PN4K(2)GV Series Line Scan Camera User Manual

(V0.2 Jan.18, 2024)

Hefei I-TEK Optoelectronics Co.,Ltd.

http://www.i-tek.cn/

Revision History

Revision	Date	Description
0.1	2023/09/04	● Initial version
0.2	2024/02/18	● Encoder multiply factor add x8/x16/x32 options

Manufacturer Information

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Contents

1 Precautions

- **General**

① Do not drop, damage, disassemble the camera.

② Do not let children touch the camera without supervision.

③ Do not use the camera for other purposes than those specified herein.

④ If there is any problem with the camera, please contact us in time for technical support.

- **Installation and Maintenance**

① Do not install the camera in an environment with direct sunlight, high humidity or heavy dust.

② Keep the camera away from an environment with strong electromagnetic interference.

③ Keep the camera away from heat sources.

④ Be careful not to let the camera soak in liquid, such as water and drinks.

⑤ Clean dust on the surface of the camera as often as possible to avoid dust entering the camera, otherwise it may cause fault to the camera.

⑥ To clean the dust on the camera surface, do not wash with water, wipe it with lint-free cloth.

- **Power Supply**

① The camera supports external power supply or PoE power supply. The recommended voltage is +12~24V (±10%), PN4K(2)GV-10KC camera requires 0.5A current, and PN4K(2)GV-30KN4 camera requires 1.0A current.

② Hefei I-TEK Optoelectronics Co., LTD. does not provide external power supply. Users need to connect power supply by themselves.

- **Document**

① Hefei I-TEK Optoelectronics Co., LTD. does not warrant that the document is the final version. The document may be updated after product upgrade. Please contact market@i-tek.cn for the latest version, which is provided for the authorized users.

2 Camera Models

- **Camera Product Model**

Abbreviation	Name	Description
Line Scan Camera:		
PA	Panther	Panther (Single line industrial line scan camera)
PL	Plasma	Plasma (Multi-line industrial line scan camera)
PH	Phoenix	Phoenix (TDI industrial line scan camera)
TPH	TEC-Phoenix	TEC-Phoenix (TEC-TDI industrial line scan camera)
PN	Pneuma	Pneuma (Basic industrial line scan camera)
PR	Prometheus	Prometheus (High resolution industrial line scan camera)
PU	PupMaya	PupMaya (High width industrial line scan camera)
PT	Ptepare	Ptepare (Special custom industrial line scan camera)
PM	Prism	Prism line scan camera
Area Scan Camera:		
TM	Taurus-Prism	Prism area scan camera
HS	Hercules	Hercules (CCD industrial area scan camera)
TS	Taurus	Taurus (CMOS industrial area scan camera)
THS	TEC-Hercules	TEC-Hercules (CCD TEC industrial area scan camera)
TTS	TEC-Taurus	TEC-Taurus (CMOS industrial area scan camera)
XS	XStream	XStream (Super high speed camera)

- **Interface Specification**

Abbreviation	Interface Type
GV	GigE Vision
CL	Camera Link
CXP/CXP10/CXP12	CoaXPress
U30	USB3.0
XGV	10 GigE Vision
PCIe	PCI-Express
SFP	Small Form Pluggable

- **Color Form**

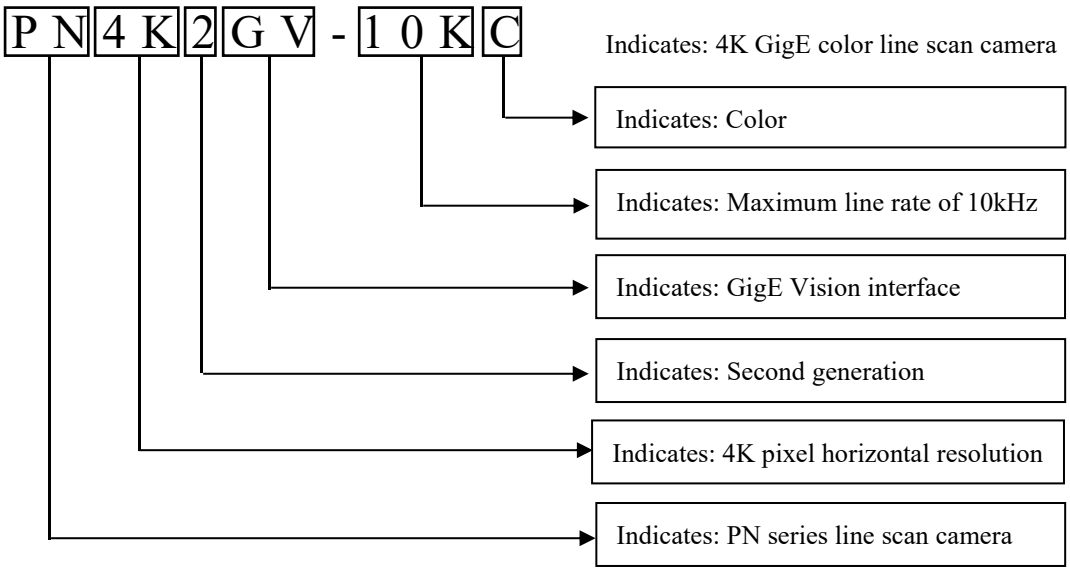
Abbreviation	Image Mode
M	Monochrome
C	Color
F	Full Color
T	Monochrome TDI (Time Delay Integration)
X	Time Division Camera
U	UV (Ultraviolet)
N	NIR (Near Infrared)

S	SWIR (Short Wave Infrared)
W	MWIR (Middle Wave Infrared)
L	LWIR (Long Wave Infrared)

- **Line Rate or Frame Rate**

Camera Type	Description
Line Scan Camera	Maximum line rate, e.g. 30kHz
Area Scan Camera	Maximum frame rate, e.g. 4000fps

e.g.



3 Product Appearance

PN4K(2)GV-10KC:

PN4K(2)GV-30KN4:

Fig.1 Product Appearance

Note:

① The front and the side of camera provide threaded holes for mounting camera.

② Please refer to “Mechanical Dimensions and Interfaces” below for detailed camera dimensions.

4 Product Specifications

PN4K(2)GV series camera is designed for high-speed line scanning application in industrial automatic detection and is developed and manufactured by Hefei I-TEK Optoelectronics Co., LTD.. The camera integrates international leading high-speed linear array image sensor, large-scale field programmable logic gate array parallel processor, and external output data through gigabit Ethernet interface. At the same time, it has features of high speed, high sensitivity and low noise.

4.1 Main Features

- Global Shutter CMOS Sensor
- Line Resolution 4096 Pixels
- High Sensitivity and Low Noise
- Rich Exposure Control Modes (External Trigger, Free-Run)
- Binning
- Multiple Exposure
- Spatial Correction
- Flat Field Correction
- White Balance
- Analog Gain / Digital Gain / Offset Control
- Real-time Temperature Monitoring
- Gigabit Ethernet Interface
- Support GigEVision V2.0 and GenICam Standard

4.2 Camera Specifications

Table 1 PN4K(2)GV-10KC Product Specification

Model	PN4K(2)GV-10KC
Product Description	4K GigE color line scan camera
Resolution	4096 x 3
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Color
Sensor Length	28.67mm
Dynamic Range	≥ 53.6dB
SNR	43dB
Data Rate	123MB/s
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Digital Gain	0.1~8
Digital Offset	-1023~1023
Lens Mount	M42
Max Line Rate	10 kHz

Trigger Mode	Free-Run, Line Trigger Mode, Frame Trigger Mode
External Trigger	RS422 input
Exposure Control	Pulse Width Control, Timed
Exposure Time	4.5us~63997us (step: 0.17us)
Data Format	8bit
Operating Temperature	0~55°C
Data Interface	GigE Vision
Power Supply	DC 12~24V (±10%) 0.5A or PoE power supply
Power Consumption	3.7W (DC power supply) or 4.1W (PoE power supply)
Mechanical	62mm x 62mm x 37.5mm (without adapter)

Table 2 PN4K(2)GV-30KN4 Product Specification

Model	**PN4K(2)GV-30KN4**
Product Description	4K GigE near-infrared line scan camera
Resolution	4096 x 4
Pixel Size	7um x 7um
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Length	28.67mm
Dynamic Range	≥ 54.2dB
SNR	48.3dB
Data Rate	123MB/s
Analog Gain	X1/X2/X3/X4/X5/X6/X7/X8
Digital Gain	0.1~8
Digital Offset	-1023~1023
Lens Mount	M42
Max Line Rate	30kHz
Trigger Mode	Free-Run, Line Trigger Mode, Frame Trigger Mode
External Trigger	RS422 input
Exposure Control	Pulse Width Control, Timed
Exposure Time	10.5us~63997us (step: 0.016us~0.017us)
Data Format	8bit
Operating Temperature	0~55°C
Data Interface	GigE Vision
Power Supply	DC 12~24V (±10%) 1.0A or PoE power supply
Power Consumption	3.7W (DC power supply) or 4.4W (PoE power supply)
Mechanical	62mm x 62mm x 37.5mm (without adapter)

Note: This table is for 0103-8608 version of PN4K(2)GV series camera specifications, which may vary slightly from version to version.

4.3 Camera Structure

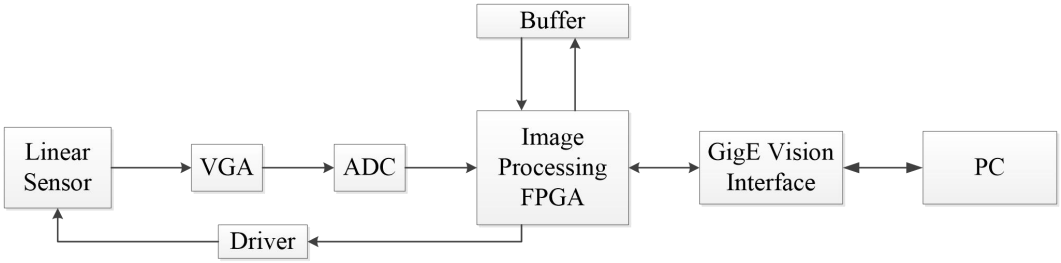


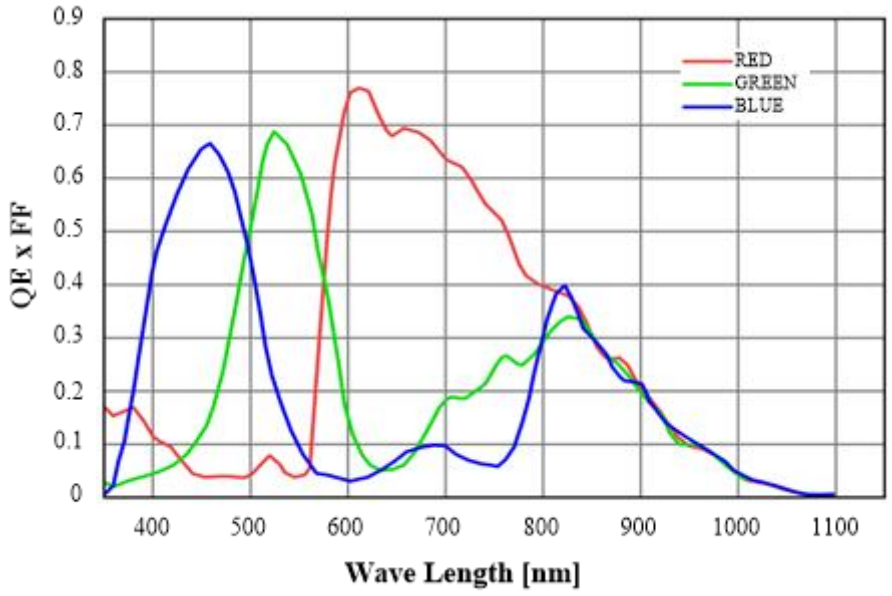
Fig.2 Internal Implementation Structure of Camera

PN4K(2)GV series camera uses a unified architecture to realize image sensor control, data transmission and embedded algorithm processing with different resolutions. The internal structure of camera is shown in the figure above. The pixel array is uniformly sampled and maintained by global shutter control system, converted into digital signals by analog front end, and then transmitted to PC network card through GigEVision interface after relevant algorithm processing by FPGA.

