TS25MCXP12-150M/C Area Scan Camera User Manual

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Hefei I-TEK Optoelectronics Co., LTD.

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

Revision History

Revision	Date	Description
0.1	2022/03/05	● Initial version
0.2	2022/04/25	● Update the logo of company
0.3	2022/06/28	● Add two-channel connection function
0.4	2022/09/05	● Update structure charts
0.5	2023/02/11	● Update company address
0.6	2023/10/12	● Update chapter 7 ● Update camera parameter list

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 recommended voltage is +12V±10%, and the current must be 2.0A.

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**

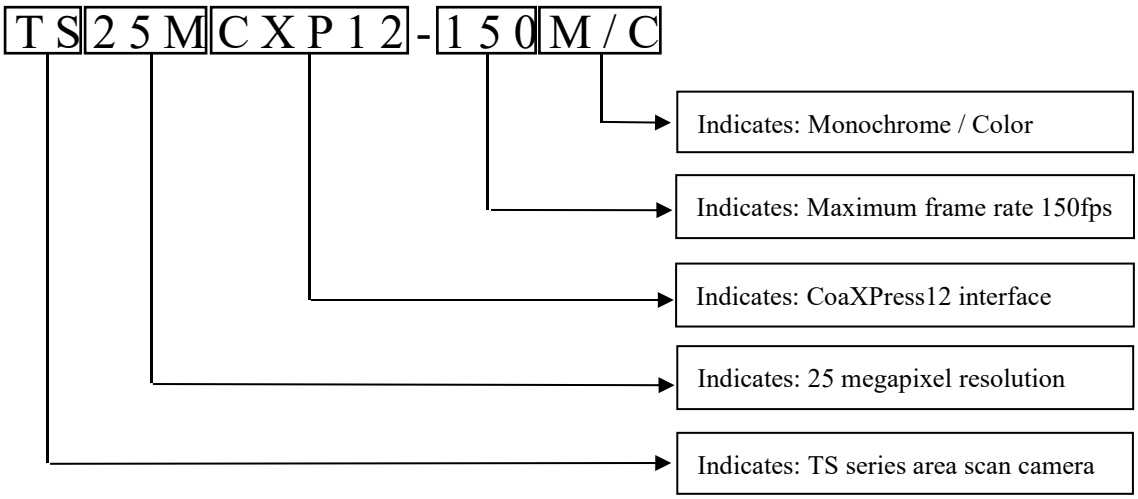
Abbreviation	Image Mode
M	Monochrome
C	Color
F	Full Color
T	Monochrome TDI (Time Delay Integration)
X	Time Division Camera
U	UV (Ultraviolet)
N	NIR (Near Infrared)

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: 25 mega-pixel high-speed industrial camera



3 Product Appearance

Fig.1 Product Appearance

Note:

① The front and the sides of camera provides threaded holes for mounting and fixing.

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

4 Product Specifications

TS25MCXP12 camera adopts advanced global shutter CMOS image sensor and CoaXPress12 data interface. It is a high-speed area scan camera designed for industrial measurement and inspection. It has high reliability and stability, suitable for image acquisition with high requirements (high resolution, high speed), such as surface inspection, electronic mount inspection, etc.

4.1 Main Features

- Global Shutter CMOS Sensor
- 25 Megapixel Resolution
- Full Frame Rate up to 150fps
- High Sensitivity and Low Noise
- ROI
- Rich Exposure Control Modes (External Trigger, Free-Run)
- Minimum Exposure Time: 3us Exposure Time Step: 1us
- Pixel Format: 8/10bit
- LUT
- White Balance
- Defect Pixel Correction
- Flat Field Correction
- Analog Gain / Digital Gain / Offset Control
- Scanning Direction Configurable
- Real-time Temperature Monitoring

4.2 Camera Specifications

Table 1 TS25MCXP12-150M/C Product Specifications

Model	TS25MCXP12-150M/C
Product Description	25 mega-pixel high-speed industrial camera
Resolution	5120 x 5120
Pixel Size	2.5um x 2.5um
Sensor Type	Global shutter CMOS
Image Type	Monochrome / Color
Sensor Size	18.10mm (diagonal)
Dynamic Range	≥ 57.2dB
SNR	37.9dB
Data Rate	4620MB/s
Lens Mount	M42/M58/C Mount
Max Frame Rate	Two-channel: 91.2fps@8bit, 73.8fps@10bit Four-channel: 150.1fps@8bit, 141.0fps@10bit
Analog Gain	x1/x1.5/x2/x2.5
Analog Offset	0~4095

Digital Gain	0.1~8
Digital Offset	-4095~4095
Trigger Mode	External Trigger, Free-Run
External Trigger	External IO/CXP
Exposure Control	External PWM, Timed
Exposure Time	3us~10s (step: 1us)
Data Format	8/10bit
Operation Temperature	0~50°C
Data Interface	CoaXPress12
Power Supply	DC12V±10%　2.0A
Power Consumption	15.4W
Mechanical	80mm x 80mm x88mm

Note: This table is for 0406-810E version of TS25MCXP12 camera specifications, which may vary slightly from version to version.

