(T)PH9KCXP12 Series Line Scan Camera User Manual

(V0.3 Oct.29, 2024)

Hefei I-TEK Optoelectronics Co., LTD.

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

Revision History

Revision	Date	Description
0.1	2024/08/01	● Initial version
0.2	2024/10/23	● Add information for uncooled and UV camera
0.3	2024/10/29	● Update structure diagram of uncooled air version camera ● Correct sensor type

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. Please use a soft object dipped in a small amount of 70% alcohol to wipe it off.

- **Power Supply**

① The recommended voltage is +12~24V (±10%). The current must be 3.5A.
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**

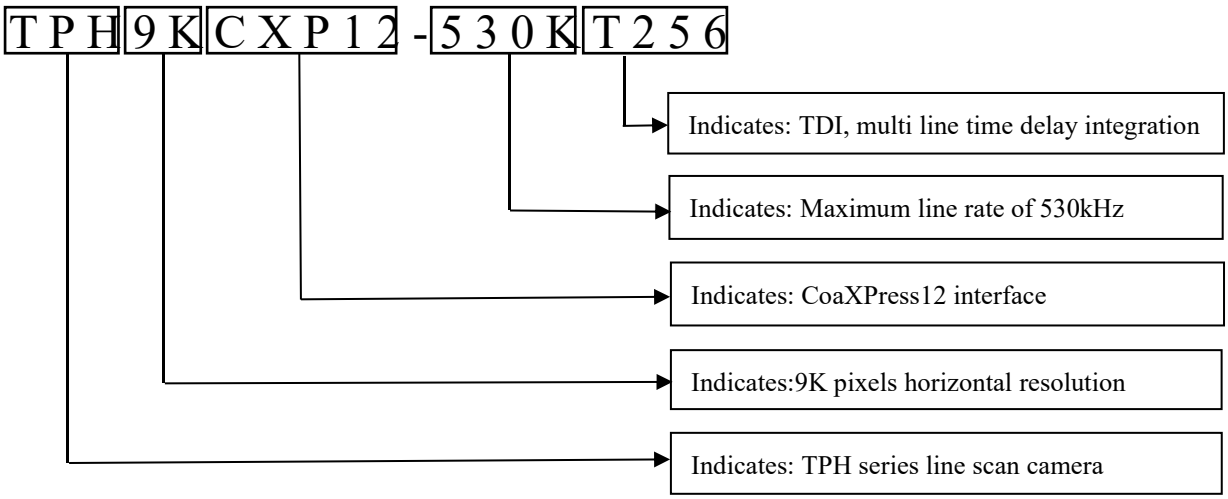
Abbreviation	Image Mode
M	Monochrome
C	Color
F	Full Color
T	Monochrome TDI (Time Delay Integration)
X	Time Division Camera
U	UV (Ultraviolet)
N	NIR (Near Infrared)

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. Indicates: 9K 256-line monochrome TDI line scan camera



3 Product Appearance

- Electric cooled water version:

- Uncooled air version:

- Uncooled fanless version:

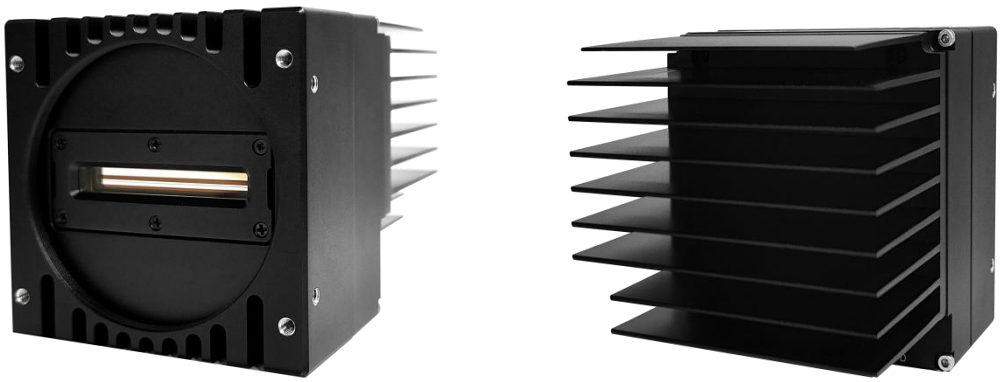


Fig. 1 Product Appearance

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

(T)PH9KCXP12 camera is designed for high-speed line scan applications in industrial automation inspection 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 CoaXPress interface. It also has features of high speed, high sensitivity and low noise.

4.1 Main Features

- Backshot CMOS Sensor
- Line Resolution 9072 Pixels
- Maximum Line Rate 530kHz
- High Sensitivity and Low Noise
- Data Format: 8/10/12bit
- Area Mode
- Binning
- Trigger Rate Adjustment
- LUT
- Flat Field Correction
- Defect Pixel Correction
- Analog Gain / Digital Gain / Offset Control
- User-configurable Scanning Direction
- Real-time Temperature Monitor

4.2 Camera Specifications

Table 1 TPH9KCXP12 Product Specifications

Model	TPH9KCXP12-530KT256	TPH9KCXP12-530KU256
Product Description	9K 256-line monochrome TDI line scan camera	9K 256-line UV TDI line scan camera
Resolution	9072 x 256	
Pixel Size	5um x 5um	
Sensor Type	Backshot CMOS	
Image Type	Monochrome	
Sensor Size	45.36 mm	
Dynamic Range	≥65.1dB	
SNR	41.8dB	
Lens Mount	M72	
Max Line Rate	529.4kHz@8bit, 422.5kHz@10bit, 300.0kHz@12bit	
Analog Gain	X1/X2/X3/X4	
Digital Gain	0.1~8	
Digital Offset	-1023~1023	

Trigger Mode	Free-Run, External Trigger
External Trigger	External IO / CXP
Exposure Control	Timed; Line Rate Control
Exposure Time	Scan mode: Follow line rate Area mode: 3us ~ 0.2s (step: 0.005us)
Data Format	8/10/12bit
Operation Temperature	0~55°C
Data Interface	CoaXPress12
Data Rate	4800MB/s
Power Supply	DC 12~24V (±10%) 3.5A
Power Consumption	26.6W
Mechanical	Electric cooled air version: 86mm x 86mm x 85.6mm Electric cooled water version: 86mm x 86mm x 108.4mm

Note: This table is for 01.0C-01.04 version of TPH9KCXP12 camera specifications, which may vary slightly from version to version.

Table 2 PH9KCXP12 Product Specifications

Model	**PH9KCXP12-530KT256**	**PH9KCXP12-530KU256**
Product Description	9K 256-line monochrome TDI line scan camera	9K 256-line UV TDI line scan camera
Resolution	9072 x 256	
Pixel Size	5um x 5um	
Sensor Type	Backshot CMOS	
Image Type	Monochrome	
Sensor Size	45.36 mm	
Dynamic Range	≥65.1dB	
SNR	41.8dB	
Lens Mount	M72	
Max Line Rate	529.4kHz@8bit, 422.5kHz@10bit, 300.0kHz@12bit	
Analog Gain	X1/X2/X3/X4	
Digital Gain	0.1~8	
Digital Offset	-4095~4095	
Trigger Mode	Free-Run, External Trigger	
External Trigger	External IO / CXP	
Exposure Control	Timed; Line rate control	
Exposure Time	Scan mode: Follow line rate Area mode: 3us ~ 0.2s (step: 0.005us)	
Data Format	8/10/12bit	
Operation Temperature	0~45°C	
Data Interface	CoaXPress12	

Data Rate	4800MB/s
Power Supply	DC 12~24V (±10%) 3.5A
Power Consumption	26.6W
Mechanical	Uncooled air version: 86mm x 86mm x 91.6mm Uncooled water version: 86mm x 86mm x 113.6mm Uncooled fanless version: 86mm x 86mm x 113.6mm

Note: This table is for F1.17-01.0F version of PH9KCXP12 camera specifications, which may vary slightly from version to version.

4.3 Camera Structure

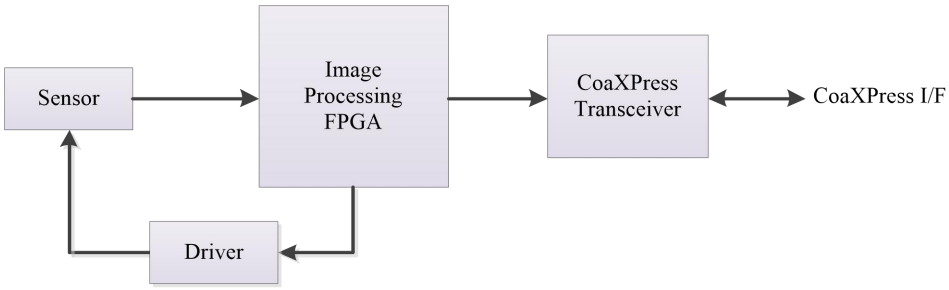


Fig. 2 Internal Implementation Structure of Camera

(T)PH9KCXP12 camera is designed based on high-speed line scanning image sensors. The pixel array is uniformly sampled and maintained by a backshot control system, converted from analog front-end to digital signal, processed by FPGA algorithms, and transmitted to the PC frame grabber through the CoaXPress interface.

(T)PH9KCXP12 camera can accept external signal triggered acquisition, sourced from 4-pin interface signals or CXP signals from the CoaXPress interface.

4.4 Spectral Response

The spectral response of (T)PH9KCXP12 camera is shown in figure below.

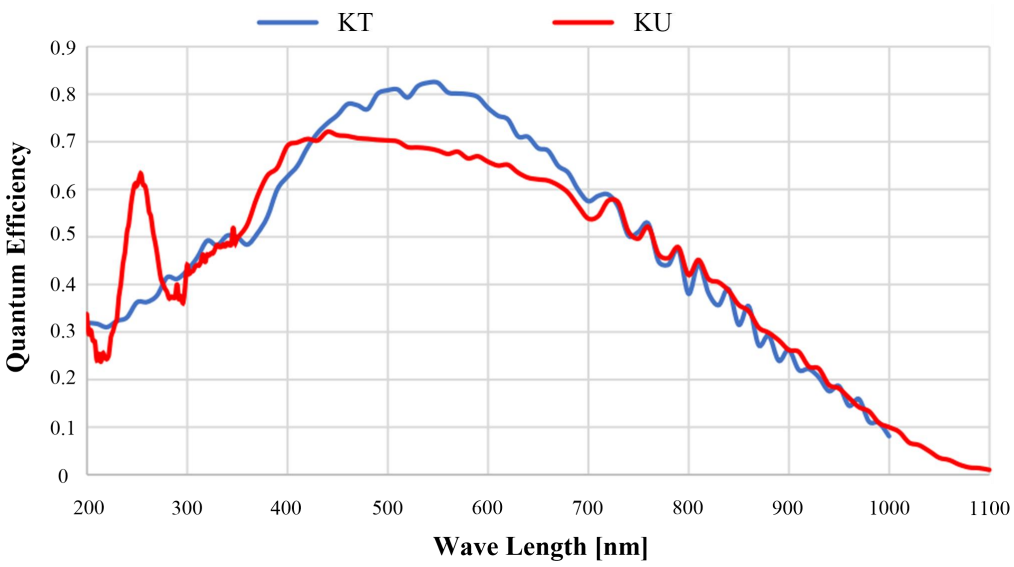


Fig. 3 Spectral Response of Camera

4.5 Environmental Requirements

(1) Operating temperature: Electric cooled version: 0℃~55℃; Uncooled version: 0℃~45℃; 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.