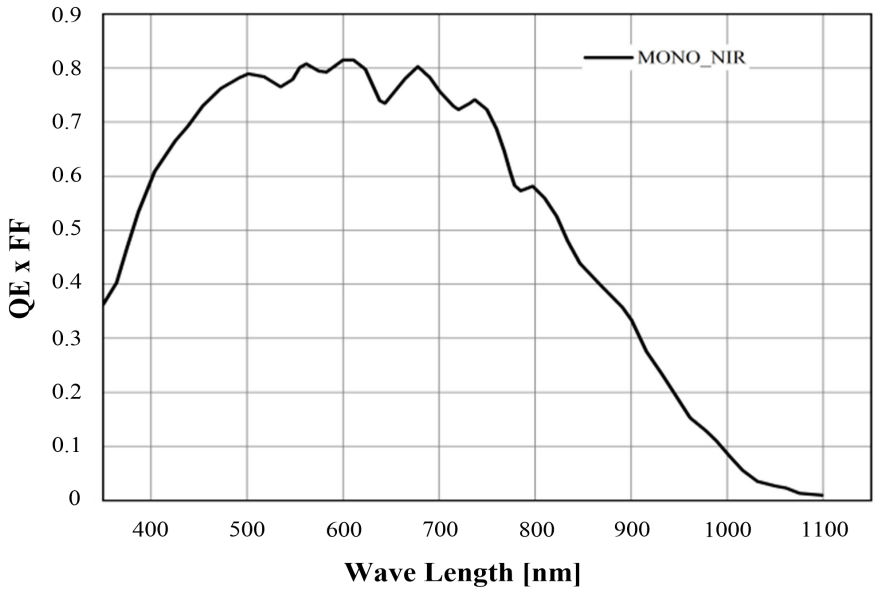
PN4K(2)GV series camera can accept external trigger acquisition, the source is IO signal. At the same time, the camera can also output synchronization signal during exposure, which is convenient for external strobe control.

4.4 Spectral Response

The following is spectral response curve of PN4K(2)GV series camera.



(a) Color Camera



(b) Near Infrared Camera

Fig.3 Spectral Response of Camera

4.5 Environmental Requirements

(1) Operating temperature: 0℃~55℃, humidity: 10% ~80%; Storage temperature: -20℃~75℃.

(2) The sensor in the camera has dust proof sealing setting, which can effectively prevent dust from entering sensor surface. If lens cap is open, dust may enter. Therefore, tighten the lens cap when the camera is not in use.

4.6 RoHS Certification

All camera components (including electronic components, PCB, and shell) are RoHS compliant.

5 Mechanical Dimensions and Interfaces

5.1 Mechanical Dimensions

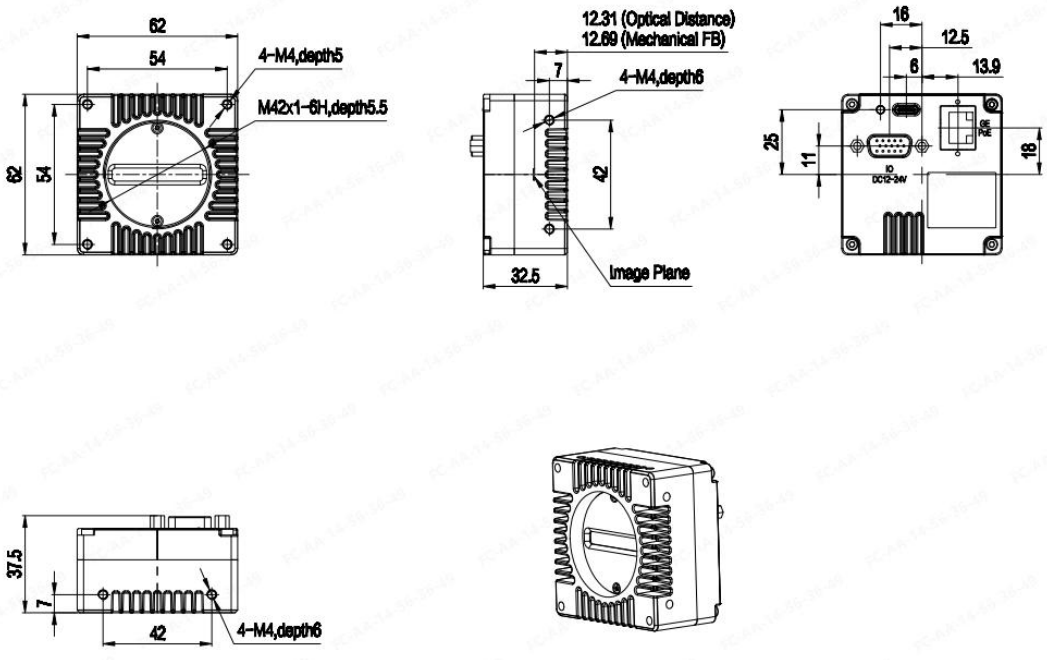


Fig.4 Camera Mechanical Dimensions

5.2 Camera Interface

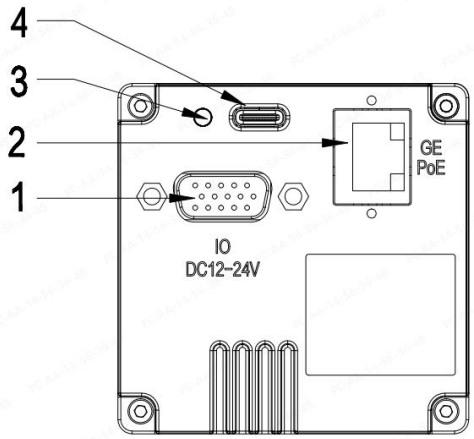


Fig.5 External Interfaces of Camera

① Power and External Trigger Input Interface
② Gigabit Ethernet Data and PoE Power Supply Interface
③ Camera Status Indicator
④ Type-C Interface

5.2.1 Camera Status Indicator

The camera status indicator is used to indicate real-time status of camera, as shown in the table below:

Table 3 Camera Status Indicators

LED Status Indicators	Camera Status
Solid Green	Normal
Blinking Green	No trigger input within three seconds in external trigger mode
Solid Red	Processor is starting or in error
Blinking Red	Camera fatal error (need contact technical support)
Solid Yellow	Camera is initializing or executing command

5.2.2 Power and Trigger Interface

A single RJ45 Ethernet connector for controlling and video data to the host Gigabit network interface card. For industrial environments, Hefei I-TEK Optoelectronics Co., LTD. GigE supports the use of screws to lock Ethernet cable.

A single HD15 female connector for all I/O and DC power source.

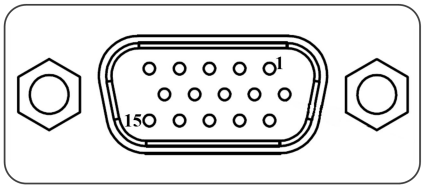


Fig.6 HD15 Connector

The detail of HD15 connector are shown in the following table:

Table 4 HD15 Connector Interface Definition

Pin Number	Pin Name	Direction	Definition
1	Line 1+	In	RS-422/Single ended Input Port 1+
2	Line 1-	In	RS-422 Input Port 1-
3	Line 2+	In	RS-422/Single ended Input Port 2+
4	Line 2-	In	RS-422 Input Port 2-
5	Signals Ground		Signals Ground
6	Line 3+	In	RS-422/Single ended Input Port 3+
7	Line 3-	In	RS-422 Input Port 3-
8	Line 4+	Out	RS-422/Single ended Output Port 4+
9	Line 4-	Out	RS-422 Output Port 4-
10	PWR-GND		Camera Power Ground
11	Line 5+	Out	RS-422/Single ended Output Port 5+
12	Line 5-	Out	RS-422 Output Port 5-
13	Line 6+	Out	RS-422/Single ended Output Port 6+
14	Line 6-	Out	RS-422 Output Port 6-
15	PWR-VCC	-	Camera Power DC +12~24 Volts

The description of connector interface signal is as follows:

- Line trigger signal: Line 1, Line 2
- Frame trigger signal: Line 3
- Exposure output signal: Line 4, Line 5, Line 6, and the output signal source can be customized
- IO input signal: above 3.3V, all signals support single-ended signal TTL level and differential signals
- IO output signal: all signals support single-ended signal output and differential signal output

The connection method of single-ended signal or differential signal is as follows:

- Single-ended signal connection: connect the positive of the signal line, such as Line 1+ and Signals Ground
- Differential signal connection: connect the positive and negative of the signal line, such as Line 1+ and Line 1-
- Encoder signal: Line 1 is connected to encoder signal phase A, and Line 2 is connected to encoder signal phase B

The circuit diagram of trigger interface is as follows:

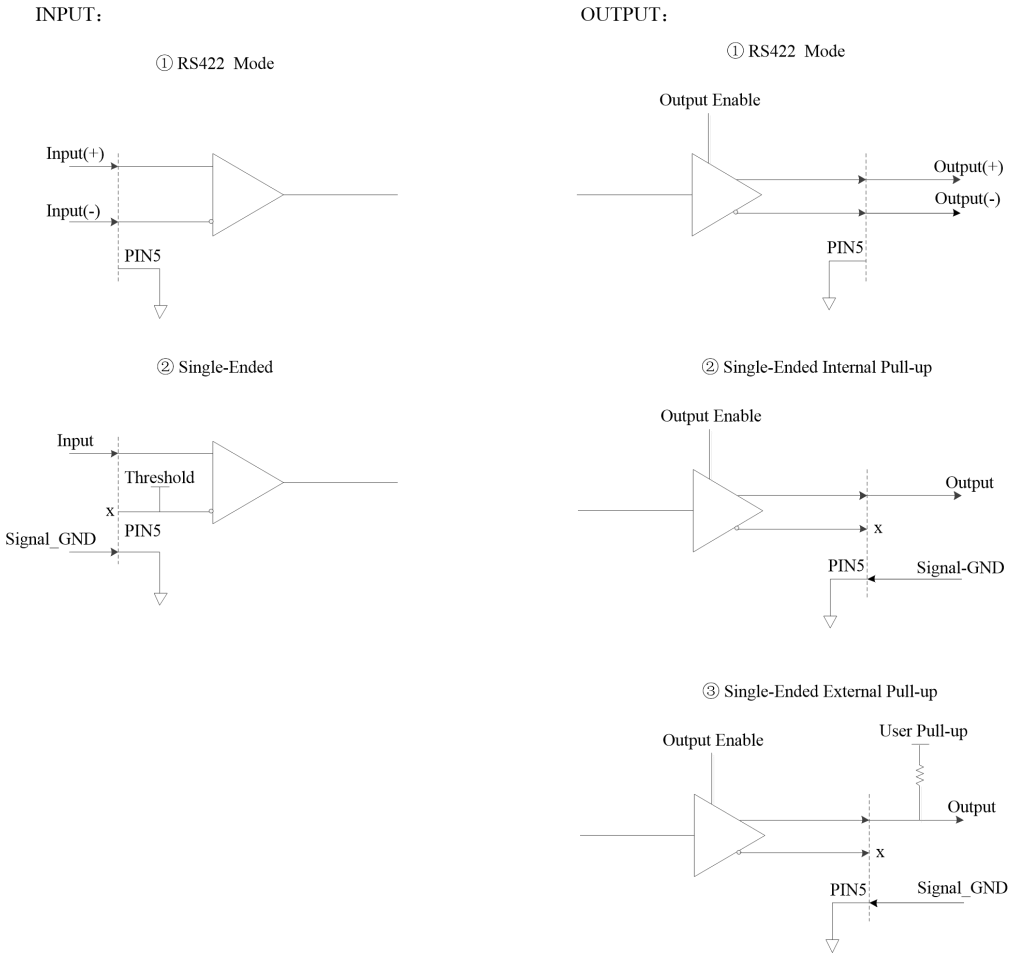


Fig.7 Trigger Circuit Diagram

Note: In the figure, “X” stands for dangling, and “PIN5” is the fifth pin of network port camera.