4.3 Camera Structure

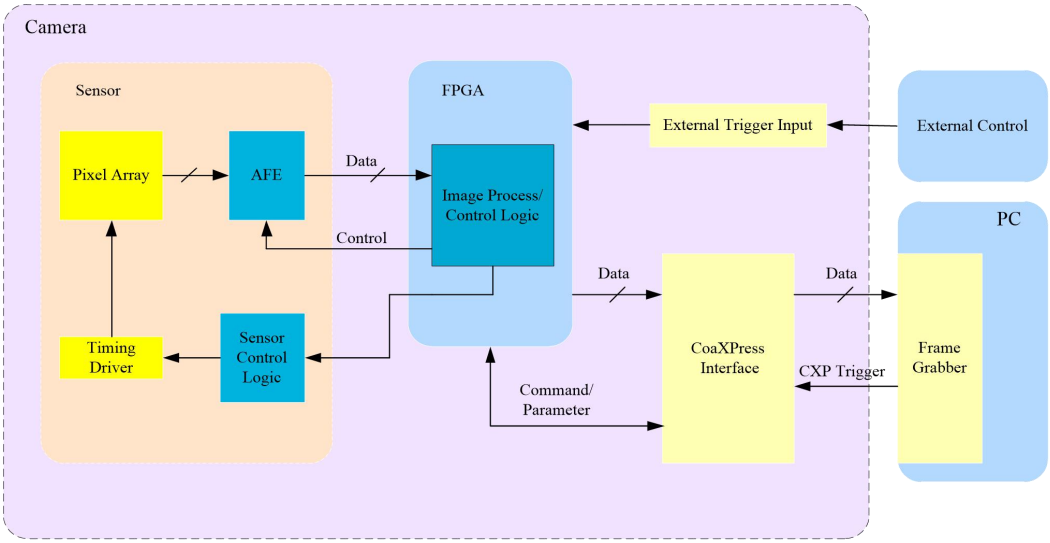


Fig.2 Internal Implementation Structure of Camera

TS25MCXP12 camera uses a unified architecture to achieve image sensor control, data transmission and embedded algorithm processing with different resolutions. The internal structure of the camera is shown in figure above. The pixel array is uniformly sampled and maintained by the global shutter control system, converted into digital signals by analog front end, and then transmitted to PC frame grabber through CoaXPress interface after processed by FPGA and microprocessor.

TS25MCXP12 camera can receive external signal trigger acquisition, from IO signal or CXP signal of CoaXPress12 interface.

4.4 Spectral Response

The spectral response of TS25MCXP12 camera is shown below.

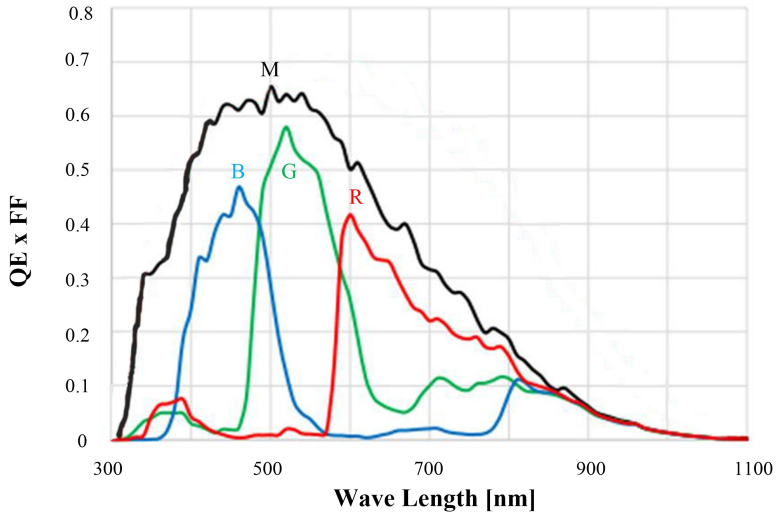


Fig.3 Spectral Response of Camera

4.5 Camera Bayer Pattern

TS25MCXP12 camera supports color mode, and the Bayer pattern is shown as follows (HR is horizontal resolution, VR is vertical resolution):