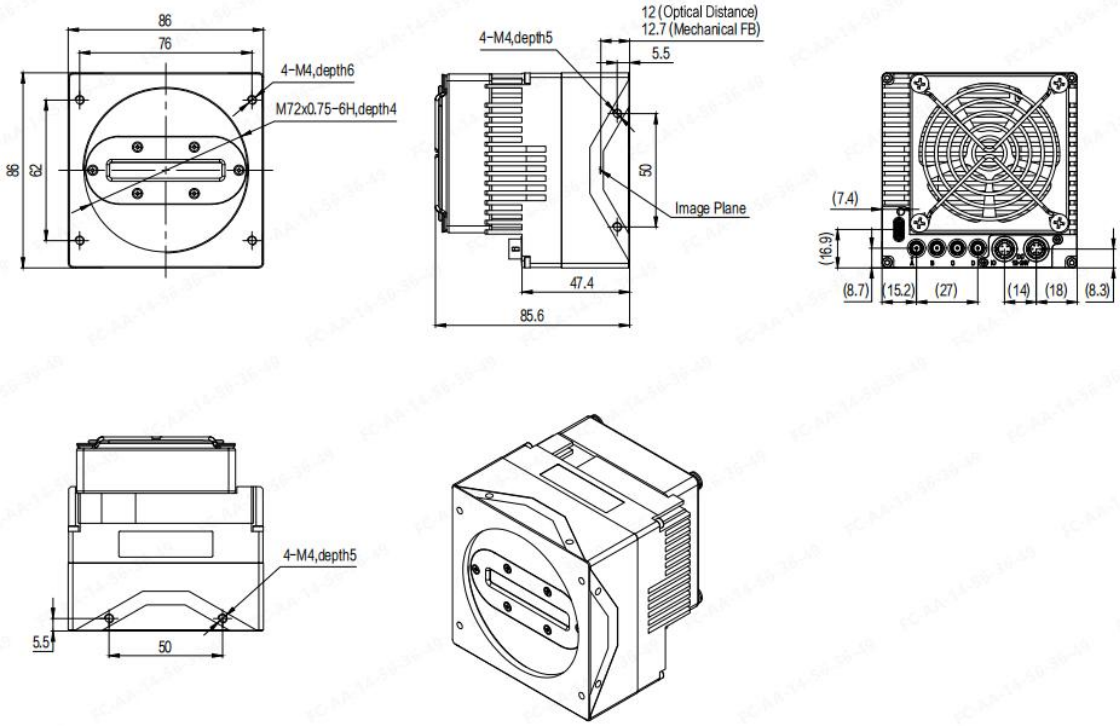
4.6 RoHS Certification

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

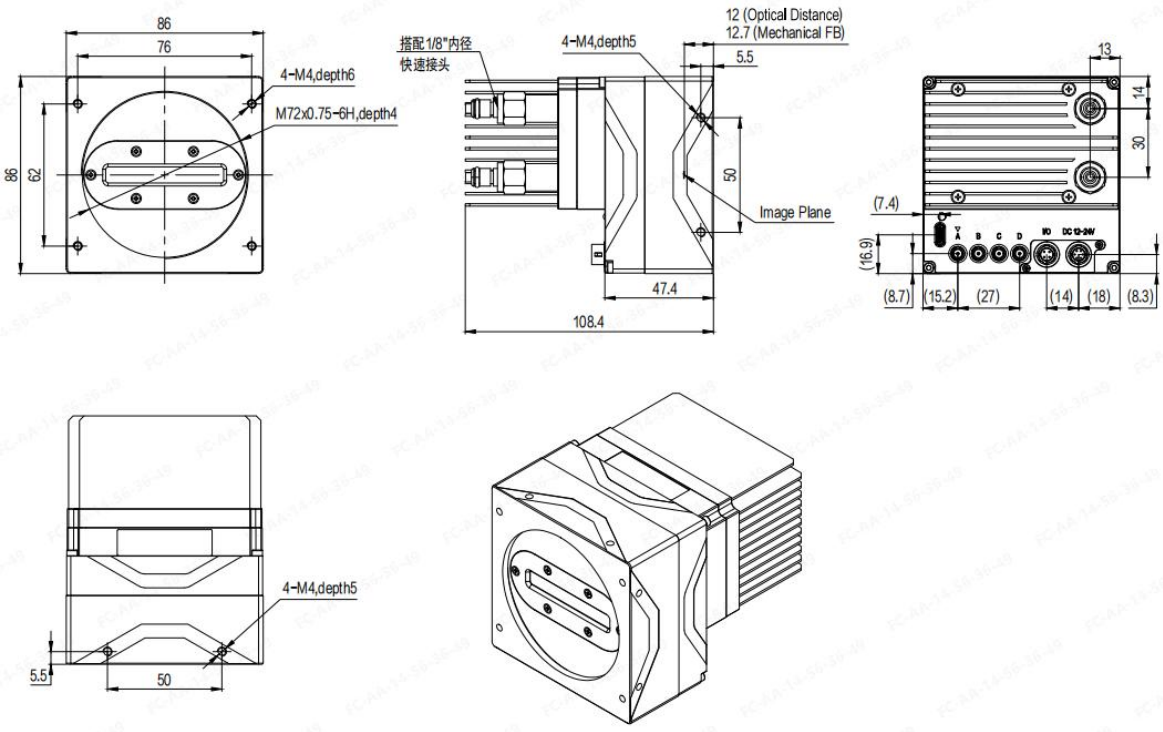
5 Mechanical Dimensions and Interfaces

5.1 Mechanical Dimensions

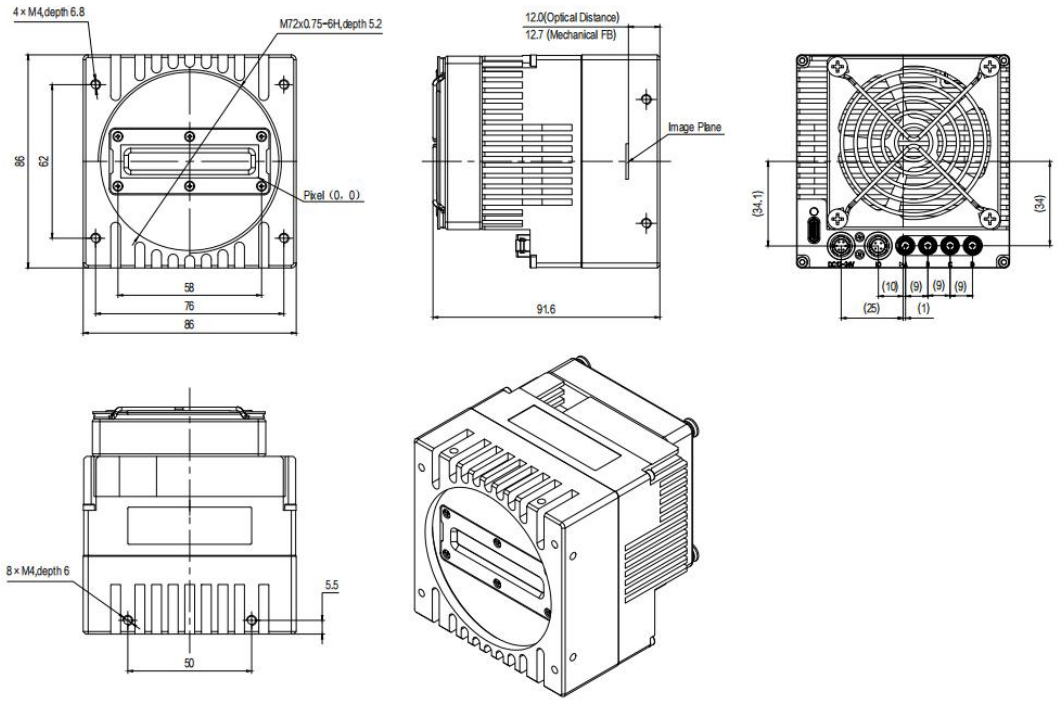
- Electric cooled air version:



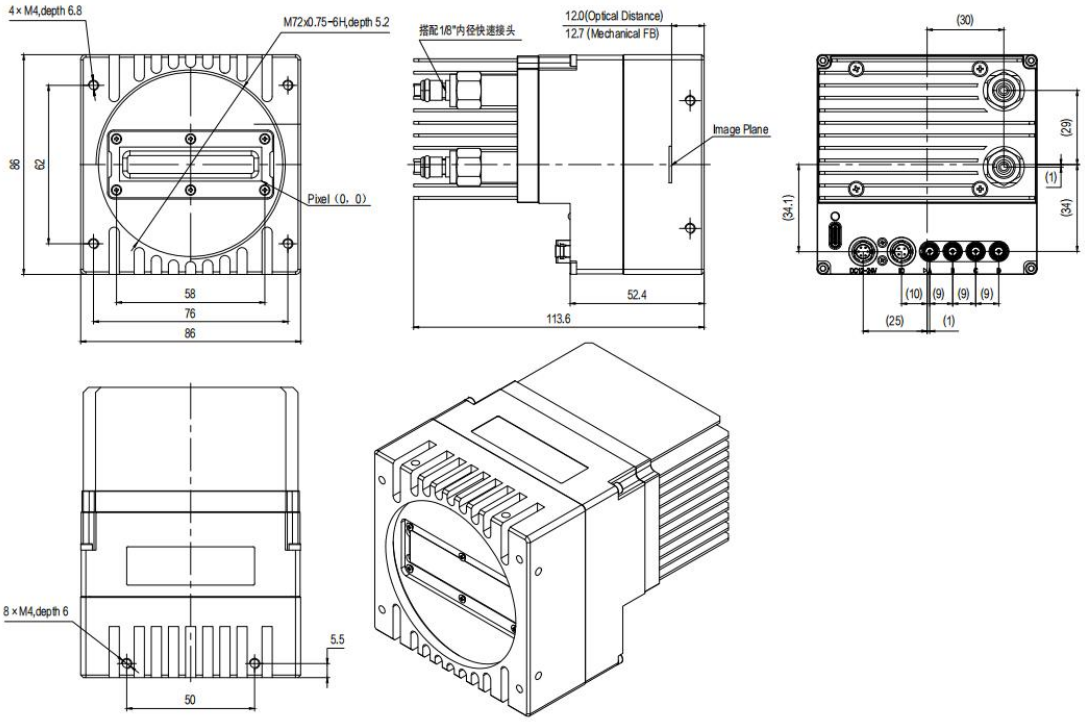
- Electric cooled water version:



- Uncooled air version:



- Uncooled water version:



- Uncooled fanless version:

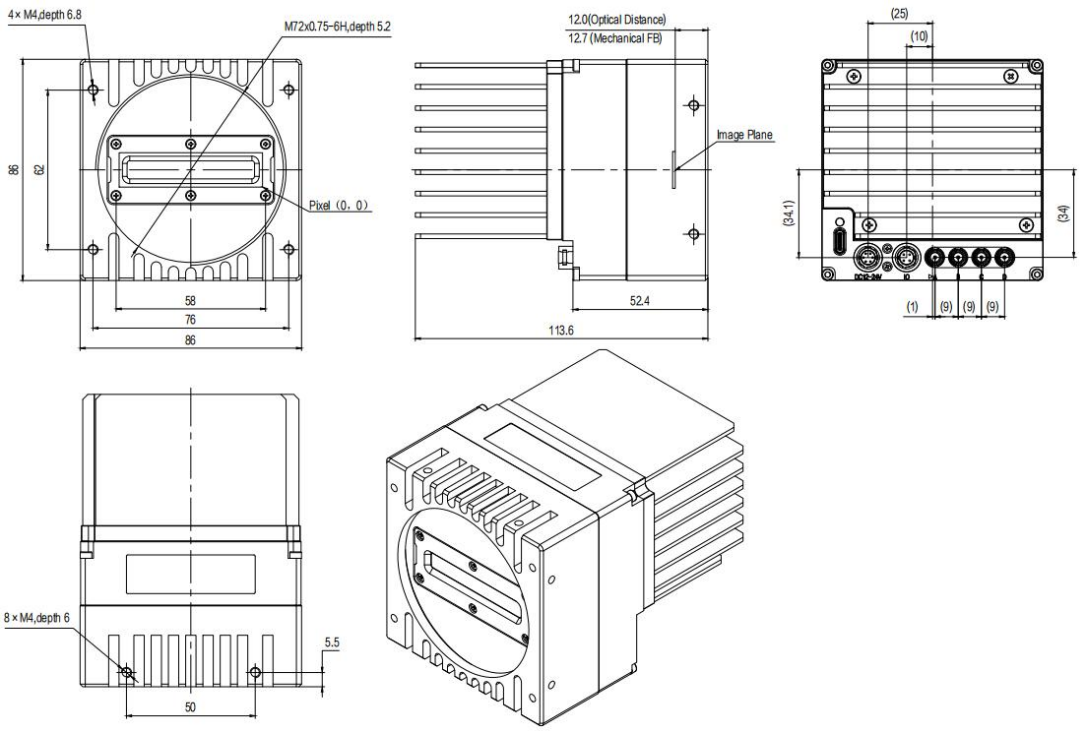


Fig. 4 Camera Mechanical Dimensions

5.2 Camera Interface

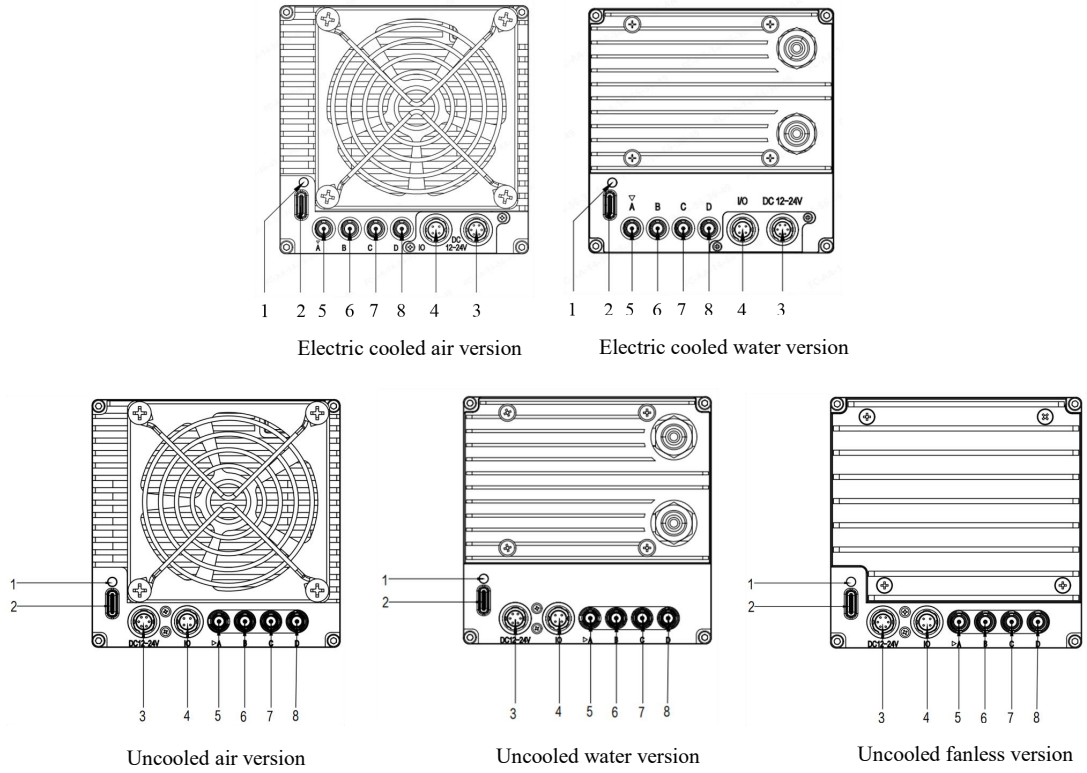


Fig. 5 Interfaces of Camera

① Camera Status Indicator

② Type-C Interface
③ 6-pin Power Input
④ 4-pin Control Interface
⑤ CoaXPress Connection A **(Master)**
⑥ CoaXPress Connection B
⑦ CoaXPress Connection C
⑧ CoaXPress Connection D

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 Interface

The power interface adopts a 6-pin connector with the model:
Hirose HR10A-7R-6PB(Male).

Corresponding connector on the cable model:
Hirose HR10A-7P-6S(Female).

The power interface on the back of the camera is shown as follows:

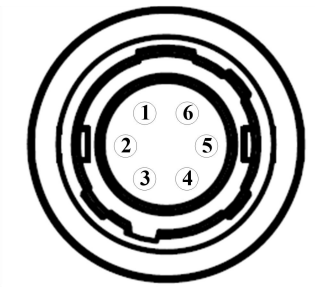


Fig. 6 Pin Assignments for Interface

Table 4 Interface Pin Definition

Signal	Pin	Signal	Pin
VCC	1	GND	4
VCC	2	GND	5
VCC	3	GND	6

5.2.3 Control Interface

The control interface adopts a 4-pin connector with the model:
Hirose HR10A-7R-4PB(Male).

Corresponding connector on the cable model:
Hirose HR10A-7P-4S(Female).

The control interface on the back of the camera is shown as follows:

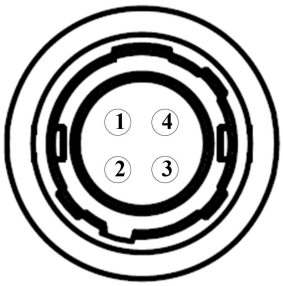


Fig. 7 Control Interface Plugin

Table 5 Control Interface Plugin Pin Definition

Signal	Pin	Signal	Pin
Line1+	1	Line2_GND	3
Line1 -	2	Line2_IN	4

The external trigger circuit is shown as follows:

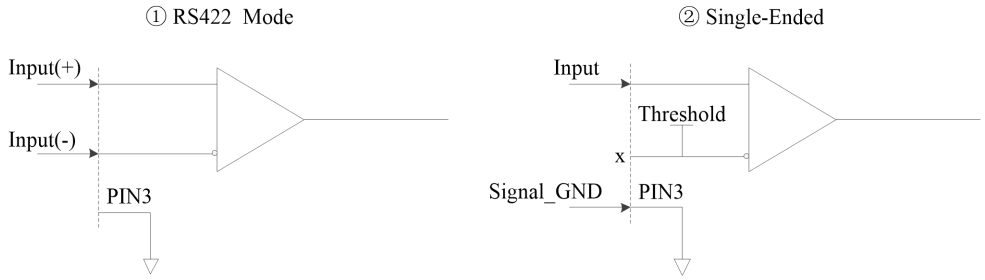
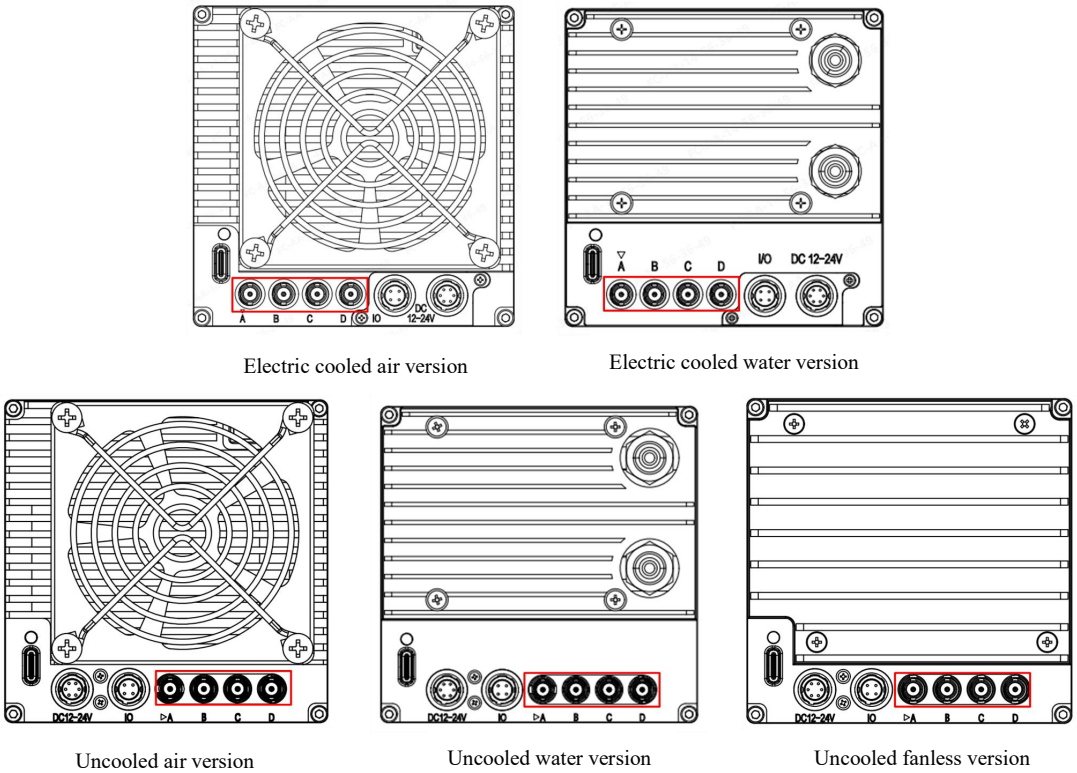