6 Camera Features

This chapter introduces the main features of PN4KG(2)V series camera.

6.1 Trigger Mode

PN4KG(2)V series camera supports three timing control modes: Free-Run, Line Trigger and Frame Trigger.

6.1.1 Free-Run Mode

In Free-Run mode, camera's internal logic automatically generates camera control timing, so that it can produce normal image output without external trigger signal.

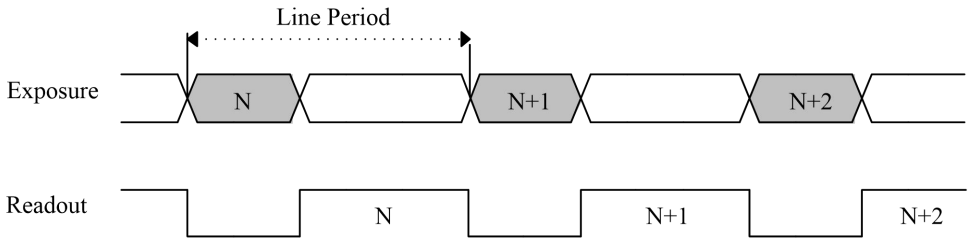


Fig.8 Free-Run Mode

In this mode, exposure time and line rate (reciprocal of line period) can be set by instructions. Note that line period should not be less than readout time of a line and should be greater than the sum of the set exposure time and the minimum exposure interval parameters. The internal running sequence of camera is shown in the figure above.

6.1.2 Line Trigger Mode

In Line Trigger mode, it supports setting fixed exposure time, and also supports PWM pulse width to control exposure time. Users need to provide an external trigger signal to control line trigger. At this time, Exposure Mode is valid, and Exposure Mode switch is used to select fixed exposure time mode or PWM pulse width control mode.

In fixed exposure time mode (LineStart: on, Exposure Mode: Timed), camera starts exposure at the rising edge of external trigger signal, while exposure time is determined by the value of “Exposure Time”. At this time, the line rate of camera is determined by the interval between rising edges of external trigger pulse, and its operation timing is shown in the figure below.

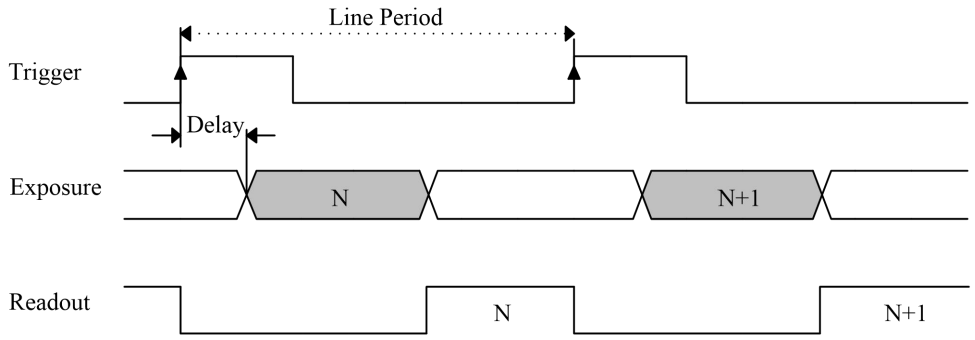


Fig.9 Fixed Exposure Time Mode

In PWM pulse width control mode (LineStart: on, Exposure Mode: TriggerWidth), camera exposure starts at the rising edge and ends at the falling edge of external trigger signal. The operation timing is shown in the figure below.

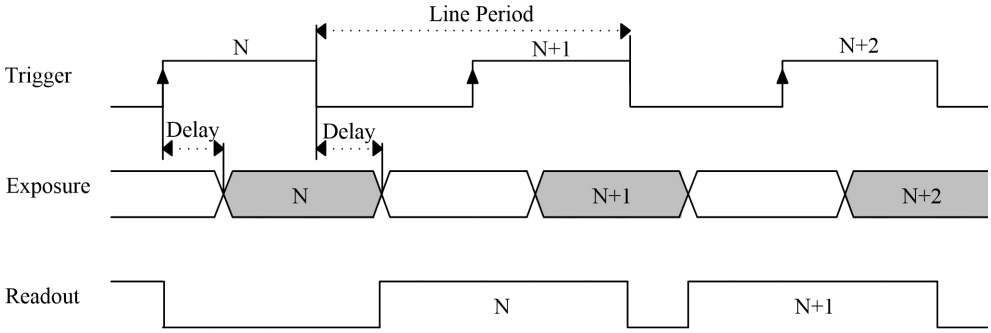


Fig.10 PWM Pulse Width Control Mode

6.1.3 Frame Trigger Mode

Frame Trigger mode is controlled by external signal, that is, the starting point of each image is controlled during continuous acquisition. The camera starts grabbing images from the rising edge of external trigger signal. The number of frames to be triggered at a time is determined by Trigger Frames Count. Its running sequence is shown in the figure below (Trigger Frames Count=2).

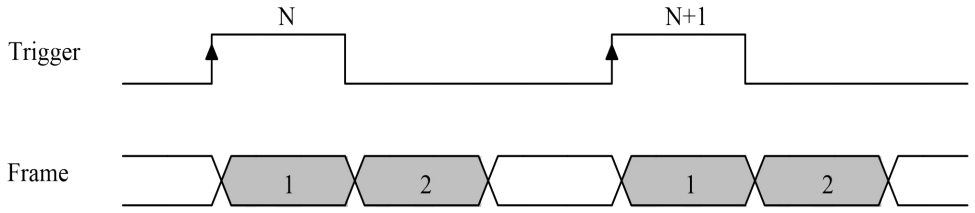


Fig.11 Frame Trigger Mode

6.2 Multiple Exposure

In practical applications, users sometimes need to obtain image information of the same object at different grayscale values. PN4K(2)GV-30KN4 camera provides a built-in multiple exposure function

for imaging the same object at the same position and time but with different exposure times, in order to acquire richer information about the object.

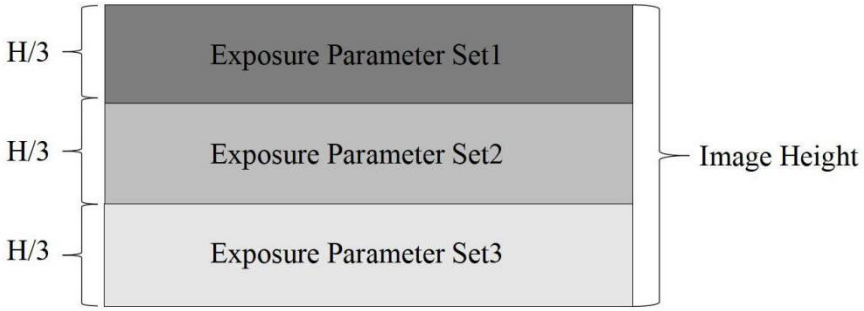
To ensure the normal progress of multiple exposure imaging, it is necessary to constrain the exposure time and line period. Since the image readout time is limited by the maximum line rate under the current mode, in order to satisfy that the current line image has been completed before the next line image starts to expose, the interval from the end of the current line exposure to the start of the next line exposure must be greater than the minimum line cycle under the current mode.

Taking triple exposure as an example, please consider the following situation:

- **Scene 1**

In Free-Run mode, after starting grabbing images, the image height will be divided into three equal parts, each representing the imaging of an object under an exposure parameter set. Finally, the images under three exposure configurations will be concatenated into one image and output.

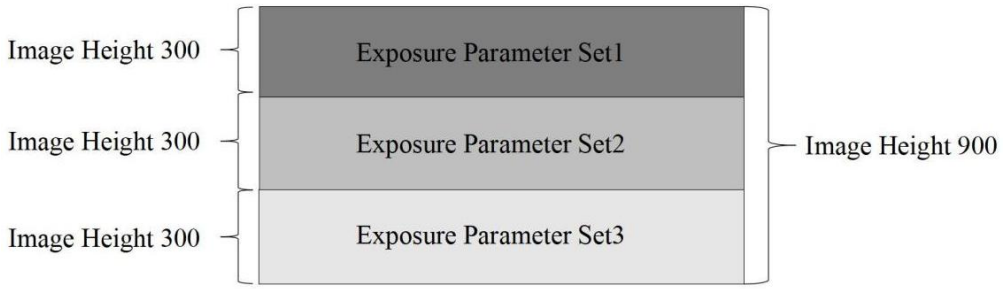
Exposure Parameter Set Index	Exposure Time: us
1	100
2	200
3	300



- **Scene 2**

In line trigger mode, with the image height set to 900, 300 line trigger signals are sent. In this case, each line trigger signal will trigger n lines of image (n is the number of multiple exposure parameter sets, in this example n=3), so after starting the acquisition, every 300 heights of the image represent the object's imaging under one exposure parameter set.

Exposure Parameter Set Index	Exposure Time: us
1	100
2	200
3	300



Note:

① After enabling multiple exposure function, the total height of the image will automatically match to an integer multiple of the number of exposure parameter sets.

② Multiple exposure parameters must be configured before image acquisition, otherwise it may result in abnormal images.

6.3 Camera Scanning Direction

The scanning direction of PN4K(2)GV series camera is vertical scanning direction. It supports from top to bottom and from bottom to top, can be controlled internally by camera or externally by IO signals.

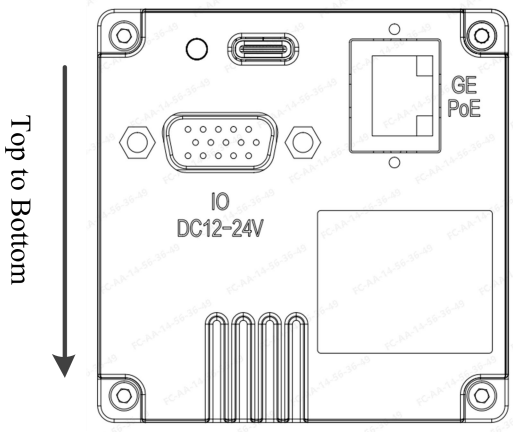
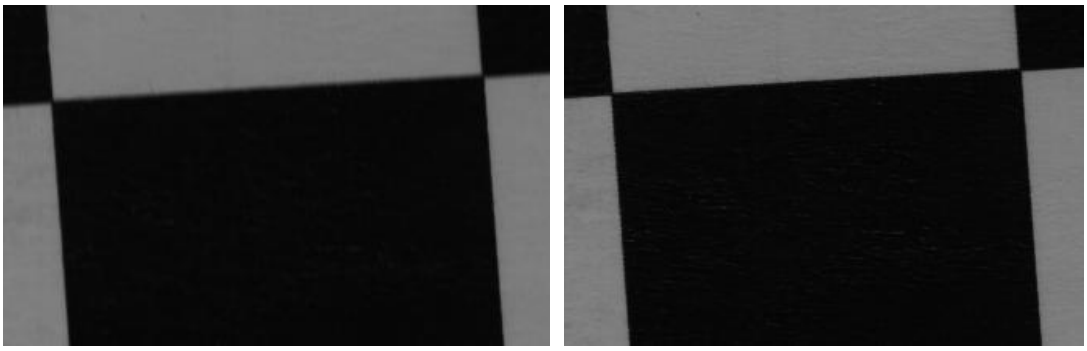


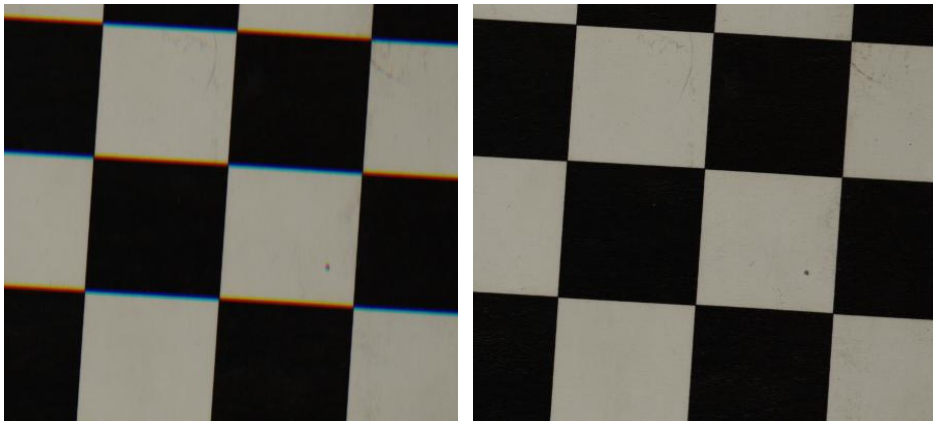
Fig.12 Camera Scanning Direction

Note: For monochrome camera, when camera is set to multi line mode and motion direction does not match, image edge will be blurred. When camera is set to single line mode, sharpness is not affected by scanning direction. For color camera, when vertical scanning direction does not match the direction of the object's movement, it will cause image edge dispersion.