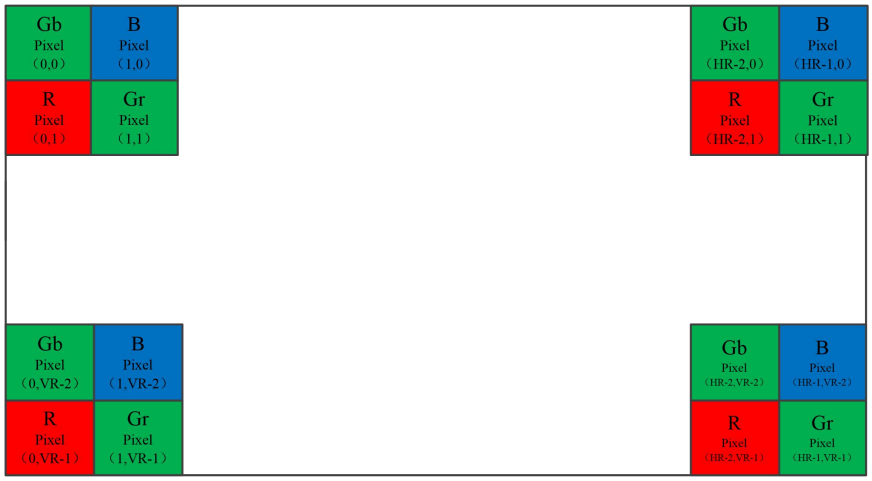


Fig.4 Camera Bayer Pattern

4.6 Environmental Requirements

(1) Operating temperature: 0℃~50℃, 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.

4.7 RoHS Certification

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

5 Mechanical Dimensions and Interfaces

5.1 Mechanical Dimensions

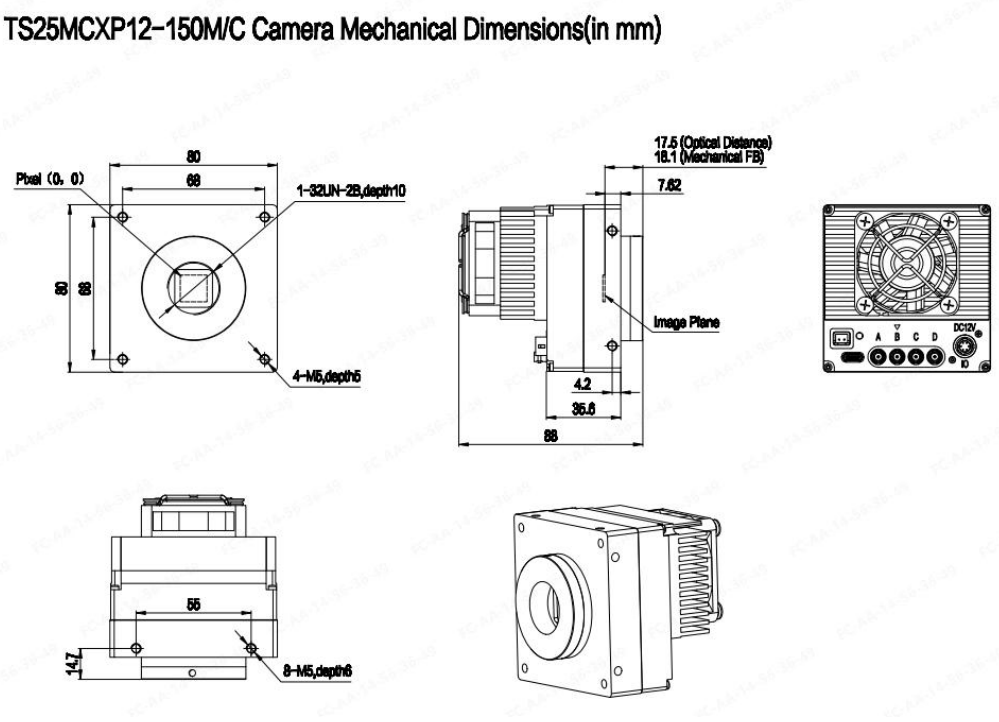


Fig.5 Camera Mechanical Dimensions

5.2 Camera Interface

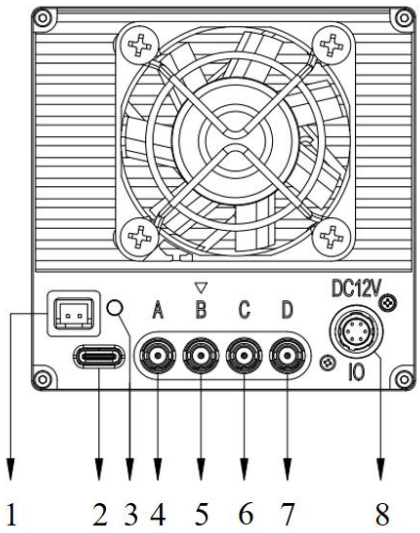


Fig.6 External Interfaces of Camera

① Fan Power Interface
② Type-C Interface
③ Camera Status Indicator
④ CoaXPress Connection A

⑤ CoaXPress Connection B **(Master)**
⑥ CoaXPress Connection C
⑦ CoaXPress Connection D
⑧ 6-pin Power Input

Note:
① If users use Euresys frame grabber, it is necessary to connect channel A of the frame grabber to channel B of the camera, otherwise the software cannot scan the camera.
② If users use two-channel connection method, they need to connect B and C channels of camera to frame grabber. Then select "Two" in ConnectionLinkCount, and scan and open the camera again.

