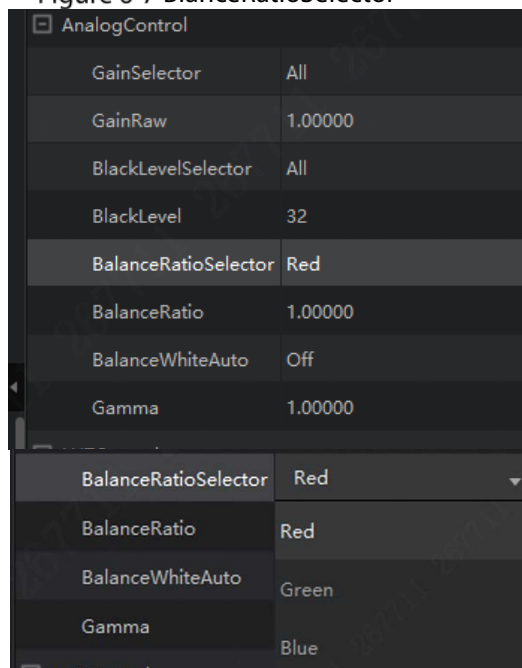


Due to the difference in the light source in each scene, the actual response of camera to RGB is different from the image capture by eyes, we need to do the white balance again.

Place a white paper in the view of the camera.

Click **AnalogControl**, and 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.

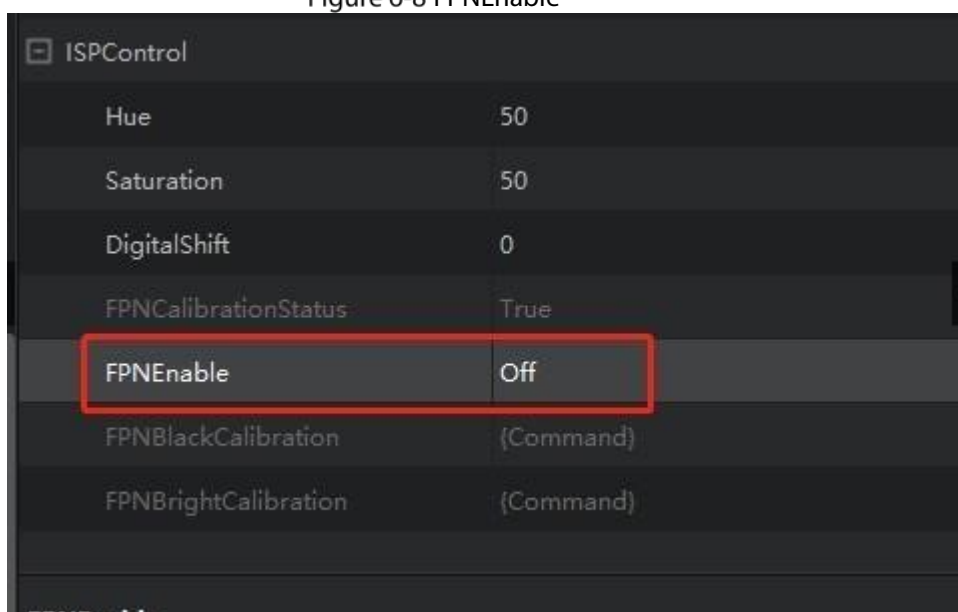
Figure 6-7 BlanceRatioSelector



6.10 FPN

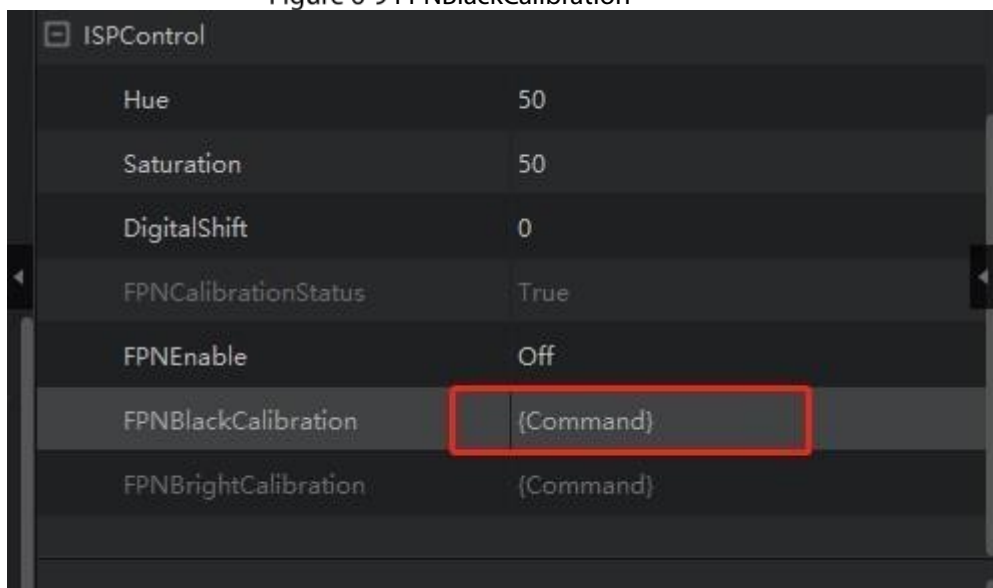
In ISPControl, set **FPNEnable** to **Off**.