(a) Multi Line Mode and Motion Direction does not Match (b) Multi Line Mode and Motion Direction Matches

Fig.13 Vertical Scanning Direction of Monochrome Camera



(a) Motion Direction does not Match (b) Motion Direction Matches

Fig.14 Vertical Scanning Direction of Color Camera

6.4 Image Flip

The image is flipped along X direction. Users can use this function to change scanning direction of camera, as shown in the figure below:

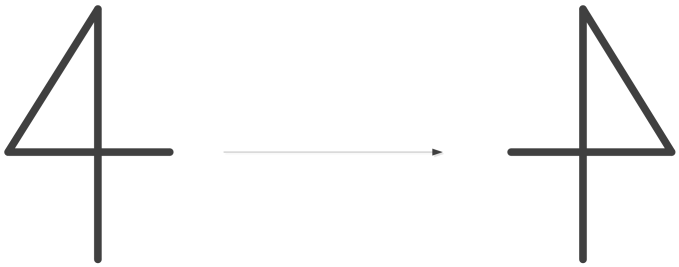


Fig.15 Horizontal Binning

6.5 Encoder Module

PN4K(2)GV series camera is designed with an encoder module for receiving encoder signals from channel A or B as the signal source for the line trigger function. The main parameters are as follows:

➢ RotaryEncoderInputA/BSource: Set the trigger source for rotary encoder A/B phase, choosing according to the actual trigger connection.

➢ RotaryEncoderMultiplier/Divider: When image appears compressed or elongated distortion, it can be improved respectively by adjusting the encoder's multiplication/division factor.

➢ RotaryEncoderCounterMode: Set the counter mode of the rotary encoder, divided into "FollowDirection" and "IgnoreDirection". If the current value of the encoder counter does not change during the image acquisition process, it indicates that camera has not received a signal that complies with the rules. When the count reaches the set maximum value, it resets and starts counting from zero again. To reset to zero, you can click the reset button.

Two main attributes affecting the camera's reception of encoder forward/reverse signals are the Encoder Working Mode and the Encoder Reverse Counter Max.

➢ When the Encoder Working Mode is set to Forward Only, if the reverse counter value does not increase or decrease, camera can normally grab images upon receiving forward signals.

➢ When the Encoder Working Mode is set to Backward Only, if the reverse counter value does not increase or decrease, camera can normally grab images upon receiving reverse signals.

➢ When the Encoder Working Mode is set to Any Direction, if the reverse counter value does not increase or decrease, camera will grab images upon receiving each line trigger signal; if the reverse counter value is increasing or decreasing, camera will stop grabbing images.

To understand how these rules affect the operation of the encoder software module, consider the following situations:

- **Scene1**

Shaft Encoder Reverse Max is set to zero, the reverse counter never increases or decreases. It will not affect operation of encoder software module. In this case, if Shaft Encoder Reverse Mode is set to Forward Only, when camera receives forward signal from encoder, it will normally grab images. But when camera receives reverse signal, it will not grab images. If Shaft Encoder Reverse Mode is set to Backward Only, when camera receives backward signal from encoder, it will normally grab images. But when camera receives reverse signal, it will not grab images. If Shaft Encoder Reverse Mode is set to Any Direction, camera will grab images when it receives forward or reverse signal from encoder.

- **Scene 2**

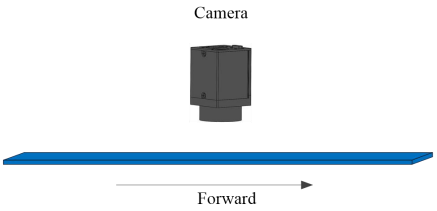
Suppose that:

➢ The camera is fixed, the conveyor belt carries object forward, and encoder rotates along with it, generating differential signals.

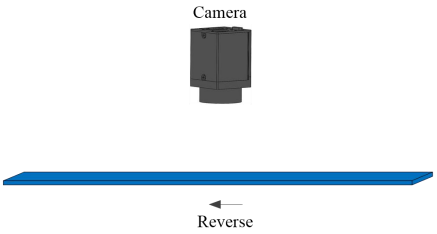
➢ The conveyor belt may jitter, in which case it may move backward, and encoder will send out, for example, 10 reverse signals.

In this case, Shaft Encoder Reverse Mode should be set to Forward Only, and Shaft Encoder Reverse Max should be set to a value higher than expected jitter. Here, we can set the maximum value of reverse count to 15.

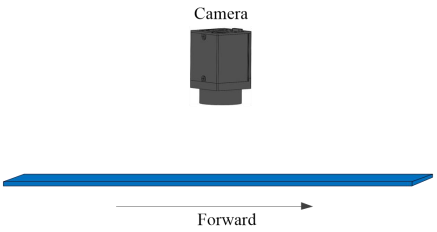
Shown in following:



Conveyor belt forward movement, the camera normal drawing, at this time the reverse counter is 0.



The conveyor belt produces jitter, and the reverse counter accumulates 10 reverse signals. As the reverse counter is increasing, the camera will not take pictures. At this time, the reverse counter is 10.



As the conveyor belt continues to move forward, the value of the reverse counter decreases. As the value of the reverse counter is decreasing, the camera will not take pictures at this time until the reverse counter returns to 0 and the material returns to the position before the jitter and continues to take pictures.

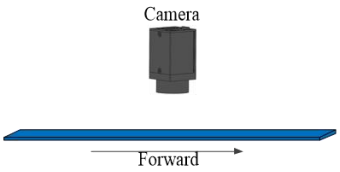
- **Scene 3**

Suppose that:

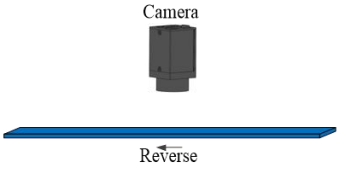
- The camera is fixed, conveyor belt carries object forward, and encoder rotates along with it, generating differential signals.
- The conveyor belt may jitter, when conveyor belt may move in the opposite direction, and encoder will send out, for example, 10 signals.
- After conveyor belt moves the object completely past camera's range, it comes back and grabs images again. Forward movement requires complete grabbing and reverse movement requires complete grabbing as well.

In this case, Shaft Encoder Reverse Mode should be set to Any Direction, and Shaft Encoder Reverse Max should be set to a value higher than expected jitter. Here, we can set the maximum value of reverse count to 15.

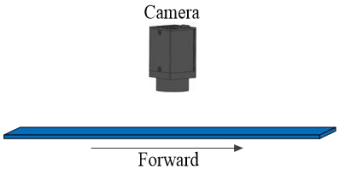
Shown in following:



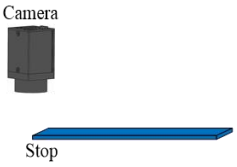
Conveyor belt forward movement, the camera normal drawing, at this time the reverse counter is 0.



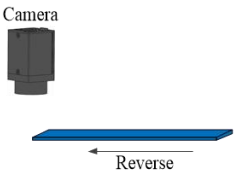
The conveyor belt produces jitter, and the reverse counter accumulates 10 reverse signals. As the reverse counter is increasing, the camera will not take pictures at this time, and the reverse counter is 10.



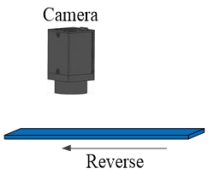
As the conveyor belt continues to move forward, the value of the reverse counter decreases. Because the value of the reverse counter is decreasing, the camera will not take pictures until the reverse counter returns to 0 and the material returns to the position before the jitter and continues to take pictures.



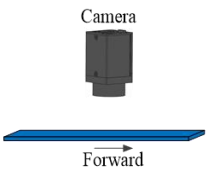
The conveyor belt completed the first forward movement, the camera finished drawing, at this time the reverse counter is 0.



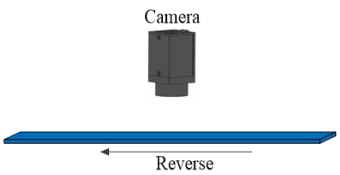
As the belt moves in the opposite direction for the first time, the counter increases, and as the belt keeps moving in the opposite direction, the counter quickly accumulates to 15. And the camera doesn't take pictures at this time.



The reverse counter accumulates to a maximum of 15. This time is so short that it doesn't affect the second image. And since the counter is limited to 15, the value does not increase and the camera starts to take pictures normally.



The conveyor belt produces jitter, producing 10 forward signals, and the reverse counter will decrease to 5. Since the counter is decreasing, the camera will not take pictures at this time.



The conveyor belt continues to move in the opposite direction, increasing the counter until it reaches 15. Since the counter is passing, increasing, the camera does not take pictures at this time. After 15 counts continue normal drawing, and so on.

6.6 Binning

Binning supports two or four pixel binning. After normal exposure acquisition, camera sums the values of adjacent pixels and outputs them as a single pixel value.