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 2 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 Control Interface

The power input and control I/O 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 and control interface on the back of the camera is shown as follows:

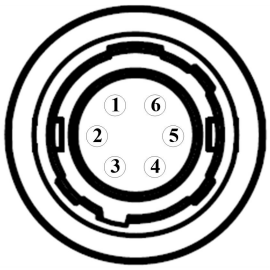


Fig.7 Pin Assignments for Interface

Table 3 Interface Pin Definition

Signal	Pin	Signal	Pin

Power	1	Trigger in_GND	4
Power	2	GND	5
Trigger in	3	GND	6

External trigger circuit diagram is as follows:

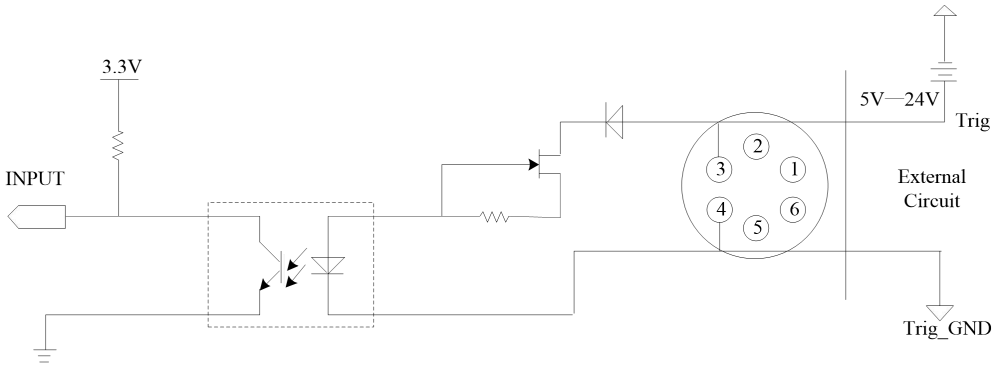


Fig.8 Trigger Input Circuit Schematic

- Trigger Level Standard: 5~24V

5.2.3 Data Interface

TS25MCXP12 camera implements standard Quad CoaXPress protocol, and data interface is four Micro BNC sockets on the back of the camera. The data interface on the back of the camera is shown in the red box below:

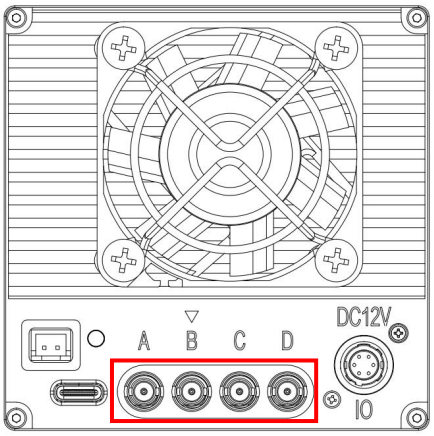


Fig.9 Data Interface

The mechanical drawing of Micro BNC socket is as follows:

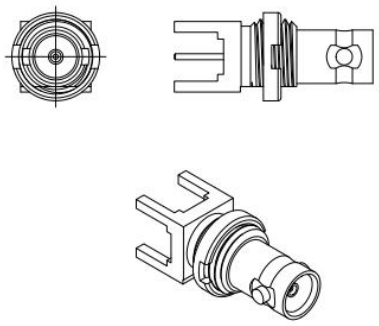


Fig.10 Micro BNC Socket

6 Camera Features

This chapter introduces the main features of TS25MCXP12 camera.

6.1 Trigger Mode

TS25MCXP12 camera supports three trigger modes: Free-Run mode, External Pulse mode and External PWM mode.

6.1.1 Free-Run Mode

In Free-Run mode (Trigger Mode=Off, Exposure Mode=Timed), camera generates the relevant control sequence internally according to frame period and exposure time parameters configured by users and outputs image.

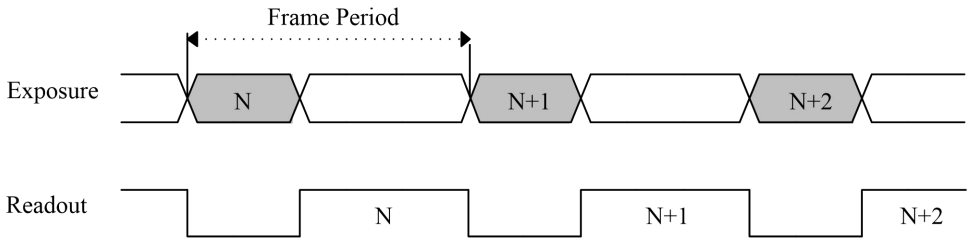


Fig.11 Free-Run Mode

To achieve normal image output, TS25MCXP12 camera limits the range of frame period and exposure time, and the minimum frame period should be greater than both exposure time and readout time of a frame. The operation sequence of the camera is shown in the figure above.