Fig. 8 Diagram of Trig Input Circuit

- Input voltage range: 3.3~24V

5.2.4 Data Interface

(T)PH9KCXP12 camera implements standard Quad CoaXPress protocol, and data interface is four Micro BNC sockets on the back of camera. The data interface on the back of camera is shown in the red box below:



Electric cooled air version

Electric cooled water version

Uncooled air version

Uncooled water version

Uncooled fanless version

Fig. 9 Data Interface

The mechanical drawing of Micro BNC socket is as follows:

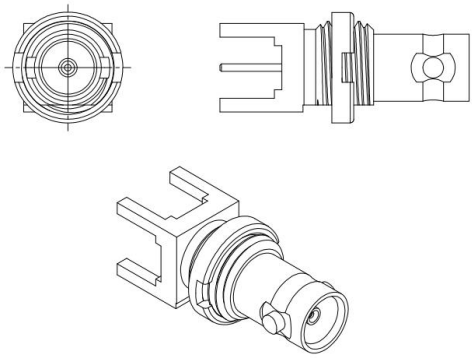


Fig. 10 Micro BNC Socket

6 Camera Features

This chapter introduces the main features of (T)PH9KCXP12 camera.

6.1 Trigger Mode

(T)PH9KCXP12 camera supports two trigger modes: Free-Run mode, External Pulse mode.

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.

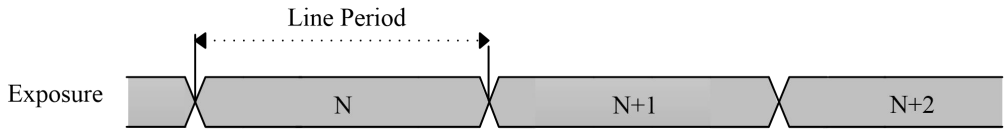


Fig. 11 Free-Run Mode

In Free-Run mode, exposure time can be controlled by line rate (reciprocal of line period). The internal running sequence of camera is shown in the figure above.

6.1.2 External Pulse Mode

In External Pulse mode, camera starts exposure at the rising edge of the external trigger signal, and the line period at this time is determined by the interval between the rising edges of the external trigger pulse.

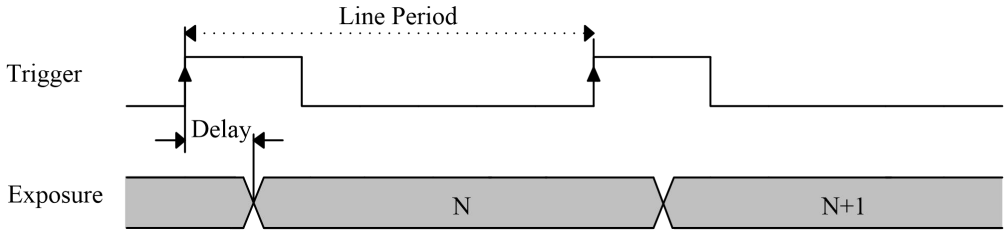


Fig. 12 External Pulse Mode

6.2 Trigger Rescale

In an ideal situation, when camera images objects in uniform motion, the image quality obtained can meet the user's needs. In fact, due to the non-uniform motion of objects and the imprecise matching of motion speed and image taking speed, users need to adjust the trigger rate to achieve ideal shooting conditions.

(T)PH9KCXP12 camera can select a specified number of trigger signals through a smooth window for rate averaging processing to obtain rate stable trigger signals. At the same time, the trigger signal rate can be precisely adjusted through functions such as rate division, multiple, and smoothing coefficient, so that the object's motion speed matches the camera's image acquisition speed perfectly, thus meeting the user's demand for high-quality acquisition.

6.3 Area Mode

(T)PH9KCXP12 camera has a resolution of 9072 x 256, which can be used as both a TDI line scan camera and an area scan camera. When used as an area scan camera, the image height is fixed at 256, and the exposure time can be independently set in area mode.

6.4 Binning

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

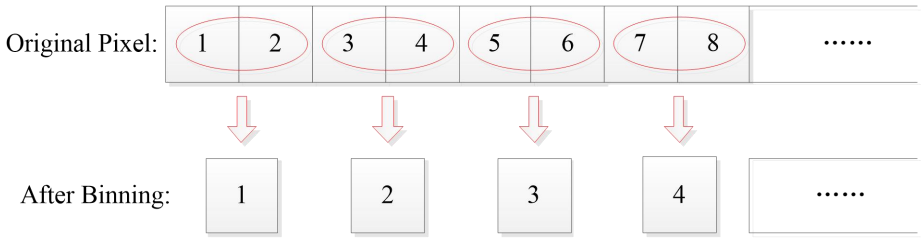


Fig. 13 Horizontal Binningx2

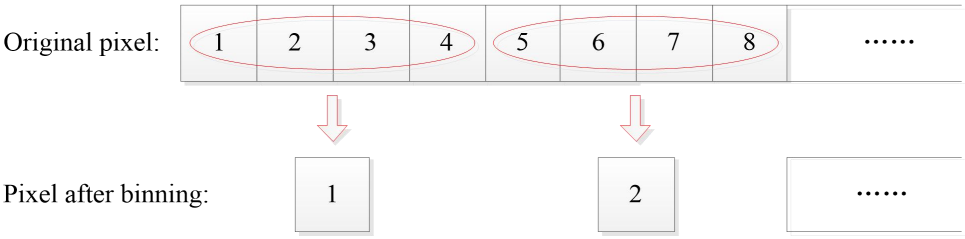


Fig. 14 Horizontal Binningx4

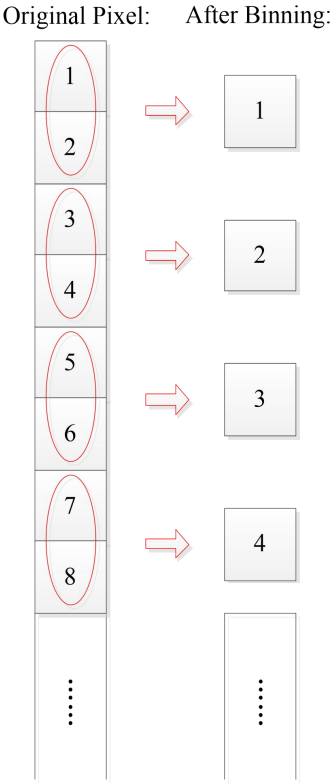


Fig. 15 Vertical Binningx2

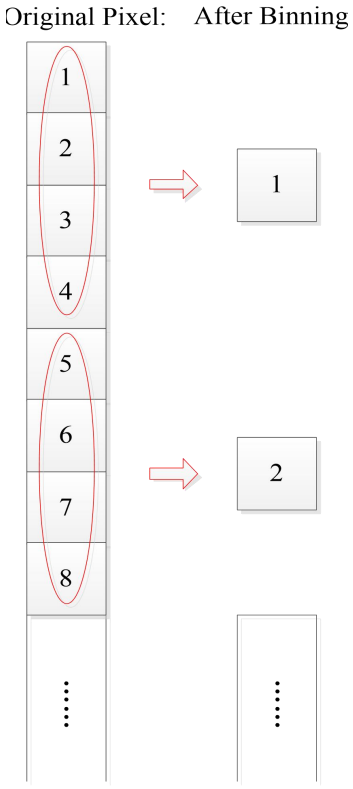
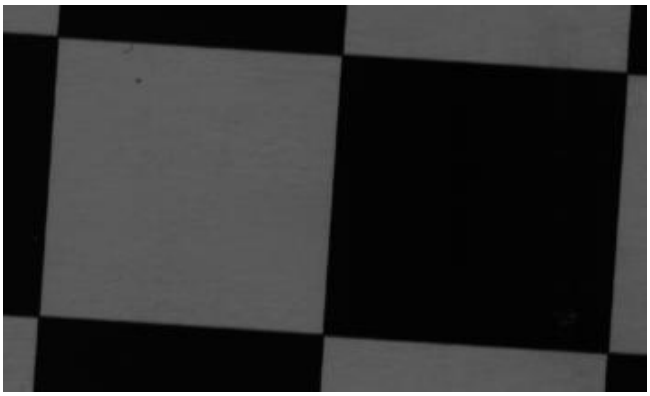


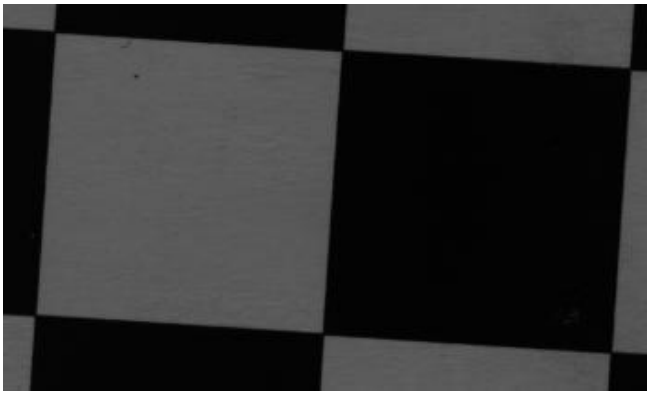
Fig. 16 Vertical Binningx4

6.5 Time Delay Integration

Using a multi line sensor camera, adjacent exposures can place multiple rows of pixels in the same position, and adding their values can increase pixel responsiveness. If multiple lines of pixels are averaged, the signal-to-noise ratio of the image can be improved. In order to ensure that multiple lines of pixels from adjacent exposures are in the same position, the aspect ratio of the image needs to be 1:1, and the vertical scanning direction needs to be set correctly, otherwise it will cause blurred edges of the image.



(a) Blurred Edges



(b) Clear Edges

Fig 17 Time Delay Integration

6.6 Camera Scanning Direction

The scanning direction of (T)PH9KCXP12 camera is divided into horizontal scanning direction and vertical scanning direction, as shown in the following figure.