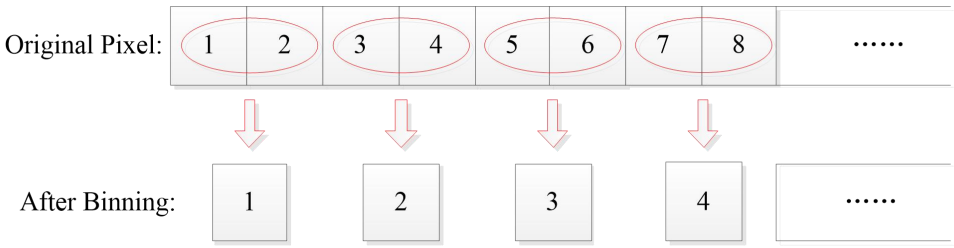


Fig.16 Horizontal Binningx2

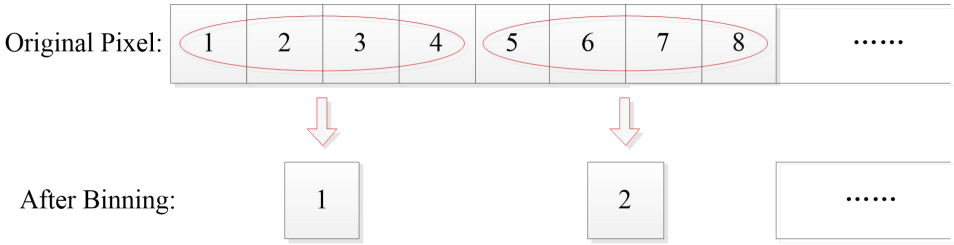


Fig.17 Horizontal Binningx4

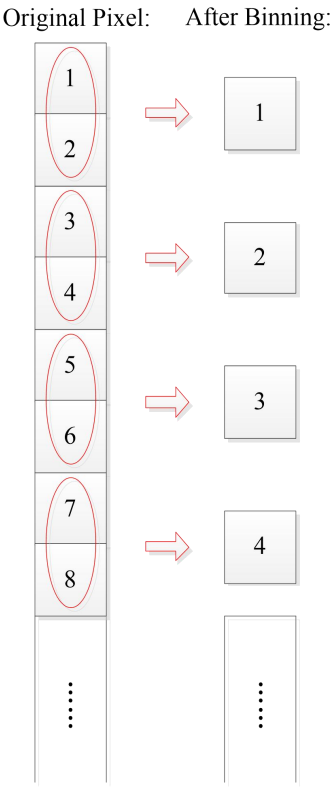


Fig.18 Vertical Binningx2

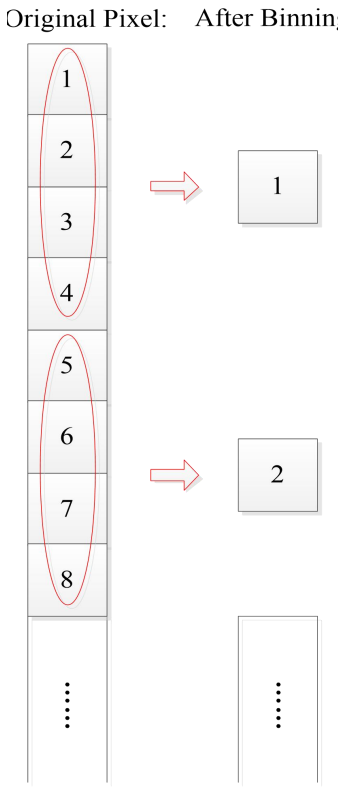
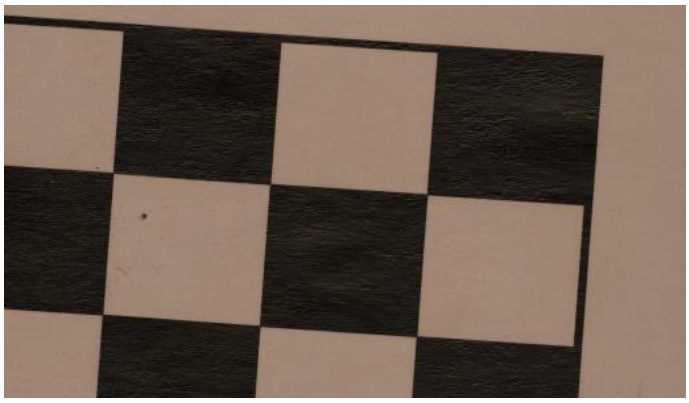


Fig.19 Vertical Binningx4

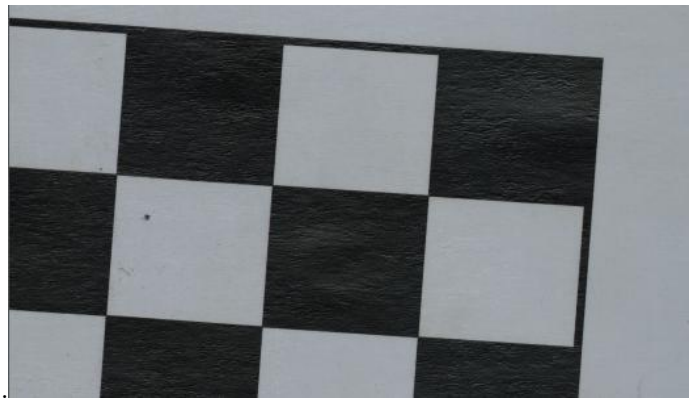
6.7 White Balance

White balance is an important parameter of color industrial camera, which directly affects color effect of reconstructed image. When white balance of industrial camera is not properly set, reconstructed image will appear color deviation phenomenon. Ideally, white objects should remain white after being photographed by color camera. However, due to inconsistent response of light source band and sensor RGB channel, image obtained by shooting white objects is generally not completely white. White balance correction redefines white by adjusting compensation coefficient of each RGB channel. When a change in external lighting or in optics causes a white object not to be white, users need to perform white balance function.

PN4K(2)GV color camera internally provides white balance function, which balances output values of each channel of sensor. Automatic white balance calculates white balance coefficient by sampling local pixels in sensor, and then adjusts each component of image according to coefficient, so that values of Red, Green and Blue components in output image are consistent.



(a) Before White Balance



(b) After White Balance

Fig.20 White Balance Effect

6.8 Flat Field Correction

Ideally, when camera imitates a uniform target, gray value of all pixels in resulting image should theoretically be the same. However, values of each pixel in image often vary considerably. These differences may result from uneven illumination, inconsistent light transmittance between lens center and lens edge, and inconsistent response of camera sensor pixels. The difference of sensor pixel response has been corrected before delivery. In general, it is mainly to correct dark brightness between two sides of image caused by lens. The camera calculates correction parameters of each pixel and stores them in camera for image correction. In some cases, lens and lighting conditions are better and better images can be obtained without flat field correction.

Flat field correction effect is shown in the figure below:

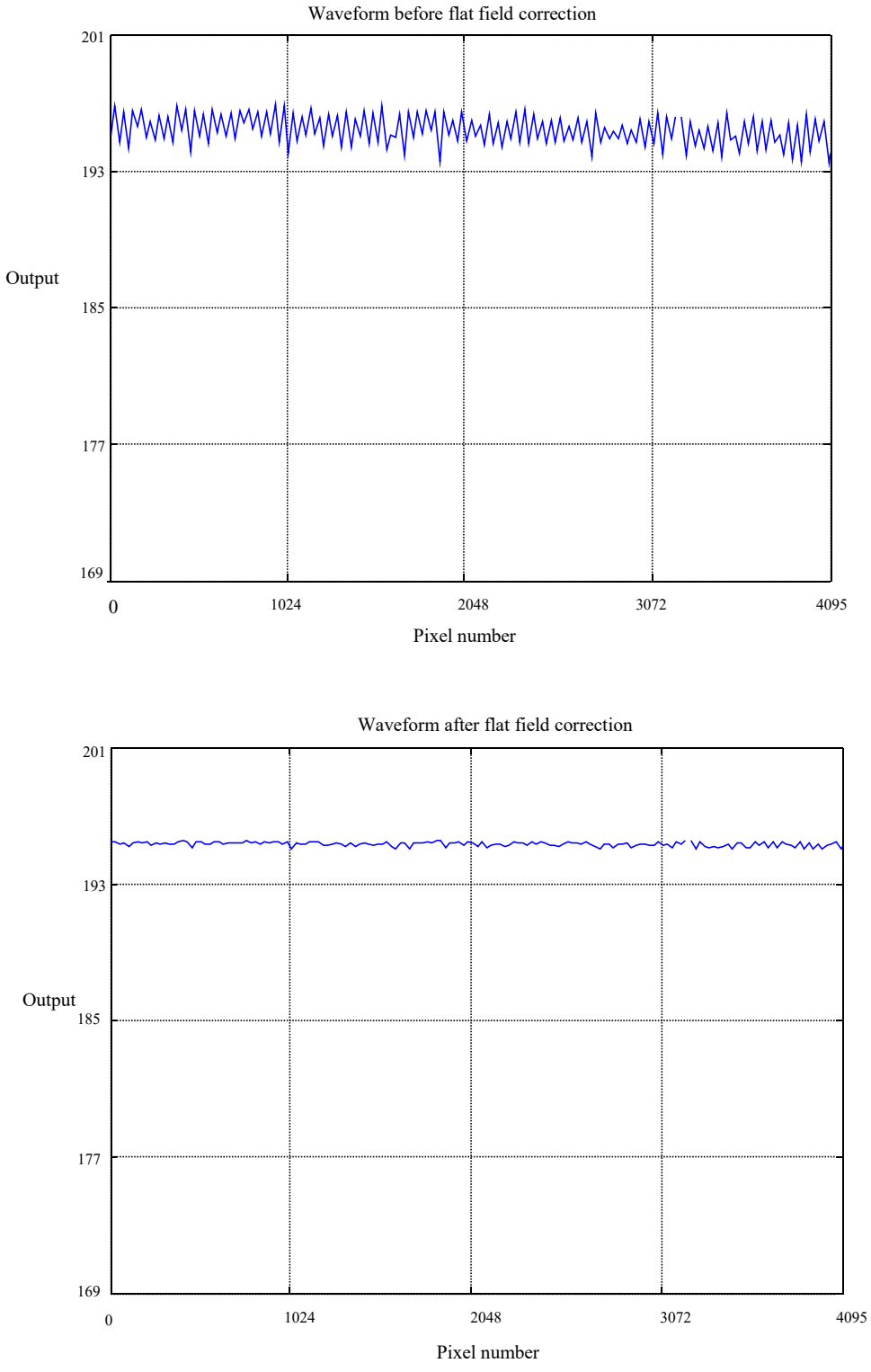
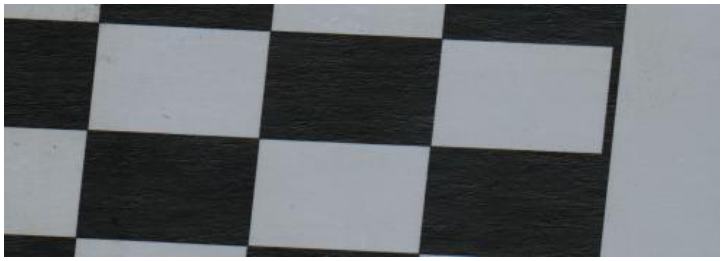


Fig.21 Flat Field Correction

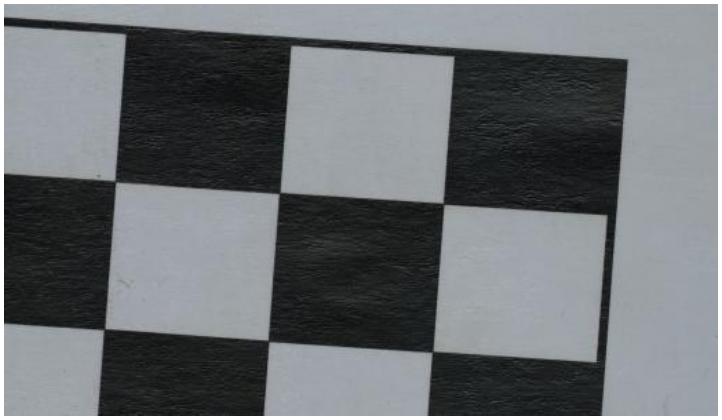
6.9 Spatial Correction

When horizontal and vertical magnification of camera are the same, a square object should remain square after being photographed. However, in actual situation, external trigger signal cannot be completely transformed to the most accurate proportion in most cases, a little error will lead to square

being stretched or compressed, object in the same position cannot be superimposed to the same pixel, and edge transition is shown as artifacts. The spatial correction function compensates camera acquisition speed proportionally according to received line signal, which can ensure that a square object should remain square after being photographed as an image.



(a) Before Spatial Correction



(b) After Spatial Correction

Fig. 22 Spatial Correction Effect

6.10 Test Image

PN4K(2)GV series camera provides two test images. Unlike images acquired from sensor data, test images are pre-edited and stored inside the camera as a fixed style. Test images can be used to test whether the data link works well.

The camera provides the following test images shown in the figure below:

- Vertical test image: Fixed image with gray gradient in horizontal direction.
- Horizontal test image: Scroll image with gray gradient in the vertical direction.

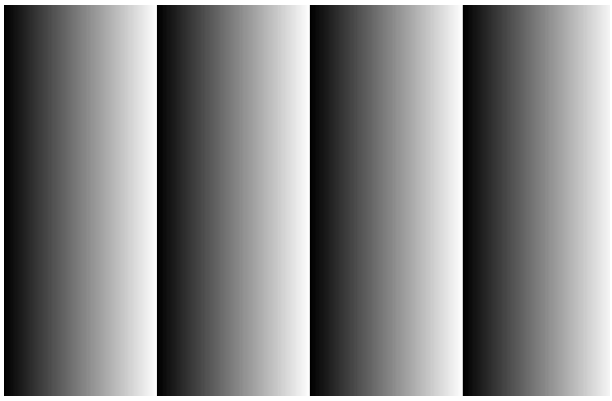


Fig.23 Vertical Test Image

Fig.24 Horizontal Test Image

6.11 Gain & Offset

Camera gain is divided into analog gain and digital gain.