6.1.2 External Pulse Mode

In External Pulse mode (Trigger Mode=On, Exposure Mode=Timed), camera starts to expose at rising edge of trigger signal, and exposure time length is set by users command (consistent with Free-Run mode). At this point, frame rate of camera output image is determined by the interval between rising edge of external trigger pulse, as shown in the figure below.

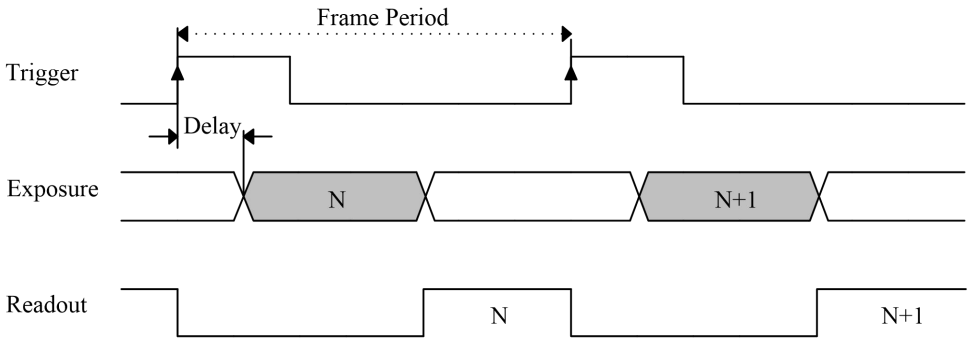


Fig.12 External Pulse Mode

External trigger can be input from CoaXPress12 interface or control interface. Input source can be selected by users through instruction. To get a higher frame rate, a new trigger pulse can be fired at the same time the camera reads data after the last frame exposure. In this fast mode, since it is necessary to ensure that reading stages of two frames do not conflict, external trigger with an interval less than 1 frame readout time will be automatically ignored by camera, as shown in the figure below.

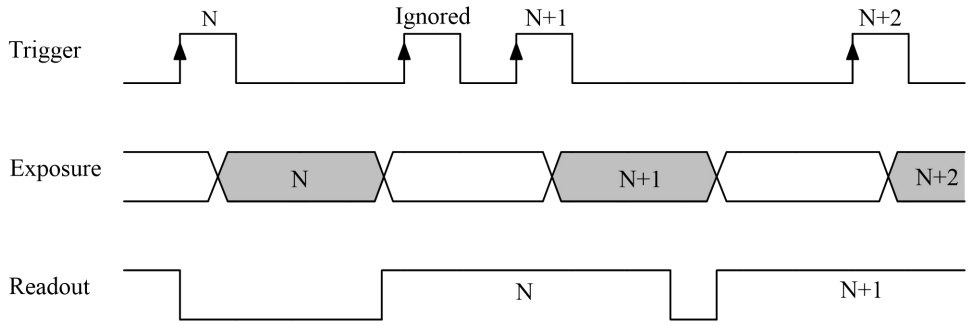


Fig.13 Frame Period of External Trigger is Too Short

6.1.3 External PWM Mode

In External PWM mode (Trigger Mode=On, Exposure Mode=TriggerWidth), camera exposure starts at the rising edge of external trigger and ends at the falling edge of trigger signal. That is, the actual exposure time is equal to the externally triggered high level duration, and the frame period is equal to pulse interval.

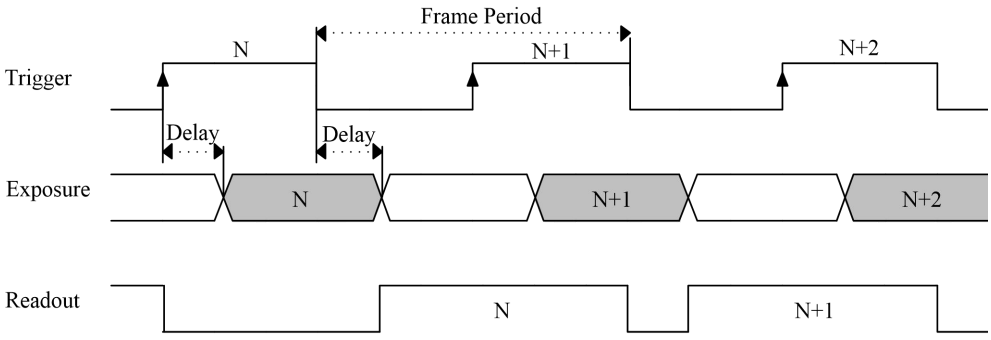


Fig.14 External PWM Mode

In this mode, external trigger high level should ensure a time greater than the minimum exposure time. For pulses lower than this width, camera will treat them as the minimum exposure time.

If external trigger interval is too short, it will lead to a conflict between readout time of two frames before and after camera. The pulse which does not meet requirements will be ignored inside camera, so that camera can maintain normal operation, as shown in the figure below. The interval between adjacent falling edges should be greater than readout time of each frame.