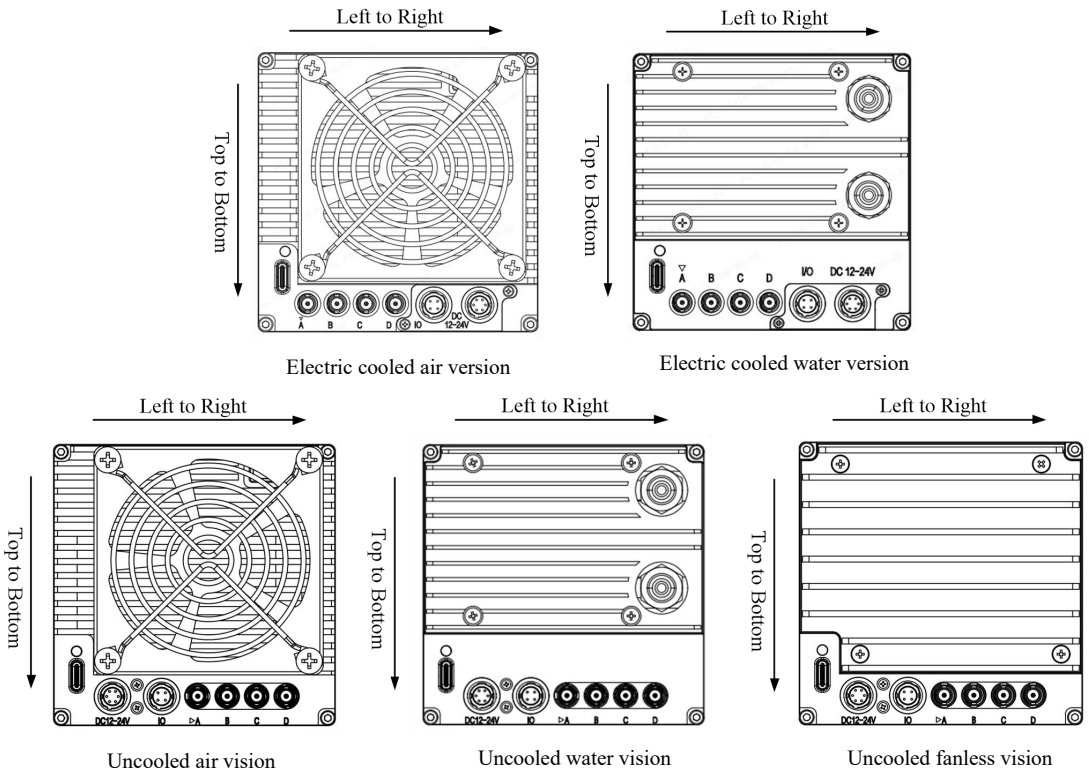
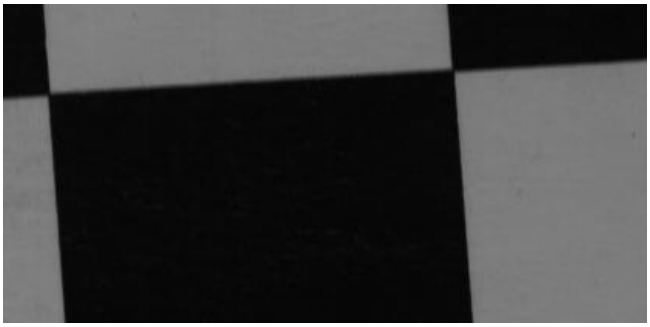


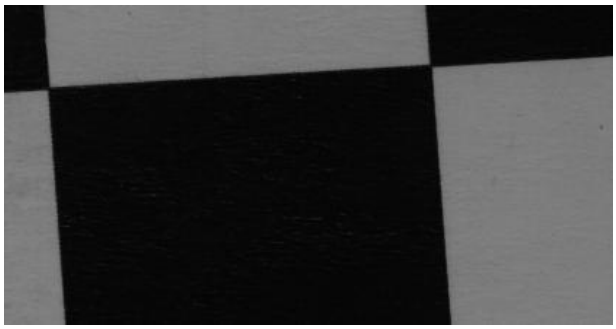
Fig.18 Camera Scanning Direction

Horizontal scanning direction supports two scanning directions: left to right and right to left.

Vertical scanning direction supports two scanning directions: bottom to top and top to bottom. Note that when the vertical scanning direction does not match the direction of object movement, it can cause image edges to blur.



(a) Opposite to the Direction of Object Movement



(b)Same as the Direction of Object Movement

Fig.19 Vertical Scanning Direction

6.7 LUT

The LUT uses a 12bit input and 12bit output LUT to map and convert the values of the original image. Users can use this function to implement gamma correction.

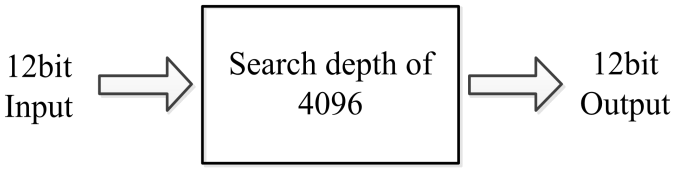


Fig. 20 LUT Structure

The following figure is the LUT mapping curve with Gamma = 0.5:

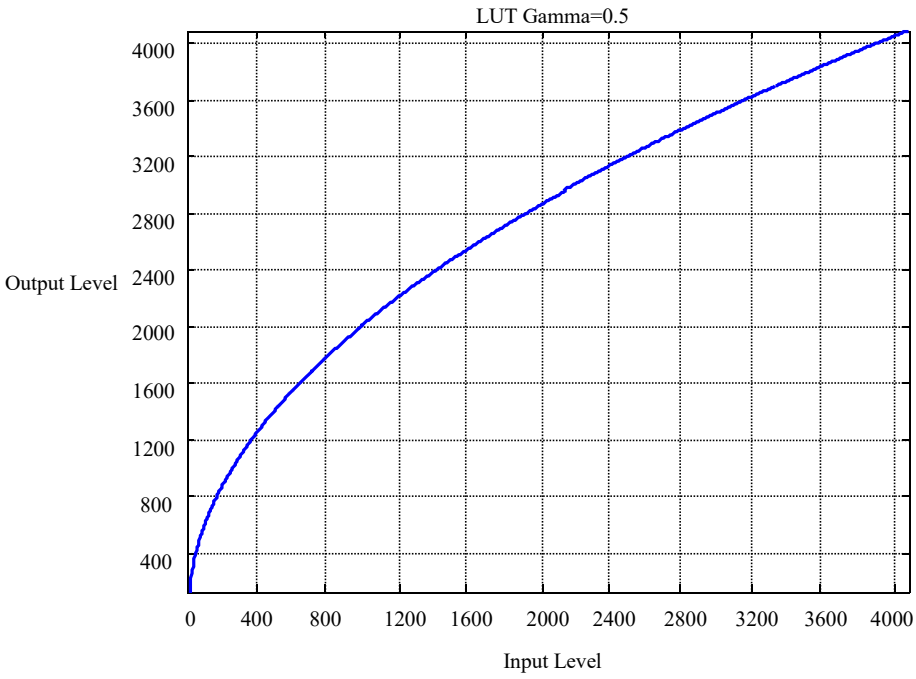


Fig. 21 LUT: Gamma=0.5

6.8 Defect Pixel Correction

Due to the defects of the material itself and the issue with the process flow of semiconductor production, there are usually a certain number of pixels in area scan imaging sensors that cannot properly response to the input light, which we call defect pixels. (T)PH9KCXP12 camera provides with defect pixel automatic correction feature. The defect pixel information of the imaging sensor is written into the camera before the camera is delivered out of the factory. Users can control whether to enable the defect pixel correction, add new defect pixels and read out the current defect pixel list from the camera.

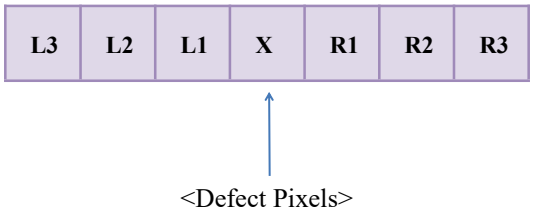


Fig22 Position of Defect Pixels to be Corrected

Define the following adjacent pixels L3, L2, L1, X, R1, R2, R3, with specific replacement rules as follows:

If X is at the beginning of the line and R1 is not a bad dot, then X is replaced with R1;

If X is the beginning of the line and R1 is a bad dot, then X is replaced with R2;

If X is at the end of the line and L1 is not a bad dot, then X is replaced with L1;

If X is at the end of the line and L1 is a bad dot, then X is replaced with L2;

If X is the middle pixel and L1 is not a bad pixel, then X is replaced with L1;

If X is the middle pixel, L1 is a bad pixel, and R1 is not a bad pixel, then X is replaced with R1;

If X is the middle pixel, and L1 and R1 are bad pixels, and L2 is not a bad pixel, then X is replaced with L2;

If X is the middle pixel and L1, L2, and R1 are bad pixels, then X is replaced with R2.

Note: If there are more than 4 consecutive bad points, it will result in the replacement of bad points with bad points.

6.9 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:

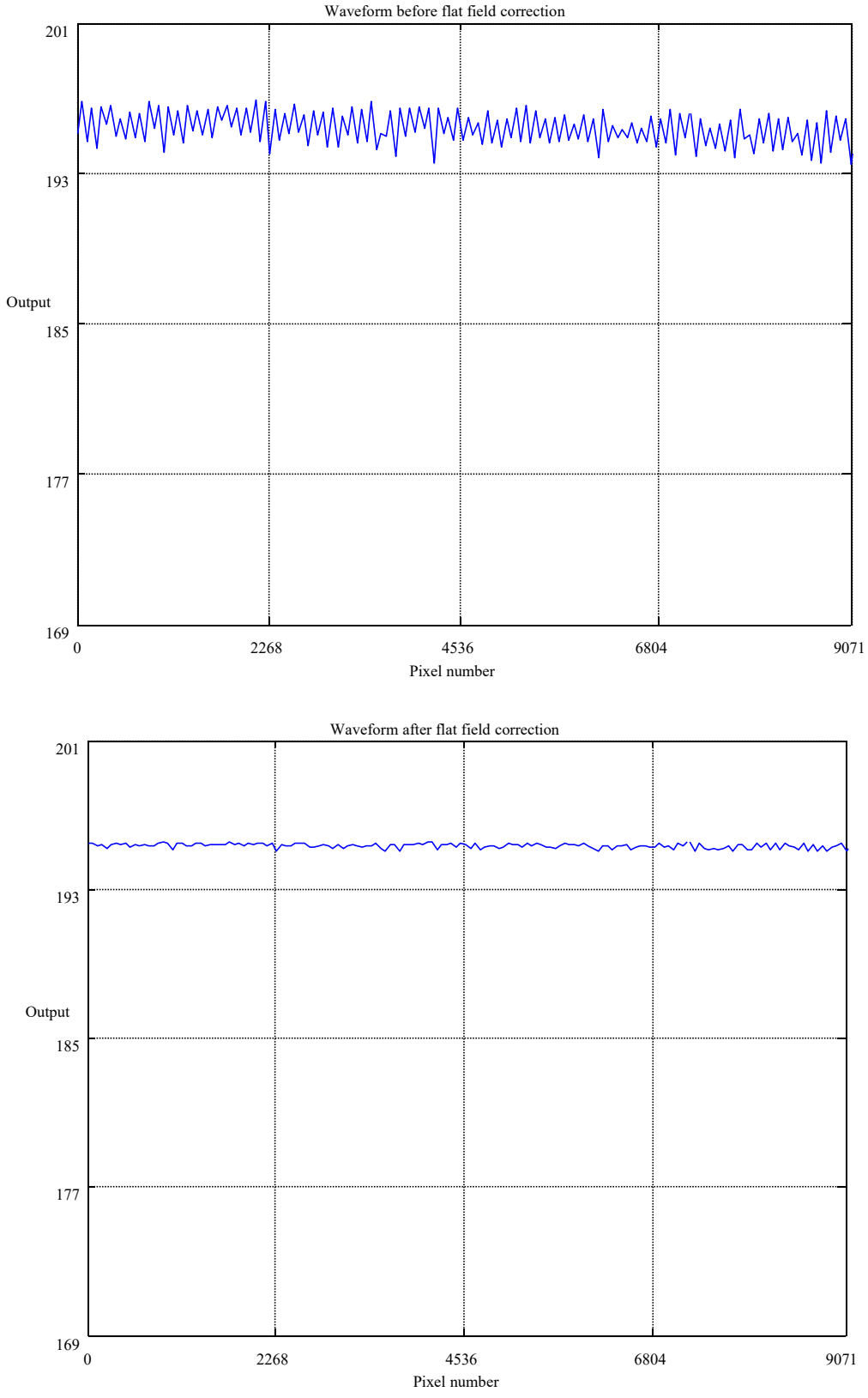


Fig. 23 Flat Field Correction Effect

6.10 Test Image

Unlike images obtained from sensors, test images are fixed style images pre-edited and stored inside

the camera. Test images can be used to test whether the data link is unobstructed.

The following figure shows the scrolling diagonal stripe mode, where the horizontal data of the output image continuously increases and starts counting again from 0 after reaching the maximum value, repeating the cycle.

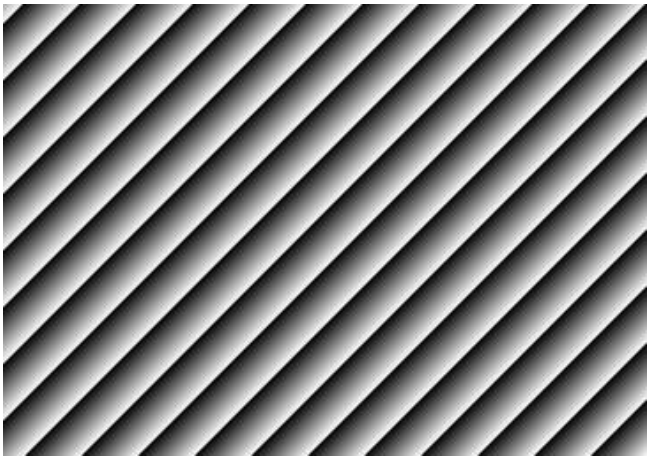


Fig. 24 Test Image

6.11 Data Format

(T)PH9KCXP12 camera processes data in 12bit data format, but provides 8bit, 10bit and 12bit output. When camera outputs 8bit data, the lowest 4bit data will be deleted. When the camera outputs 10bit of data, the lowest 2bit will be deleted.

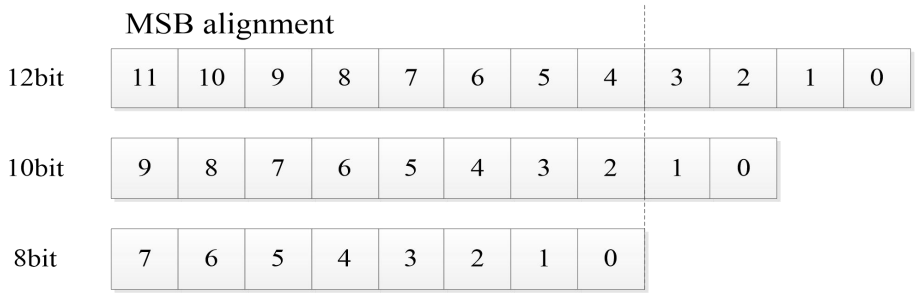


Fig. 25 Data Format

6.12 Gain and Offset

Camera gain is divided into the analog gain and digital gain.

Analog gain acts on the analog signal. By increasing analog gain, a stronger response can be generally obtained under weak illumination, thus realizing a higher SNR. Users can configure camera's analog gain.

Digital gain amplifies or reduces the data of the photoelectric conversion signal after AD, which is usually used to increase the dynamic range of the output image. Digital gain can also be used to adjust the brightness of the image. Digital offset is commonly used to adjust the overall background

brightness of an 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 gain 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

Digital offset is set for 12bit data. If the image data is 8bit or 10bit, the actual digital offset will be divided by 16 or 4.

6.13 Camera Temperature

TPH9KCXP12 camera supports real-time acquisition of camera temperature. Users can read camera temperature value to monitor the current temperature value of sensor or make some responses according to temperature value.

The recommended working environment temperature for electrically cooled camera is 0~55℃, while for uncooled camera it is 0~45℃. If the user detects an abnormal temperature (such as exceeding 60℃), it is recommended to immediately stop the camera and contact our technical support.

6.14 Load/Save Configuration

(T)PH9KCXP12 camera supports multiple sets of working parameter sets, including one set of factory default parameter sets and multiple sets of 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.

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 regardless of which transmission protocol the camera uses or which functions 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 description 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.

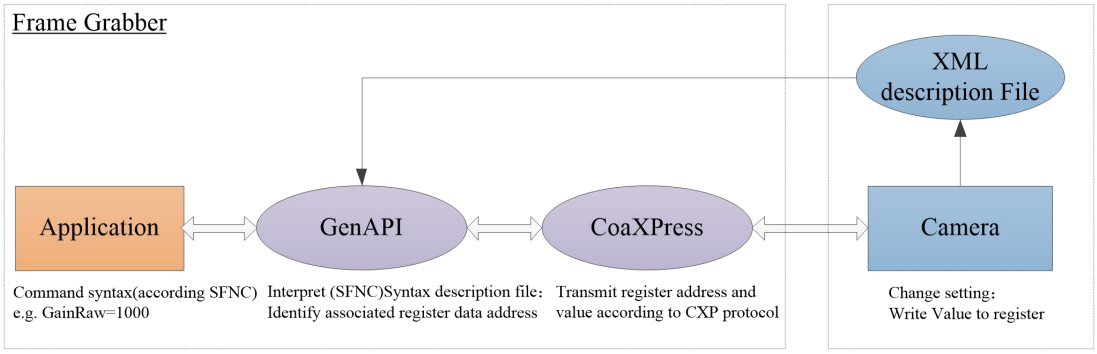


Fig. 26 Communication Principle Diagram Between Application and Camera

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 the description file. For example, to set the gain to 1000, the value of 0x3E8 (HEX) must be written to the register at address 0x0815 (HEX). Other tasks involved may be to check whether the camera has gain characteristics in advance and check whether the new value are consistent with the allowable gain range. This register message is transmitted and parsed by protocol and applied to camera.

7.2 GenAPI Parameter Attributes

The actual method of controlling camera is related to software implementation of frame grabber and SDK. Most frame grabber software provides a graphical user interface (GUI) that is automatically generated from XML files. This manual focuses on functions of camera, detailing the specific commands and their impact on operation of camera, listing the name, interface, access, description, range and default value of each GenAPI parameter.

(1) Register name

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

(2) Register address

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

(3) Register size

This parameter represents the size of the register value (in byte).

(4) Register interface

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

Table 6 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	Command type
Boolean	B	Boolean type

(5) Parameter access

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

(6) Default parameter value and range

When setting the parameter, it will check whether the input value is within the valid range of parameter.

7.3 Register Classification

7.3.1 Bootstrap CoaXPress Registers

Table 7 Bootstrap CoaXPress Registers

Name	Address	Size	Interface	Access	Visibility
Standard	0x0	4	I	RO	Beginner
Revision	0x4	4	I	RO	Beginner
XmlManifestSize	0x8	4	I	RO	Guru
XmlManifestSelector	0xc	4	I	RW	Guru
XmlVersion	0x10	4	I	RO	Guru
XmlSchemeVersion	0x14	4	I	RO	Guru

XmlUrlAddress	0x18	4	I	RO	Guru
Iidc2Address	0x1c	4	I	RO	Guru
ConnectionReset	0x4000	4	I	RW	Guru
DeviceConnectionID	0x4004	4	I	RO	Guru
MasterHostConnectionID	0x4008	4	I	RW	Guru
ControlPacketSizeMax	0x400c	4	I	RO	Guru
StreamPacketSizeMax	0x4010	4	I	RW	Guru
ConnectionConfig	0x4014	4	E	RW	Beginner
ConnectionConfigDefault	0x4018	4	E	RO	Beginner
ConnectionConfigDefaultPreferred	0x6008	4	E	RW	Beginner
TestMode	0x401c	4	E	RW	Guru
TestErrorCountSelector	0x4020	4	I	RW	Guru
TestErrorCount	0x4024	4	I	RW	Guru
TestPacketCountTx	0x4028	8	I	RW	Guru
TestPacketCountRx	0x4030	8	I	RW	Guru
ElectricalCompliancyTest	0x4038	4	E	RW	Guru
WidthAddress	0x3000	4	I	RO	Guru
HeightAddress	0x3004	4	I	RO	Guru
AcquisitionModeAddress	0x3008	4	I	RO	Guru
AcquisitionStartAddress	0x300c	4	I	RO	Guru
AcquisitionStopAddress	0x3010	4	I	RO	Guru
PixelFormatAddress	0x3014	4	I	RO	Guru
DeviceTapGeometryAddress	0x3018	4	I	RO	Guru
Image1StreamIDAddress	0x301c	4	I	RO	Guru
HsUpconnection	0x403c	4	I	RO	Guru
DeviceTapGeometry	0x6004	4	E	RO	Expert

- **Standard**
  Unique identification of CoaXPress standard.

- **Revision**
  CoaXPress protocol version number.

- **XmlManifestSize**
  The number of XML files available.

- **XmlManifestSelector**
  Select XML manifest entry.

- **XmlVersion**
  The version of XML file referenced by XmlManifestSelector.

- **XmlSchemeVersion**

The version of XML file format scheme referenced by XmlManifestSelector.

- **XmlUrlAddress**

  The URL address of XML file referenced by XmlManifestSelector.