The analog gain acts on analog signal, which has a greater impact on signal SNR. Generally speaking, the larger analog gain, the higher SNR. Users can configure analog gain of the camera.

Digital gain amplifies or reduces data after photoelectric conversion signal passes through AD. It is usually used to increase dynamic range of output image. Digital gain can also be used to adjust brightness of image. Digital offset is often used to adjust overall background brightness of image.

The effect of digital gain can be summarized by the following equation:

Data value (Output) = Data value (digital gain=1 & digital offset=0) x Digital gain value

The effect of digital offset can be summarized by the following equation (Data values less than 0 will be output as 0) :

Data value (Output) = Data value (digital offset=0) + Digital offset value

6.12 Data Format

PN4K(2)GV series camera processes data and outputs in 8bit data format.

6.13 Camera Temperature

PN4K(2)GV series camera supports real-time temperature acquisition of camera. Users can read temperature of the camera to monitor working status of the sensor.

The recommended operating temperature range of the camera is 0~55℃. If users detect an abnormal temperature (such as over 65℃), it is recommended to stop the camera immediately and contact our technical support.

6.14 Load/Save Configuration

PN4K(2)GV series camera supports three working parameter sets, including one factory default parameter set and two user parameter sets. Factory default parameter set can be used in most occasions. Users can also configure parameters based on actual requirements and save in user parameter set for self-loading after power on. The camera will automatically load the last saved parameter set each time.

Due to the correlation between parameters of camera, if camera does not work properly after modifying parameters, users can restore the factory default parameter set, and then reset parameters and save settings.

6.15 Camera IP Address

PN4K(2)GV series camera communicates with the host computer through Gigabit Ethernet, so users must set a proper IP address before using PN4K(2)GV camera. When camera and the host are in the same local area network, they can normal communication.

PN4K(2)GV series camera supports three IP configuration modes, namely static IP, DHCP, and LLA, with descending priorities. Static IP and DHCP are enabled for users. If DHCP fails, LLA is used to allocate IP addresses.

7 Camera Control

7.1 GenICam Standard

GenICam standard, promulgated by European Machine Vision Association (EMVA), provides a unified programming interface for all types of industrial cameras. The programming interface (API) is the same no matter what transport protocol the camera uses or what functionality it implements. It mainly contains the following three modules:

- GenAPI: Responsible for parsing XML files and solving problem of how to configure camera
- GenTL: Transport layer, for device enumeration, attribute control, and image acquisition
- SFNC: Standard for naming camera features

Camera XML file is stored locally on the PC, and collection software will select the most appropriate XML file according to camera model. Application and camera communicate with each other through SFNC, GenAPI, and GigEVision, as shown in the figure.

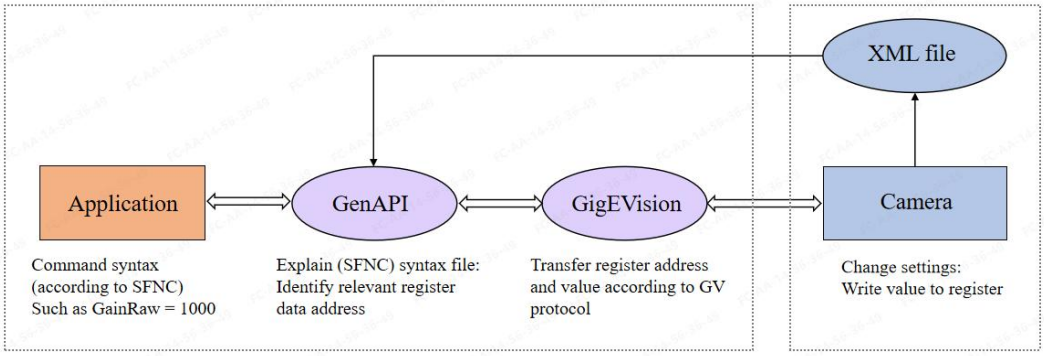


Fig.25 Communication Schematic between Application and Camera

In fact, if users want to change camera settings, such as gain, GenICam (SFNC) specifies a standardized syntax:

```
if( IsAvailable(Camera.GainRaw) )
    Camera.GainRaw = 1000;
```

GenAPI can parse these commands through a description file, for example, to set the gain to 1000, the value 0x3E8 (HEX) must be written to a register at address 0x0815 (HEX). Other tasks involved may be to check in advance whether the camera has gain feature and to check that the new values are consistent with the allowed gain range. The register message is transmitted and parsed by protocol and applied to camera.

7.2 GenAPI Parameter Attribute

The actual method of controlling camera is related to software implementation and SDK of frame grabber. Most frame grabber software provides a graphical user interface (GUI) that is automatically generated from XML files. This manual focuses on function of camera, detailing the specific

commands and their impact on the operation of camera, listing the name, interface, access, description, range, and default values of each GenAPI parameter.

(1) Register name

Each parameter is identified by a unique name. Most of names are part of SFNC, and camera custom names are used for non-standard parameters.

(2) Register address

This parameter represents the address value of register (in hexadecimal format).

(3) Register size

This parameter represents register value size (in bytes).

(4) Register interface

The parameter interface represents type of parameter, which is mainly used for the GUI of frame grabber and assign a display type to parameter.

Table 5 Overview of Parameter Interface

Interface	Interface Name	Description
Integer	I	Integer with value, minimum, maximum, and increment
Float	F	Float with value, minimum, maximum, and physical unit
String	S	String
Enumeration	E	Enumerate type
Command	C	Execute the command
Boolean	B	Boolean type

(5) Parameter access

This parameter represents whether users can read (RO), write (WO) or read/write (RW) parameters.

(6) Parameter range

When setting parameter, it checks whether input value is in valid range of parameter.

7.3 Register Classification

7.3.1 Device Control Register

Table 6 Device Control Register

Name	Address	Size	Interface	Access	Visibility
DeviceVendorName	0x0048	32	S	RO	Beginner
DeviceModelName	0x0068	32	S	RO	Beginner
DeviceManufacturerInfo	0x00a8	48	S	RO	Beginner
DeviceVersion	0x0088	32	S	RO	Beginner

DeviceSerialNumber	0x00d8	16	S	RO	Expert
DeviceUserID	0x00e8	16	S	RW	Beginner
DeviceScanType	/	/	E	/	Beginner
DeviceMCUTemperature	0x6118	4	F	RO	Expert
SensorType	0x6050	4	E	RW	Beginner
TDILineSelector	0x6054	4	E	RW	Beginner

- **DeviceVendorName**
  Device vendor name.

- **DeviceModelName**
  Device model name.

- **DeviceManufacturerInfo**
  Device manufacturer information.

- **DeviceVersion**
  Device version.

- **DeviceSerialNumber**
  Device serial number.

- **DeviceUserID**
  User-defined ID.

- **DeviceScanType**
  Device scan type. The enumeration names and values are as follows:
  - AreaScan (0): Area scan
  - LineScan (1): Line scan

- **DeviceMCUTemperature**
  Device MCU temperature.

- **SensorType**
  Sensor type. The enumeration names and values are as follows:
  - 4KRGBTripleLine (13): 4K color triple line
  - 4KNirFourLine (15): 4K infrared four line

- **TDILineSelector**
  TDI working mode selection. The enumeration names and values are as follows:
  - Line1(1): Line1, that means selecting the value of Line1 as the output value. Only PN4K(2)GV-30KN4 camera supports this option.

- Sum (5): Summation. For monochrome camera, represents the sum of each line. For color camera, represents each channel are summed separately. Only PN4K(2)GV-30KN4 camera supports this option.
- Average (6): Average. For monochrome camera, represents taking the average of each line. For color camera, calculate the average of each line for each channel separately。
- Sum/2 (7): Sum and divide by 2. For monochrome camera, represents the sum of each line divided by 2. For color camera, the lines for each channel are summed and divided by 2. Only PN4K(2)GV-30KN4 camera supports this option.

7.3.2 Image Format Control Register

Table 7 Image Format Control Register

Name	Address	Size	Interface	Access	Visibility
Width	0x6000	4	I	RW	Beginner
Height	0x61ec	4	I	RW	Beginner
BinningHorizontal	0x61b0	4	E	RW	Beginner
BinningVertical	0x61f8	4	E	RW	Beginner
PixelFormat	0x6020	4	E	RW	Beginner
OffsetX	0x6010	4	I	RW	Beginner
VideoMode	0x602c	4	E	RW	Beginner
ReverseX	0x613c	4	B	RW	Beginner

- **Width**

  Actual width of output image.

- **Height**

  Actual height of output image. The parameter range is as follows:
  - Maximum: 65535
  - Minimum: 1

- **BinningHorizontal**

  Horizontal binning. The enumeration names and values are as follows:
  - Binning_X1 (0)
  - Binning_X2 (1)
  - Binning_X4 (2)

- **BinningVertical**

  Vertical binning. The enumeration names and values are as follows:
  - Binning_X1 (0)
  - Binning_X2 (1)
  - Binning_X4 (2)

- **PixelFormat**

  Pixel format. The enumeration names and values are as follows:

- Mono8 (0x01080001): Monochrome 8bit
- RGB8 (0x02180014): Color RGB 8bit
- BGR8 (0x02180015): Color BGR 8bit

- **OffsetX**

  Horizontal offset. The parameter range is as follows:
  - Minimum: 0
  - Increment: 16

- **VideoMode**

  Output image mode. The enumeration names and values are as follows:
  - Original (0): Original image
  - Corrected (1): Corrected image
  - VerticalPattern (2): Vertical test image
  - HorizontalPattern (3):Horizontal test image

- **ReverseX**

  Enable horizontal flipping.

7.3.3 Acquisition Control Register

Table 8 Acquisition Control Register

Name	Address	Size	Interface	Access	Visibility
AcquisitionMode	0x603c	4	E	RW	Beginner
AcquisitionStart	0x6040	4	C	RW	Beginner
AcquisitionStop	0x6044	4	C	RW	Beginner
MultiExposureTimeCount	0xf900	4	E	RW	Beginner
ExposureSelect	/	/	E	/	Beginner
AcquisitionLineRate	0：0xa1a0 1：0xf93c 2：0xf940 3：0xf944 4：0xf948 5：0xf94c 6：0xf950 7：0xf954	4	F	RW	Beginner
ExposureMode	0x605c	4	E	RW	Beginner
ExposureTime	0：0xa060 1：0xf904 2：0xf908 3：0xf90c 4：0xf910 5：0xf914	4	F	RW	Beginner

	6：0xf918 7：0xf91c				

- **AcquisitionMode**

  Acquisition mode, usually default to continuous acquisition. The enumeration names and values are as follows:

  - Continuous (0): Continuous acquisition

- **AcquisitionStart**

  Start acquisition.

- **AcquisitionStop**

  Stop acquisition.

- **MultiExposureTimeCount**

  The number of multiple exposures. Which means the number of multiple exposure parameter sets to be configured, involves parameters including AcquisitionLineRate and ExposureTime. Only PN4K(2)GV-30KN4 camera supports this function.The enumeration names and values are as follows:

  - 1 (0)
  - 2 (1)
  - 3 (2)
  - 4 (3)
  - 5 (4)
  - 6 (5)
  - 7 (6)
  - 8 (7)

- **ExposureSelect**

  Exposure parameter set selection refers to the index of the exposure parameter set that needs to be configured.Only PN4K(2)GV-30KN4 camera supports this function.The enumeration names and values are as follows:

  - 1 (0)
  - 2 (1)
  - 3 (2)
  - 4 (3)
  - 5 (4)
  - 6 (5)
  - 7 (6)
  - 8 (7)

- **AcquisitionLineRate**

  Acquisition line rate, unit is Hz.

- **ExposureMode**

Exposure mode. The enumeration names and values are as follows:

- Timed (0): Timed
- TriggerWidth (2): Pulse width control

- **ExposureTime**
  - Exposure time, unit is us.