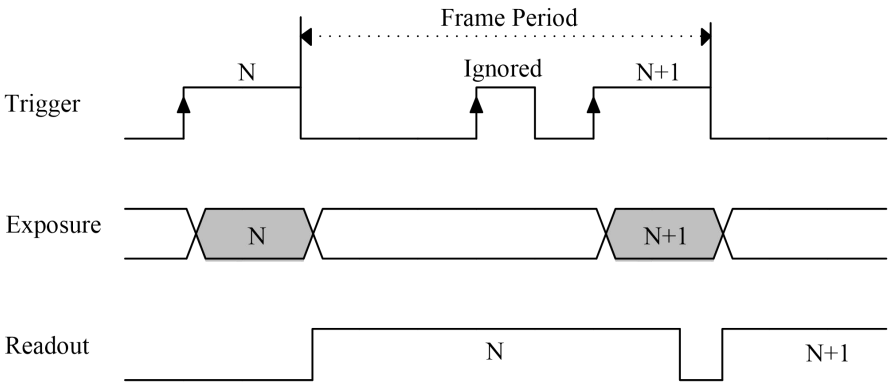


Fig.15 Frame Period of External Trigger is Too Short

6.2 Region of Interest

Region of interest (ROI) is part of the specified sensor array. Users can obtain frame data from the specified part of sensor array with the same frame quality as from the entire sensor array. When the starting point and the number of pixel lines are specified in both horizontal and vertical directions, ROI is determined to be an overlap of the two regions, as shown in the figure below.

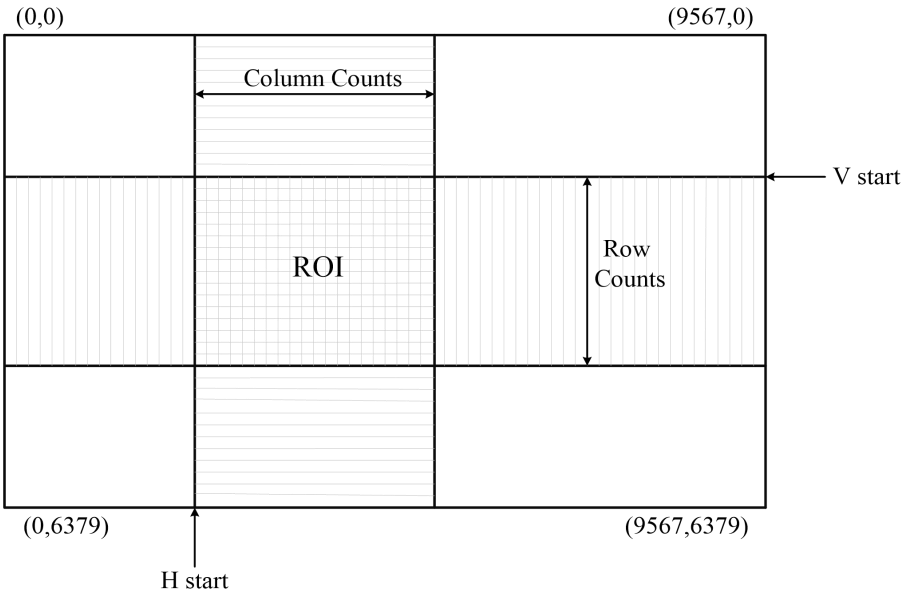


Fig.16 ROI

Table 4 Maximum Frame Rate Depending on ROI Values

TS25MCXP12 camera (four-channel):

ROI Size H	ROI Size V	8bit	10bit
5120	5120	150.1fps	141.0fps
4992	5120	150.1fps	141.0fps
3968	5120	150.1fps	141.0fps
2944	5120	150.1fps	141.0fps
1984	5120	150.1fps	141.0fps

960	5120	150.1fps	141.0fps
128	5120	150.1fps	141.0fps
5120	5000	153.6fps	144.3fps
5120	4000	191.6fps	180.1fps
5120	3000	254.7fps	239.3fps
5120	2000	379.7fps	356.6fps
5120	1000	744.6fps	699.8fps
5120	128	4629.6fps	4629.6fps
128	128	4629.6fps	4629.6fps

TS25MCXP12 camera (two-channel):

ROI Size H	ROI Size V	8bit	10bit
5120	5120	91.2fps	73.8fps
4992	5120	91.2fps	73.8fps
3968	5120	91.2fps	73.8fps
2944	5120	91.2fps	73.8fps
1984	5120	91.2fps	73.8fps
960	5120	91.2fps	73.8fps
128	5120	91.2fps	73.8fps
5120	5000	93.4fps	75.6fps
5120	4000	116.5fps	94.3fps
5120	3000	154.8fps	125.3fps
5120	2000	230.8fps	186.8fps
5120	1000	452.9fps	366.6fps
5120	128	2816.9fps	2277.9fps
128	128	2816.9fps	2277.9fps