- **Iidc2Address**

  If device supports IIDC 2 protocol, this register should provide start address of IIDC 2 register space.

- **ConnectionReset**

  Reset all connections to device.

- **DeviceConnectionID**

  Provide ID of device connection from which this register is read.

- **MasterHostConnectionID**

  ID of host device.

- **ControlPacketSizeMax**

  Provide maximum control packet data size, which is defined in bytes and should be multiples of 4 bytes.

- **StreamPacketSizeMax**

  Provide maximum flow packet data size that host can accept. The size is defined in bytes and should be a multiple of 4 bytes.

- **ConnectionConfig**

  Current device link speed and number of link channels. The enumeration names and values are as follows:

  - CXP1_X1(0x00010028)
  - CXP2_X1(0x00010030)
  - CXP3_X1(0x00010038)
  - CXP5_X1(0x00010040)
  - CXP6_X1(0x00010048)
  - CXP10_X1(0x00010050)
  - CXP12_X1(0x00010058)
  - CXP1_X2(0x00020028)
  - CXP2_X2(0x00020030)
  - CXP3_X2(0x00020038)
  - CXP5_X2(0x00020040)
  - CXP6_X2(0x00020048)
  - CXP10_X2(0x00020050)
  - CXP12_X2(0x00020058)
  - CXP1_X4(0x00040028)

- CXP2_X4(0x00040030)
- CXP3_X4(0x00040038)
- CXP5_X4(0x00040040)
- CXP6_X4(0x00040048)
- CXP10_X4(0x00040050)
- CXP12_X4(0x00040058)

- **ConnectionConfigDefault**

Default link speed and number of link channels. The enumeration names and values are as follows:

- CXP1_X1(0x00010028)
- CXP2_X1(0x00010030)
- CXP3_X1(0x00010038)
- CXP5_X1(0x00010040)
- CXP6_X1(0x00010048)
- CXP10_X1(0x00010050)
- CXP12_X1(0x00010058)
- CXP1_X2(0x00020028)
- CXP2_X2(0x00020030)
- CXP3_X2(0x00020038)
- CXP5_X2(0x00020040)
- CXP6_X2(0x00020048)
- CXP10_X2(0x00020050)
- CXP12_X2(0x00020058)
- CXP1_X4(0x00040028)
- CXP2_X4(0x00040030)
- CXP3_X4(0x00040038)
- CXP5_X4(0x00040040)
- CXP6_X4(0x00040048)
- CXP10_X4(0x00040050)
- CXP12_X4(0x00040058)

- **ConnectionConfigDefaultPreferred**

Preferred default mode for device connection speed and dynamic connection count. The enumeration names and values are as follows:

- CXP6_X1(0x00010048)
- CXP10_X1(0x00010050)
- CXP12_X1(0x00010058)
- CXP6_X2(0x00020048)
- CXP10_X2(0x00020050)
- CXP12_X2(0x00020058)
- CXP6_X4(0x00040048)
- CXP10_X4(0x00040050)
- CXP12_X4(0x00040058)

- **TestMode**

  Enable test packet transmission from device to host. The enumeration names and values are as follows:

  - Off (0)
  - Mode1 (1)

- **TestErrorCountSelector**

  Test mode selection.The parameter range is as follows:

  - Maximum: 3
  - Minimum: 0
  - Increment: 1

- **TestErrorCount**

  Number of test errors.

- **TestPacketCountTx**

  Number of test error frames.

- **TestPacketCountRx**

  Test the number of data frames read.

- **ElectricalCompliancyTest**

  Electrical compatibility testing. The enumeration names and values are as follows:

  - NormalOperatingMode(0)
  - CXP1_X1(0x00010028)
  - CXP2_X1(0x00010030)
  - CXP3_X1(0x00010038)
  - CXP5_X1(0x00010040)
  - CXP6_X1(0x00010048)
  - CXP10_X1(0x00010050)
  - CXP1_X2(0x00020028)
  - CXP2_X2(0x00020030)
  - CXP3_X2(0x00020038)
  - CXP5_X2(0x00020040)
  - CXP6_X2(0x00020048)
  - CXP10_X2(0x00020050)
  - CXP1_X4(0x00040028)
  - CXP2_X4(0x00040030)
  - CXP3_X4(0x00040038)
  - CXP5_X4(0x00040040)
  - CXP6_X4(0x00040048)
  - CXP10_X4(0x00040050)

- **WidthAddress**
  Address of camera width register.

- **HeightAddress**
  Address of camera height register.

- **AcquisitionModeAddress**
  The address of camera acquisition mode register.

- **AcquisitionStartAddress**
  The camera start grabbing address of register.

- **AcquisitionStopAddress**
  The camera stops grabbing address of register.

- **PixelFormatAddress**
  The address of camera pixel format register.

- **DeviceTapGeometryAddress**
  The address of camera Tap arrangement register.

- **Image1StreamIDAddress**
  Address of data stream register.

- **HsUpconnection**
  Whether camera supports address of uplink channel register.

- **DeviceTapGeometry**
  Tap arrangement method. The enumeration names and values are as follows:
  - Geometry_1X_1Y(0)

7.3.2 Device Control Registers

Table 8 Device Control Registers

Name	Address	Size	Interface	Access	Visibility
DeviceVendorName	0x2000	32	S	RO	Beginner
DeviceModelName	0x2020	32	S	RO	Beginner
DeviceManufacturerInfo	0x2040	48	S	RO	Beginner
DeviceVersion	0x2070	32	S	RO	Beginner
DeviceSerialNumber	0x20b0	16	S	RO	Expert
DeviceUserID	0x20c0	16	S	RW	Beginner
DeviceScanType	/	/	E	/	Expert
DeviceSensorTemperature	0xa004	4	F	RO	Beginner

DeviceTemperature	0xa008	4	F	RO	Beginner
DeviceHumidity	0xa00c	4	F	RO	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

- **DeviceSensorTemperature**
  Device sensor temperature.

- **DeviceTemperature**
  Device temperature.

- **DeviceHumidity**
  Device humidity.

7.3.3 Image Format Control Registers

Table 9 Image Format Control Registers

Name	Address	Size	Interface	Access	Visibility
SensorVerticalBinning	0xa930	4	E	RW	Beginner
BinningHorizontal	0xa910	4	E	RW	Beginner
BinningVertical	0xa928	4	E	RW	Beginner
Width	0xa900	4	I	RW	Beginner

Height	0xa904	4	I	RO	Beginner
PixelFormat	0xa914	4	E	RW	Beginner
OffsetX	0xa918	4	I	RW	Beginner
VideoMode	0xa920	4	E	RW	Beginner
ReverseX	0xa924	4	B	RW	Beginner

- **SensorVerticalBinning**

  Vertical pixel merging at the sensor end. The enumeration names and values are as follows:
  - Binning_X1(1)
  - Binning_X2(2)

- **BinningHorizontal**

  Horizontal binning. The enumeration names and values are as follows:
  - Binning_X1(1)
  - Binning_X2(2)
  - Binning_X4(4)

- **BinningVertical**

  Vertical binning. The enumeration names and values are as follows:
  - Binning_X1(1)
  - Binning_X2(2)
  - Binning_X4(4)

- **Width**

  Actual camera output width.

- **Height**

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

- **PixelFormat**

  Pixel format. The enumeration names and values are as follows:
  - Mono8(17301505):Monochrome 8bit
  - Mono10(17825795):Monochrome 10bit
  - Mono12(17825797):Monochrome 12bit

- **OffsetX**

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

- **VideoMode**

Output image format. The enumeration names and values are as follows:

- Original (0): Original image
- Corrected (1): Corrected image
- TestPattern (2): Test image

- **ReverseX**

  Horizontal flipping.

7.3.4 Acquisition Control Registers

Table 10 Acquisition Control Registers

Name	Address	Size	Interface	Access	Visibility
AcquisitionMode	0xb000	4	E	RW	Beginner
AcquisitionStart	0xb004	4	C	RW	Beginner
AcquisitionStop	0xb008	4	C	RW	Beginner
AcquisitionLineRate	0xb018	4	F	RW	Beginner
ExposureTime	0xb020	4	F	RW	Beginner
DualBandEnable	0xb204	4	B	RW	Expert
BandSelector	0xb224	4	E	RW	Beginner
TDIStage	0xb024	4	E	RW	Beginner
VerticalScanDirection	0xb030	4	E	RW	Expert
VerticalScanControl	0xb02c	4	E	RW	Beginner
AcquisitionFrameRateEnable	0xb010	4	B	RW	Expert
AcquisitionFrameRate	0xb014	4	F	RW	Beginner

- **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.

- **AcquisitionLineRate**

  Acquisition line rate, unit is Hz. The parameter range is as follows:

  - Increment: 0.001

- **ExposureTime**

  Exposure time, unit is us, using this parameter in area mode. The parameter range is as follows:

  - Increment: 0.001

- **DualBandEnable**

  Enable dual image area function.

- **BandSelector**

  Time delay integration image area selection. The enumeration names and values are as follows:
  - Band_P1(0)
  - Band_P2(1)

- **TDIStage**

  Time delay integration series. The enumeration names and values are as follows:
  - Stage2(2):Only allow selection when Zone 2 is available
  - Stage4(4)
  - Stage8(8)
  - Stage16(16)
  - Stage24(24):Only allow selection when Zone 2 is available
  - Stage28(28):Only allow selection when Zone 2 is available
  - Stage30(30):Only allow selection when Zone 2 is available
  - Stage32(32)
  - Stage64(64):Only allow selection when Zone 1 is available
  - Stage96(96):Only allow selection when Zone 1 is available
  - Stage128(128):Only allow selection when Zone 1 is available
  - Stage160(160):Only allow selection when Zone 1 is available
  - Stage192(192):Only allow selection when Zone 1 is available
  - Stage224(224):Only allow selection when Zone 1 is available
  - Stage240(240):Only allow selection when Zone 1 is available
  - Stage248(248):Only allow selection when Zone 1 is available
  - Stage252(252):Only allow selection when Zone 1 is available
  - Stage256(256):Only allow selection when Zone 1 is available

- **VerticalScanDirection**

  Vertical scanning direction. The enumeration names and values are as follows:
  - Forward(0):Forward
  - Backward(1):Backward

- **VerticalScanControl**

  Vertical scanning direction control. The enumeration names and values are as follows:
  - Internal(0):Internal controls
  - Line1_Positive(1):Line 1 signal positive direction
  - Line1_Negative(2):Line 1 signal negative direction
  - Line2_Positive(3):Line 2 signal positive direction
  - Line2_Negative(4):Line 2 signal negative direction
  - CXP_Positive(5):CXP signal positive direction
  - CXP_Negative(6):CXP signal negative direction

- **AcquisitionFrameRateEnable**

  Enable frame rate collection settings. By selecting this option, users can set the collection frame rate themselves. Otherwise, the frame rate will be set to the maximum allowed value by default.