Figure 6-8 FPNEnable



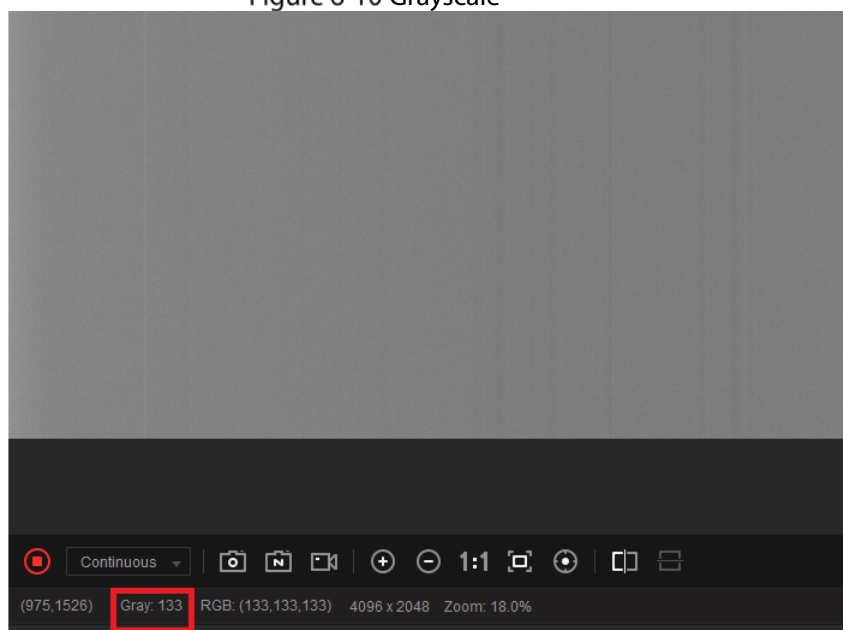
In a dark environment, completely cover the lens, and then click **{Command}** next to **FPNBlackCalibration**.; Wait for the command to take effect, and then click to capture images.

Figure 6-9 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 6-10 Grayscale



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

Figure 6-11 FPNBrightCalibration

ISPControl	
Hue	50
Saturation	50
DigitalShift	0
FPNCalibrationStatus	True
FPNEnable	Off
FPNBlackCalibration	{Command}
FPNBrightCalibration	{Command}

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 6-12 FPNEnable

ISPControl	
Hue	50
Saturation	50
DigitalShift	0
FPNCalibrationStatus	True
FPNEnable	On
FPNBlackCalibration	(Not Available)
FPNBrightCalibration	(Not Available)

Images must not be overexposed.

6.11 Influence of Sensor Analog Gain Stage 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.

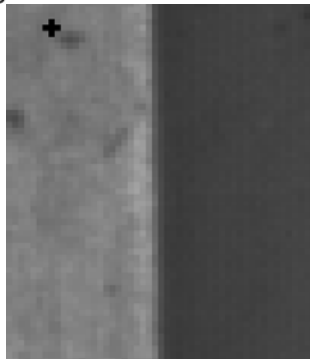
Table 6-1 Anglog gain stage

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

6.12 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 6-13 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 6-14 Light source not in parallel with the camera

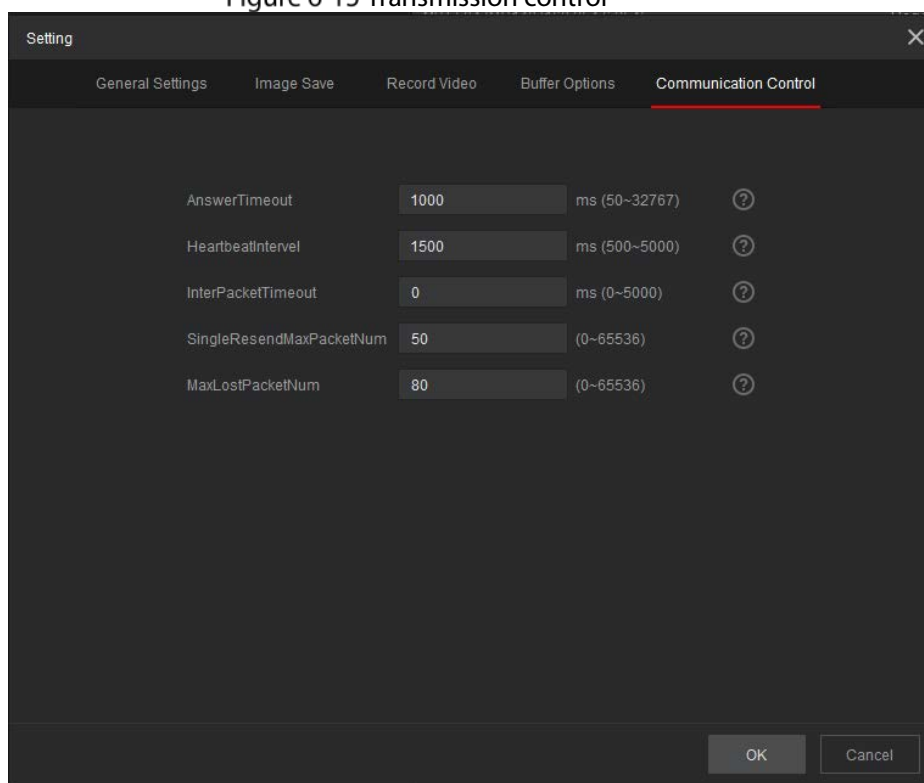


4. Errors are reported when exporting or importing camera attributes:

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 lostcount 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 issue:** 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 6-15 Transmission control



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 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 IP address 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. 8. 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. 10. 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. 15. 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.