7.3.4 IO Control Register

Table 9 IO Control Register

Name	Address	Size	Interface	Access	Visibility
TriggerSoftware	0xf800	4	C	WO	Expert
TriggerSelector	/	/	E	/	Beginner
TriggerMode	LineStart：0xf808 FrameActive：0xf804 FrameStart：0xf80c	4	E	RW	Beginner
TriggerFrameCount	0xf810	4	I	RW	Beginner
TriggerSource	LineStart：0xf818 FrameActive：0xf814 FrameStart：0xf818	4	E	RW	Beginner
TriggerDelaySource	0xf81c	4	E	RW	Expert
TriggerDelay	0xf820	4	I	RW	Beginner
TriggerDelayLines	0xf824	4	I	RW	Beginner
RotaryEncoderInputASource	/	/	E	/	Expert
RotaryEncoderInputBSource	/	/	E	/	Expert
RotaryEncoderMultiplier	0xf82c	4	E	RW	Expert
RotaryEncoderDivider	0xf830	4	I	RW	Beginner
RotaryEncoderMinWidth	0x6334	4	F	RW	Beginner
RotaryEncoderUseSingleChannel	0x631c	4	B	RW	Beginner
RotaryEncoderCounterMode	0xf840	4	E	RW	Expert
RotaryEncoderCounterMax	0xf848	4	I	RW	Beginner
RotaryEncoderCounter	0xf844	4	I	RO	Beginner
RotaryEncoderCounterReset	0xf84c	4	C	WO	Expert
RotaryEncoderWorkingMode	0xf854	4	E	RW	Expert
RotaryEncoderReverseCounter	0xf83c	4	I	RO	Beginner
RotaryEncoderReverseCounterMax	0xf858	4	I	RW	Beginner

RotaryEncoderReverseCounterReset	0xf850	4	C	WO	Expert
InputLineSelector	/	/	E	/	Beginner
InputLinePolarity	Line1：0xf860 Line2：0xf864 Line3：0xf868	4	E	RW	Beginner
InputLineDebouncingPeriod	Line1：0xf878 Line2：0xf87c Line3：0xf880	4	I	RW	Beginner
OutputLineSelector	/	/	E	/	Beginner
OutputLineSource	Line4：0xf8a8 Line5：0xf8ac Line6：0xf8b0	4	E	RW	Expert
OutputLineWidth	Line4：0xf8b4 Line5：0xf8b8 Line6：0xf8bc	4	I	RW	Guru
OutputLinePolarity	Line4：0xf890 Line5：0xf894 Line6：0xf898	4	E	RW	Beginner
OutputLinePullUp	Line4：0xf8c0 Line5：0xf8c4 Line6：0xf8c8	4	E	RW	Beginner
ScanDirectionWorkingMode	0x6350	4	E	RW	Expert
ScanDirectionIntType	0x6354	4	E	RW	Expert
ScanDirectionExtTriggerSource	/	/	E	/	Expert
ScanDirectionExtTriggerPolarity	0x635c	4	E	RW	Expert

- **TriggerSoftware**

  Software trigger, click this parameter to generate a software trigger signal.

- **TriggerSelector**

  Trigger mode selector. The enumeration names and values are as follows:

  - LineStart (1): Line trigger
  - FrameActive (0): Frame active
  - FrameStart (2): Frame trigger

- **TriggerMode**

  Trigger mode. The enumeration names and values are as follows:

  - Off (0): Off trigger mode
  - On (1): On trigger mode

- **TriggerFrameCount**

  The number of frame trigger acquisition, that is, the number of image frames grabbed by camera for each frame trigger signal received. The parameter range is as follows:

- Maximum: 65535
- Minimum: 1

- **TriggerSource**

  Trigger source selector. The enumeration names and values are as follows:
  - Line1 (1): Line1, only be optional in line trigger mode
  - RotaryEncoder1 (4): shaft encoder signal, only be optional in line trigger mode
  - Line3 (3): Line3, only be optional in frame trigger mode
  - Software (10): Software trigger, only be optional in frame trigger mode

- **TriggerDelaySource**

  Frame trigger delay type. The enumeration names and values are as follows:
  - InternalClock (0): Time delay
  - lineTriggerSignal (1): Line delay

- **TriggerDelay**

  Frame trigger time delay. The parameter range is as follows:
  - Maximum: 1048575
  - Minimum: 0
  - Increment: 1

- **TriggerDelayLines**

  Frame trigger line delay. The parameter range is as follows:
  - Maximum: 65535
  - Minimum: 0
  - Increment: 1

- **RotaryEncoderInputASource**

  Signal source of shaft encoder A phase. The enumeration names and values are as follows:
  - Line1 (1): Line 1

- **RotaryEncoderInputBSource**

  Signal source of shaft encoder B phase. The enumeration names and values are as follows:
  - Line2 (2): Line 2

- **RotaryEncoderMultiplier**

  Shaft encoder multiplier. The enumeration names and values are as follows:
  - x1 (0)
  - x2 (1)
  - x4 (2)
  - x8 (3)
  - x16 (4)
  - x32 (5)

- **RotaryEncoderDivider**

  Shaft encoder divider. The parameter range is as follows:

  - Maximum: 255
  - Minimum: 1

- **RotaryEncoderMinWidth**

  Shaft encoder minimum pulse width. The parameter range is as follows:

  - Maximum: 819
  - Minimum: 1

- **RotaryEncoderUseSingleChannel**

  Use encoder signal single channel mode.

- **RotaryEncoderCounterMode**

  Shaft encoder counter mode. The enumeration names and values are as follows:

  - FollowDirection (0): Forward increasing and backward decreasing
  - IgnoreDirection (1): Incremental in any direction

- **RotaryEncoderCounter**

  The current value of shaft encoder counter, that is, the number of shaft encoder signals currently received that meet the requirement. The parameter range is as follows:

  - Maximum: 65535
  - Minimum: 0
  - Increment: 1

- **RotaryEncoderCounterMax**

  The maximum value of shaft encoder counter, beyond which the counter value does not increase. The parameter range is as follows:

  - Maximum: 65535
  - Minimum: 0
  - Increment: 1

- **RotaryEncoderCounterReset**

  Reset shaft encoder counter, click this parameter to clear shaft encoder counter value to zero.

- **RotaryEncoderWorkingMode**

  Shaft encoder counter working mode. The enumeration names and values are as follows:

  - AnyDirection (1): Any direction
  - ForwardOnly (0): Only forward
  - Backward (2): Only backward

- **RotaryEncoderReverseCounter**

  Shaft encoder reverse counter, that is, the number of encoder reverse signals received that meet the requirements. The parameter range is as follows:

- Maximum: 65535
- Minimum: 0
- Increment: 1

- **RotaryEncoderReverseCounterMax**

The maximum value of shaft encoder reverse counter, beyond which the reverse counter value does not increase. The parameter range is as follows:

- Maximum: 65535
- Minimum: 0
- Increment: 1

- **RotaryEncoderReverseCounterReset**

Reset shaft encoder reverse counter, click this parameter to clear shaft encoder reverse counter value to zero.

- **InputLineSelector**

Trigger line selector, which is used to select the line that need to be configured. The enumeration names and values are as follows:

- Line1 (0): Line1
- Line3 (2): Line3

- **InputLinePolarity**

Trigger polarity. The enumeration names and values are as follows:

- High (0): Signal high level trigger acquisition
- Low (1): Signal low level trigger acquisition

- **InputLineDebouncingPeriod**

Trigger signal to shake window length. Signals lower than this pulse width will be filtered out as gross signal, and the unit is us. The parameter range is as follows:

- Maximum: 800
- Minimum: 0

- **OutputLineSelector**

Output signal line selector. The enumeration names and values are as follows:

- Line4 (0): Line4
- Line5 (1): Line5
- Line6 (2): Line6

- **OutputLineSource**

Output signal source. The enumeration names and values are as follows:

- ExposureActive (0): Follow exposure, output signal generated during camera exposure
- FrameActive (1): Follow frame, output signal generated when camera grabs a frame
- LineStartPulse (4): Output signal generated when a single line of image is grabbed
- FrameStartPulse (2): Output signal generated during the start of image acquisition

- FrameEndPulse (3): Output signal generated during the end of image acquisition
- AllLow (6): Output low level continuously
- AllHigh (5): Output high level continuously

- **OutputLineWidth**

  Output signal pulse width. The parameter range is as follows:
  - Maximum: 100000
  - Minimum: 0

- **OutputLinePolarity**

  Output signal polarity. The enumeration names and values are as follows:
  - SameToSource (0): Same as signal source
  - OppositeToSource (1): Opposite to signal source

- **OutputLinePullUp**

  Output signal pull-up voltage. The enumeration names and values are as follows:
  - Internal_3V3 (0): Internal 3.3V pull-up voltage
  - External_5V_to_24V (1): External 5~24V pull-up voltage

- **ScanDirectionWorkingMode**

  Scan direction working mode. The enumeration names and values are as follows:
  - InternalControl (0): Internal control
  - ExternalControl (1): External control

- **ScanDirectionIntType**

  Scan direction internal control type. The enumeration names and values are as follows:
  - BottomToTop (0): From bottom to top
  - TopToBottom (1): From top to bottom

- **ScanDirectionExtTriggerSource**

  Scan direction external control trigger source. The enumeration names and values are as follows:
  - Line2 (2): Line2

- **ScanDirectionExtTriggerPolarity**

  Scan direction external control trigger polarity. The enumeration names and values are as follows:
  - Original (0): Original polarity
  - Reverse (1): Opposite polarity

7.3.5 Image Correction Register

Table 10 Image Correction Register

Name	Address	Size	Interface	Access	Visibility
SpatialCorrectionEnable	0x60c4	4	B	RW	Expert
SpatialCorrectionFactor	0x60c8	4	F	RW	Beginner

TDIMode(Fine)	0x60cc	4	F	RW	Expert
ColorCorrectionEnable	0x60d0	4	B	RW	Expert
ColorCorrectionRRGain	0x61b4	4	I	RW	Beginner
ColorCorrectionRGGain	0x61b8	4	I	RW	Beginner
ColorCorrectionRBGain	0x61bc	4	I	RW	Beginner
ColorCorrectionGRGain	0x61c0	4	I	RW	Beginner
ColorCorrectionGGGain	0x61c4	4	I	RW	Beginner
ColorCorrectionGBGain	0x61c8	4	I	RW	Beginner
ColorCorrectionBRGain	0x61cc	4	I	RW	Beginner
ColorCorrectionBGGain	0x61d0	4	I	RW	Beginner
ColorCorrectionBBGain	0x61d4	4	I	RW	Beginner

- **SpatialCorrectionEnable**

  Enable spatial correction. Check this parameter to enable spatial correction function.

- **SpatialCorrectionFactor**

  Spatial correction coefficient. The parameter range is as follows:

  - Maximum: 2.0
  - Minimum: 0.5

- **TDIMode(Fine)**

  Fine-tuning of time delay integration. The parameter range is as follows:

  - Maximum: 0.998
  - Minimum: -0.998

- **ColorCorrectionEnable**

  Enable color correction. Check this parameter to enable color correction function and only color camera can set this parameter.