- **AcquisitionFrameRate**

  Acquisition frame rate, unit is us. The parameter range is as follows:

  - Minimum: 0.001

7.3.5 IO Control Register

Table 11 IO Control Registers

Name	Address	Size	Interface	Access	Visibility
TriggerMode	0xf804	4	E	RW	Beginner
TriggerSource	0xf808	4	E	RW	Beginner
TriggerRescaleEnable	0xf80c	4	B	RW	Expert
TriggerRescaleWindowSize	0xf810	4	E	RW	Expert
TriggerRescaleFactor	0xf820	4	F	RW	Expert
TriggerMultDivEnable	0xf814	4	B	RW	Expert
TriggerMultiplier	0xf818	4	E	RW	Expert
TriggerDivider	0xf81c	4	I	RW	Expert
LinePolarity	0xf840	4	E	RW	Beginner
LineDetectionLevel	0xf824	4	E	RW	Expert
LineDebouncingPeriod	0xf830	4	I	RW	Beginner
LineTriggerInputFrequency	0xf83c	4	I	RO	Beginner
LineTriggerCounter	0xf860	4	I	RO	Beginner
LineTriggerCounterReset	0xf864	4	C	WO	Expert
LineTriggerIgnoreCounter	0xf868	4	I	RO	Beginner

- **TriggerMode**

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

  - Off (0)
  - On (1)

- **TriggerSource**

  Trigger source selection. The enumeration names and values are as follows:

  - Line1(0):IO interface line1 signal
  - Line2(1):IO interface line2 signal
  - CXPIn(2):CXP signal

- **TriggerRescaleEnable**

  Enable trigger rescale function.

- **TriggerRescaleWindowSize**

Trigger signal smoothing window size, selecting the number of samples of trigger signals that require frequency averaging processing through the smoothing window. The enumeration names and values are as follows:

  - Window_1 (0)
  - Window_2 (1)
  - Window_4 (2)
  - Window_8 (3)
  - Window_16 (4)
  - Window_32 (5)
  - Window_64 (6)
  - Window_128 (7)
  - Window_256 (8)
  - Window_512 (9)
  - Window_1024 (10)

- **TriggerRescaleFactor**

Trigger signal smoothing coefficient, used to fine tune the rate of the trigger signal. The parameter range is as follows:

  - Maximum: 1.3
  - Minimum: 0.7
  - Increment: 0.000001

- **TriggerMultDivEnable**

Enable trigger signal rate doubling and division function.

- **TriggerMultiplier**

Trigger signal rate doubling, used to coarsely adjust the increase in trigger signal rate size. The enumeration names and values are as follows:

  - Multiplier_1(0)
  - Multiplier_2(1)
  - Multiplier_4(2)
  - Multiplier_8(3)
  - Multiplier_16(4)
  - Multiplier_32(5)
  - Multiplier_64(6)
  - Multiplier_128(7)
  - Multiplier_256(8)
  - Multiplier_512(9)
  - Multiplier_1024(10)
  - Multiplier_2048(11)
  - Multiplier_4096(12)
  - Multiplier_8192(13)
  - Multiplier_16384(14)

- Multiplier_32768(15)

- **TriggerDivider**

Trigger signal rate division, used to reduce and roughly adjust the rate of the trigger signal. The parameter range is as follows:

- Maximum: 511
- Minimum: 1
- Increment: 1

- **LinePolarity**

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

- Rising_Edge(0):Rising edge triggers collection
- Falling_Edge(1):Falling edge triggers collection

- **LineDetectionLevel**

Input signal detection level, that is input voltage range. The enumeration names and values are as follows:

- Threshold_for_3V3_to_5V (0): Voltage range 3.3~5V
- Threshold_for_6V_to_24V (1): Voltage range 6~24V

- **LineDebouncingPeriod**

Input signal jitter window length, signals below this pulse width will be considered as gross signals filtered out, with units of us. The parameter range is as follows:

- Maximum: 364000
- Minimum: 0

- **LineTriggerInputFrequency**

Trigger signal rate, unit is Hz.

- **LineTriggerCount**

The current number of trigger signals received.

- **LineTriggerCountReset**

Reset trigger signal count counter.

- **LineTriggerIgnoreCounter**

The current number of ignored trigger signals.

7.3.6 Analog Control Registers

Table 12 Analog Control Register

Name	Address	Size	Interface	Access	Visibility
AnalogGain	0xb800	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)

7.3.7 Digital Control Registers

Table 13 Digital Control Registers

Name	Address	Size	Interface	Access	Visibility
DigitalGain	0xc000	4	F	RW	Beginner
DigitalOffset	0xc004	4	I	RW	Beginner

- **DigitalGain**

  Digital gain. The parameter range is as follows:

  - Maximum: 8
  - Minimum: 0.1

- **DigitalOffset**

  Digital offset.

7.3.8 Defect Pixel Registers

Table 14 Defect Pixel Registers

Name	Address	Size	Interface	Access	Visibility
DefectPixelCorrectionEnable	0xe000	4	B	RW	Guru
DefectPixelTotal	0xe004	4	I	RO	Expert
DefectPixelSelect	0xe008	4	I	RW	Expert
DefectPixelReadX	0xe00c	4	I	RO	Expert
DefectPixelReadY	0xe010	4	I	RO	Expert
DefectPixelWriteX	0xe014	4	I	RW	Expert
DefectPixelWriteY	0xe018	4	I	RW	Expert
DefectPixelAdd	0xe01c	4	C	WO	Expert
DefectPixelRemove	0xe020	4	C	WO	Expert
DefectPixelClearAll	0xe024	4	C	WO	Expert
DefectPixelSave	0xe028	4	C	WO	Expert

- **DefectPixelCorrectionEnable**

  Enable defect pixel correction function.

- **DefectPixelTotal**

  Total number of defect pixel.

- **DefectPixelSelect**

  Select index of defect pixel. The parameter range is as follows:

  - Maximum: 16383
  - Minimum: 0
  - Increment: 1

- **DefectPixelReadX**

  Read the X coordinate of current defect pixel. The parameter range is as follows:

- **DefectPixelReadY**

  Read the Y coordinate of current defect pixel. The parameter range is as follows:

- **DefectPixelWriteX**

  Write the X coordinate of defect pixel.

- **DefectPixelWriteY**

  Write the Y coordinate of defect pixel.

- **DefectPixelAdd**

  Add defect pixel.

- **DefectPixelRemove**

  Remove current defect pixels.

- **DefectPixelClearAll**

  Remove all defect pixels.

- **DefectPixelSave**

  Save defect pixels.

7.3.9 Flat Field Correction Registers

Table 15 Flat Field Correction Registers

Name	Address	Size	Interface	Access	Visibility
FlatFieldCorrectionEnable	0xd800	4	B	RW	Beginner
FlatFieldCorrectionCalibrate	0xd804	4	C	WO	Beginner
FlatFieldCorrectionReset	0xd808	4	C	WO	Beginner
FlatFieldCorrectionOffsetX	0xd80c	4	I	RW	Expert
FlatFieldCorrectionWidth	0xd810	4	I	RW	Expert
FlatFieldCorrectionReferenceMode	0xd814	4	B	RW	Expert
FlatFieldCorrectionMonoTarget	0xd81c	4	I	RW	Expert
FlatFieldCorrectionLowPassFilterWindow	0xd82c	4	I	RW	Expert

- **FlatFieldCorrectionEnable**
  Enable flat field correction.

- **FlatFieldCorrectionCalibrate**
  Start flat field correction.

- **FlatFieldCorrectionReset**
  Restore flat field calibration parameters to factory settings.

- **FlatFieldCorrectionOffsetX**
  Flat field correction horizontal offset, used to set the starting position of the flat field correction area. The parameter range is as follows:
  - Minimum: 0
  - Increment: 2

- **FlatFieldCorrectionWidth**
  Width of flat field correction area. The parameter range is as follows:
  - Minimum: 2
  - Increment: 2

- **FlatFieldCorrectionReferenceMode**
  Flat field correction reference mode, check this option to correct the grayscale value of the selected area to the target value.

- **FlatFieldCorrectionMonoTarget**
  Flat field correction target value.

- **FlatFieldCorrectionLowPassFilterWindow**
  Flat field correction low-pass filtering. The parameter range is as follows:
  - Maximum: 64
  - Minimum: 0
  - Increment: 2

7.3.10 LUT Control Registers

Table 16 LUT Control Registers

Name	Address	Size	Interface	Access	Visibility
LUTEnable	0xd000	4	B	RW	Beginner
LUTIndex	0xd004	4	I	RW	Expert
LUTValue	0xd008	4	I	RW	Expert

- **LUTEnable**
  Enable LUT function.

- **LUTIndex**

  Lookup table data index, that is, the gray value of image before mapping lookup table.

- **LUTValue**

  Lookup table data value, that is, the gray value of image after mapping lookup table.

7.3.11 User Set Control Registers

Table 17 User Set Control Registers

Name	Address	Size	Interface	Access	Visibility
UserSetSelector	0xe800	4	E	RW	Beginner
UserSetLoad	0xe804	4	C	WO	Beginner
UserSetSave	0xe808	4	C	WO	Beginner

- **UserSetSelector**

  User configuration selector. The enumeration names and values are as follows:

  - Default (0): Factory configuration
  - UserSet1(1): User configuration 1
  - UserSet2(2): User configuration 2

- **UserSetLoad**

  Load selected camera configuration.

- **UserSetSave**

  Save selected camera configuration.

8 FAQ

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

① Ensure that CoaXPress interface cable is OK

② Ensure that serial port channel parameters of CoaXPress interface are correctly set.

- **If CoaXPress interface cannot receive camera clock signal,**

① Ensure that the camera has been turned on properly (i.e. the status indicator should be normally green).

② If a third-party frame grabber is used to grab images, ensure that frame grabber and supporting software are operating properly, which can be checked by restarting computer.

③ Ensure that CoaXPress interface cable is OK.

- **If the camera has no image output in External Pulse mode,**

① Ensure that external input pulse is normal.

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

③ If CoaXPress interface signal is used as trigger input signal, ensure that frame grabber is configured correctly.

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

① Ensure that voltage range of external connected power supply is normal.

② If the casing is hot or the camera emits smoke, immediately cut off power and stop using camera, then contact us for technical support.

- **If images are dark,**

① Ensure that sensor aperture on the casing is not blocked.

② Ensure that exposure time and gain are set properly.

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

① Ensure that sensor glass is clean.

② Ensure that camera status indicator is normal.

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

① Check whether CoaXPress interface is normal by the test image.

② Check whether the power supply is normal by camera indicator status.

③ Check whether external trigger input is normal in External Trigger mode by 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.