6.3 Image Flipping

TS25MCXP12 camera can make the image flip along the X/Y direction. Users can use this function to change the camera scan direction, the effect is shown below:

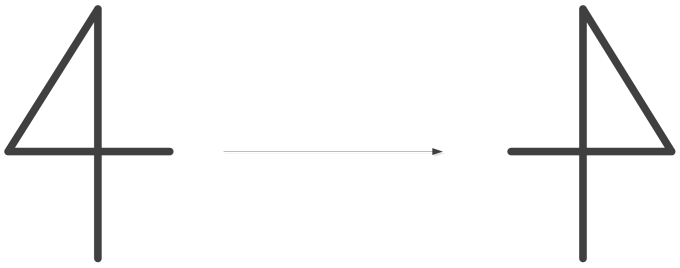


Fig.17 Flip in X Direction

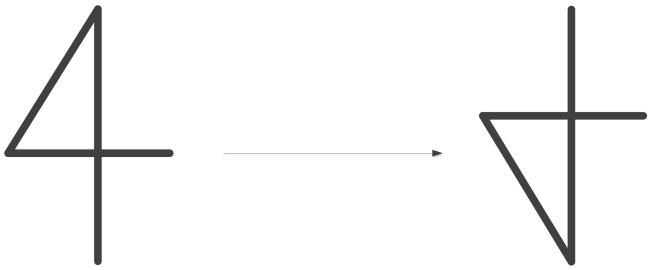


Fig.18 Flip in Y Direction

6.4 LUT

LUT uses a 10bit input and 10bit output lookup table to map values of original image. Users can use this feature to implement gamma correction.

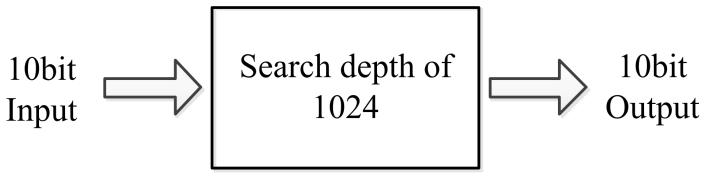


Fig.19 LUT Structure

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

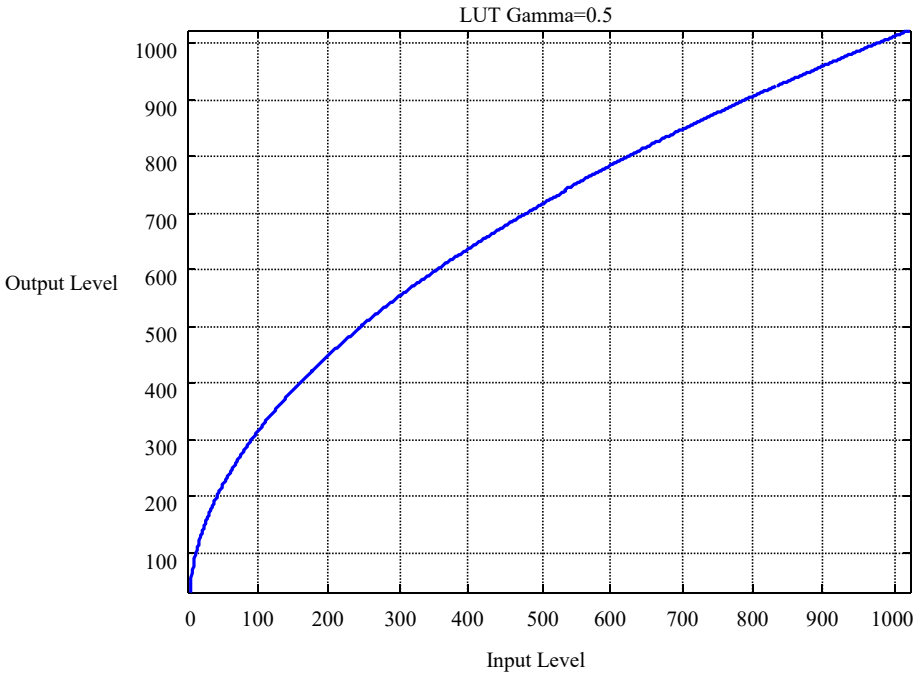


Fig.20 LUT: Gamma=0.5

6.5 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. TS25MCXP12 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.

The correction method of defective pixels is based on calculation and output of adjacent valid pixel values in the same line. The correction methods of monochrome and color cameras are different:

- For monochrome cameras, the defective pixel values are replaced by adjacent pixel values.
- For color cameras, the defective pixel values are replaced by separated pixel values.