- **ColorCorrectionRRGain**

  Red gain of R channel for color correction, only color camera can set this parameter. The parameter range is as follows:

  - Maximum: 2047
  - Minimum: 256
  - Increment: 1

- **ColorCorrectionRGGain**

  Green gain of R channel for color correction, only color camera can set this parameter. The parameter range is as follows:

  - Maximum: 2047
  - Minimum: -2047
  - Increment: 1

- **ColorCorrectionRBGain**

Blue gain of R channel for color correction, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 2047
- Minimum: -2047
- Increment: 1

- **ColorCorrectionGRGain**

Red gain of G channel for color correction, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 2047
- Minimum: -2047
- Increment: 1

- **ColorCorrectionGGGain**

Green gain of G channel for color correction, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 2047
- Minimum: 256
- Increment: 1

- **ColorCorrectionGBGain**

Blue gain of G channel for color correction, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 2047
- Minimum: -2047
- Increment: 1

- **ColorCorrectionBRGain**

Red gain of B channel for color correction, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 2047
- Minimum: -2047
- Increment: 1

- **ColorCorrectionBGGain**

Green gain of B channel for color correction, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 2047
- Minimum: -2047
- Increment: 1

- **ColorCorrectionBBGain**

Blue gain of B channel for color correction, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 2047
- Minimum: 256
- Increment: 1

7.3.6 Analog Control Register

Table 11 Analog Control Register

Name	Address	Size	Interface	Access	Visibility
AnalogGain	0x612c	4	E	RW	Beginner

- **AnalogGain**

  Analog gain. The enumeration names and values are as follows:
  - Gain_x1 (1)
  - Gain_x2 (2)
  - Gain_x3 (3)
  - Gain_x4 (4)
  - Gain_x5 (5)
  - Gain_x6 (6)
  - Gain_x7 (7)
  - Gain_x8 (8)

7.3.7 Digital Control Register

Table 12 Digital Control Register

Name	Address	Size	Interface	Access	Visibility
DigitalGain	0：0xa068 1：0xf958 2：0xf95c 3：0xf960 4：0xf964 5：0xf968 6：0xf96c 7：0xf970	4	F	RW	Beginner
DigitalOffset	0x606c	4	I	RW	Beginner
WhiteBalanceRedGain	0x6070	4	F	RW	Expert
WhiteBalanceGreenGain	0x6074	4	F	RW	Expert
WhiteBalanceBlueGain	0x607c	4	F	RW	Expert
WhiteBalanceEnable	0x608c	4	B	RW	Expert
WhiteBalanceInitialize	0x6080	4	C	WO	Expert
WhiteBalanceCalibrate	0x6080	4	C	WO	Expert
BlackLevel	0x6058	4	I	RW	Guru

- **DigitalGain**

Digital gain. The parameter range is as follows:

- Maximum: 8
- Minimum: 0.1

- **DigitalOffset**

Digital offset. The parameter range is as follows:

- Maximum: 1023
- Minimum: -1023
- Increment: 1

- **WhiteBalanceRedGain**

White balance R channel gain, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 4096
- Minimum: 256
- Increment: 1

- **WhiteBalanceGreenGain**

White balance G channel gain, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 4096
- Minimum: 256
- Increment: 1

- **WhiteBalanceBlueGain**

White balance B channel gain, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 4096
- Minimum: 256
- Increment: 1

- **WhiteBalanceEnable**

Enable white balance function, only color camera can set this parameter.

- **WhiteBalanceInitialize**

Initialize white balance correction, which can reset white balance parameters to default setting. Only color camera can set this parameter.

- **WhiteBalanceCalibrate**

Execute white balance correction, that is, execute white balance correction in current condition. Only color camera can set this parameter.

- **BlackLevel**

Black level, used to adjust the bottom value of camera output in dark field condition. The smaller

black level is, the smaller gray value of image in dark field condition is. The parameter range is as follows:

- Maximum: 31
- Minimum: 0
- Increment: 1

7.3.8 Flat Field Correction Register

Table 13 Flat Field Correction Register

Name	Address	Size	Interface	Access	Visibility
FFC_Enable	0x6100	4	B	RW	Beginner
FFC_ReferenceMode	0x60d8	4	B	RW	Beginner
FFC_TargetRed	0x60e0	4	I	RW	Beginner
FFC_TargetGreen	0x60e4	4	I	RW	Beginner
FFC_TargetBlue	0x60e8	4	I	RW	Beginner
FFC_TargetMono	0x60f8	4	I	RW	Beginner
FFC_OffsetX	0x60ec	4	I	RW	Beginner
FFC_Width	0x60f0	4	I	RW	Beginner
FFC_LineSelect	0x60d4	4	E	RW	Beginner
FFC_Start	0x6104	4	C	WO	Expert
FFC_Reset	0x6104	4	C	WO	Expert
FFC_State	0x61e8	4	E	RO	Beginner

- **FFC_Enable**

  Enable flat field correction.

- **FFC_ReferenceMode**

  Flat field correction reference mode. Check this parameter to correct gray value of the selected region to the set value.

- **FFC_TargetRed**

  Target value of flat field correction R channel, only color camera can set this parameter. The parameter range is as follows:

  - Maximum: 1023
  - Minimum: 128
  - Increment: 1

- **FFC_TargetGreen**

  Target value of flat field correction G channel, only color camera can set this parameter. The parameter range is as follows:

  - Maximum: 1023
  - Minimum: 128
  - Increment: 1

- **FFC_TargetBlue**

  Target value of flat field correction B channel, only color camera can set this parameter. The parameter range is as follows:

  - Maximum: 1023
  - Minimum: 128
  - Increment: 1

- **FFC_TargetMono**

  Target gray value of flat field correction monochrome channel, only monochrome camera can set this parameter. The parameter range is as follows:

  - Maximum: 1023
  - Minimum: 128
  - Increment: 1

- **FFC_OffsetX**

  Horizontal offset of flat field correction region. The parameter range is as follows:

  - Minimum: 0
  - Increment: 16

- **FFC_Width**

  Width of flat field correction region. The parameter range is as follows:

  - Minimum: 256
  - Increment: 16

- **FFC_LineSelect**

  Select which line to set flat field correction. The enumeration names and values are as follows:

  - Red (1): R channel
  - Green (2): G channel
  - Blue (4): B channel
  - Mono (3): monochrome channel
  - All (7): All channel

- **FFC_Start**

  Start flat field correction.

- **FFC_Reset**

  Reset flat field correction to default setting.

- **FFC_State**

  Flat field correction state. The enumeration names and values are as follows:

  - Success (0): Success
  - InvalidArgument (1): Invalid parameter
  - AccessDeny (2): Access deny

- ExposureTimeTooLow (3): Exposure time is too low
- ExposureTimeTooHigh (4): Exposure time is too high
- ValidPixelTooFew (5): Valid pixels are too few

7.3.9 User Set Control Register

Table 14 User Set Control Register

Name	Address	Size	Interface	Access	Visibility
UserSetSelector	0x6108	4	E	RW	Beginner
UserSetLoad	0x610c	4	C	WO	Beginner
UserSetSave	0x6110	4	C	WO	Beginner

- **UserSetSelector**

  User configuration selector. The enumeration names and values are as follows:
  - Default (0): Factory configuration
  - Usert1 (1): User configuration 1
  - User2 (2): User configuration 2

- **UserSetLoad**

  Load selected camera configuration.

- **UserSetSave**

  Save selected camera configuration.

7.3.10 Transport Layer Control Register

Table 15 Transport Layer Control Register

Name	Address	Size	Interface	Access	Visibility
PayloadSize	/	/	I	/	Expert
GevVersionMajor	/	/	I	/	Expert
GevVersionMinor	/	/	I	/	Expert
GevDeviceModeIsBigEndian	/	/	B	/	Guru
GevDeviceModeCharacterSet	/	/	E	/	Guru
GevMACAddress	/	/	I	/	Beginner
GevSupportedOptionSelector	/	/	E	/	Expert
GevSupportedOption	/	/	B	/	Expert
GevCurrentIPConfigurationLLA	/	/	B	/	Beginner
GevCurrentIPConfigurationDHCP	/	/	B	/	Beginner
GevCurrentIPConfigurationPersistentIP	/	/	B	/	Beginner
GevCurrentIPAddress	/	/	I	/	Beginner
GevCurrentSubnetMask	/	/	I	/	Beginner
GevCurrentDefaultGateway	/	/	I	/	Beginner

GevFirstURL	/	/	S	/	Guru
GevSecondURL	/	/	S	/	Guru
GevPersistentIPAddress	0x064c	4	I	RW	Beginner
GevPersistentSubnetMask	0x065c	4	I	RW	Beginner
GevPersistentDefaultGateway	0x066c	4	I	RW	Beginner
GevMessageChannelCount	/	/	I	/	Expert
GevStreamChannelCount	/	/	I	/	Expert
GevHeartbeatTimeout	0x0938	4	I	RW	Guru
GevCCP	/	/	E	/	Guru
GevSCPHostPort	/	/	I	/	Guru
GevSCPSFireTestPacket	/	/	C	/	Guru
GevSCPSDoNotFragment	/	/	B	/	Guru
GevSCPSBigEndian	/	/	B	/	Guru
GevSCPSPacketSize	/	/	I	/	Expert
GevSCPD	0x0d08	4	I	RW	Expert
GevSCDA	0x0d18	4	I	RW	Guru
GevGVCPPendingAck	0x0954	4	B	RW	Expert
DeviceLinkSpeed	0x0670	4	I	RO	Expert

- **PayloadSize**
  Payload size transferred.

- **GevVersionMajor**
  GigE Vision major version.

- **GevVersionMinor**
  GigE Vision minor version.

- **GevDeviceModeIsBigEndian**
  Whether device stores data in big-endian mode.

- **GevDeviceModeCharacterSet**
  Type of the storage character set.

- **GevMACAddress**
  Device MAC address.

- **GevSupportedOptionSelector**
  GigE Vision function list.

- **GevSupportedOption**
  Whether function is supported.

- **GevCurrentIPConfigurationLLA**
  Enable LLA configuring IP.

- **GevCurrentIPConfigurationDHCP**
  Enable DHCP configuring IP.

- **GevCurrentIPConfigurationPersistentIP**
  Enable static configuring IP.

- **GevCurrentIPAddress**
  Current IP address.

- **GevCurrentSubnetMask**
  Current subnet mask.

- **GevCurrentDefaultGateway**
  Current default gateway.

- **GevFirstURL**
  XML storage address first selection.

- **GevSecondURL**
  XML storage address second selection.

- **GevPersistentIPAddress**
  Static IP address.

- **GevPersistentSubnetMask**
  Static subnet mask.

- **GevPersistentDefaultGateway**
  Static default gateway.

- **GevMessageChannelCount**
  Control channel count.

- **GevStreamChannelCount**
  Data channel count.

- **GevHeartbeatTimeout**
  Heartbeat timeout time, unit is ms.

- **GevCCP**
  Device Access rights.

- **GevSCPHostPort**
  Communication host data port.

- **GevSCPSFireTestPacket**
  Send test packet.

- **GevSCPSDoNotFragment**
  Prohibit IP subcontracting.

- **GevSCPSBigEndian**
  Big-endian sequence of data channel.

- **GevSCPSPacketSize**
  Packet size.

- **GevSCPD**
  Packet delay.

- **GevSCDA**
  Image data destination address.

- **GevGVCPPendingAck**
  Whether device supports request suspension.

- **DeviceLinkSpeed**
  Device link speed, unit is Mbps.

8 FAQ

- **If the camera cannot be connected to computer,**

① Ensure that the network interface cable is OK.
② Ensure that the camera IP address and computer IP address are on the same subnet.
③ Ensure that the network card is working in Gigabit Ethernet mode.

- **If the camera has no image output in external trigger mode,**

① Ensure that the external input pulse is normal.
② Ensure that the camera has received the trigger pulse correctly (it can be confirmed by the status indicator display).

- **If temperature of camera casing is abnormal,**

① Ensure that the voltage range of external connected power supply is normal.
② If the casing is hot or the camera emits smoke, immediately cut off the power and stop using the camera, then contact us for technical support.

- **If images are dark,**

① Ensure that the sensor aperture on the casing is not blocked.
② Ensure that the exposure time and gain are set properly.

- **If the images are not clear,**

① Ensure that the sensor glass is clean.
② Ensure that the camera status indicator is normal.

- **If the camera cannot output images,**

① Check that the Gigabit Ethernet interface is normal, it can be confirmed by the test image.
② Check whether the power supply is normal by the camera indicator status.
③ Check whether the external pulse input is normal in the external trigger mode by the camera indicator.

If users have any problems during the use of the camera, please contact our technical support in time, we will provide you with the service as soon as possible.