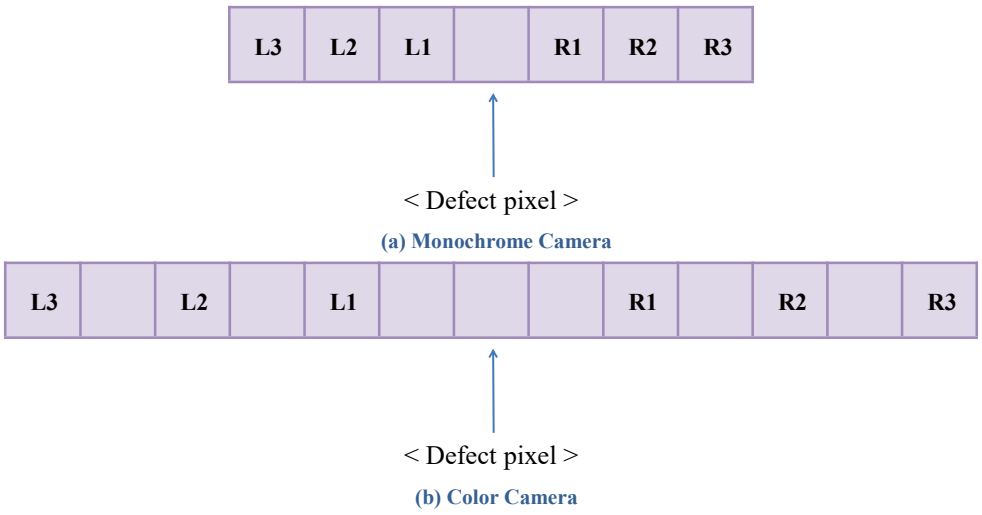


Fig.21 Defect Pixel Correction Methods for Different Cameras

In the figure above, the modified value of defective pixels will be calculated according to whether the surrounding pixels are defective pixels, as the rules shown in the following table.

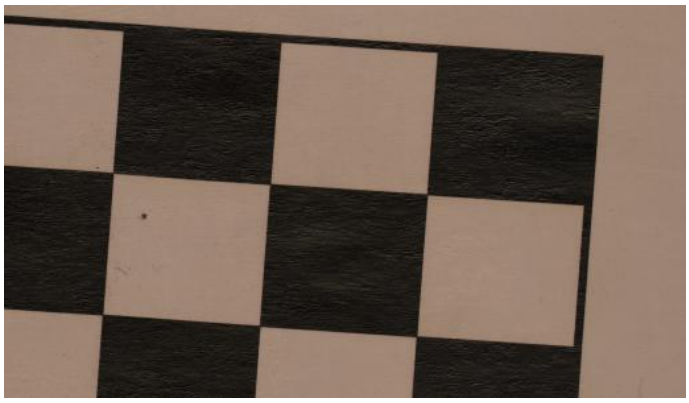
Table 5 Calculation Defect Pixel Correction Value

Adjacent Defect Pixel(s)	Correction value of Current Pixel
None	L1
L1	R1
R1	L1
L1,R1	L2
L1,R1,L2	R2
L1,R1,L2,R2	L3
L1,R1,L2,R2,L3	R3

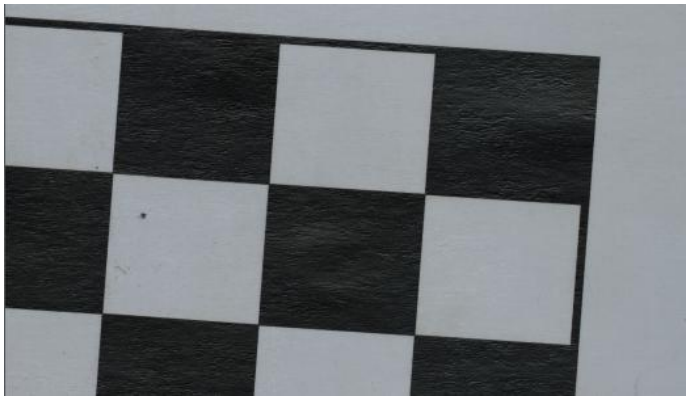
6.6 White Balance

White balance is an important parameter of color industrial camera, it directly affects the color effect of the reproduced image, when the white balance of the industrial camera is not set properly, color reproduction will occur when the image is reproduced.

TS25MCXP12 color camera provides white balance function, which balances the output value of each channel of the sensor. Automatic white balance calculates the white balance coefficient by sampling local pixels in the sensor, then adjust each component of the image according to coefficient to make red, green and blue components of the output image have the same value. Its function diagram is as follows:



(a) Before White Balance



(b) After White Balance

Fig.22 White Balance

6.7 Flat Field Correction

Generally, in the application process of area scan cameras, due to the vignetting effect of the lens and the inconsistency of illumination, there is a certain difference between image output by camera and the actual signal, that is, the output data of the camera is different for the signal with the same brightness. TS25MCXP12 camera provides a flat field correction function to correct this problem. Users can realize flat field effect by correcting signal parameters of uniform intensity target.

Considering the pixel array size and vignetting effect of area scan cameras, this camera realizes real-time flat field correction algorithm by using block data of 64*64 pixels and combining with image algorithm. The basic principle is shown in the figure below:

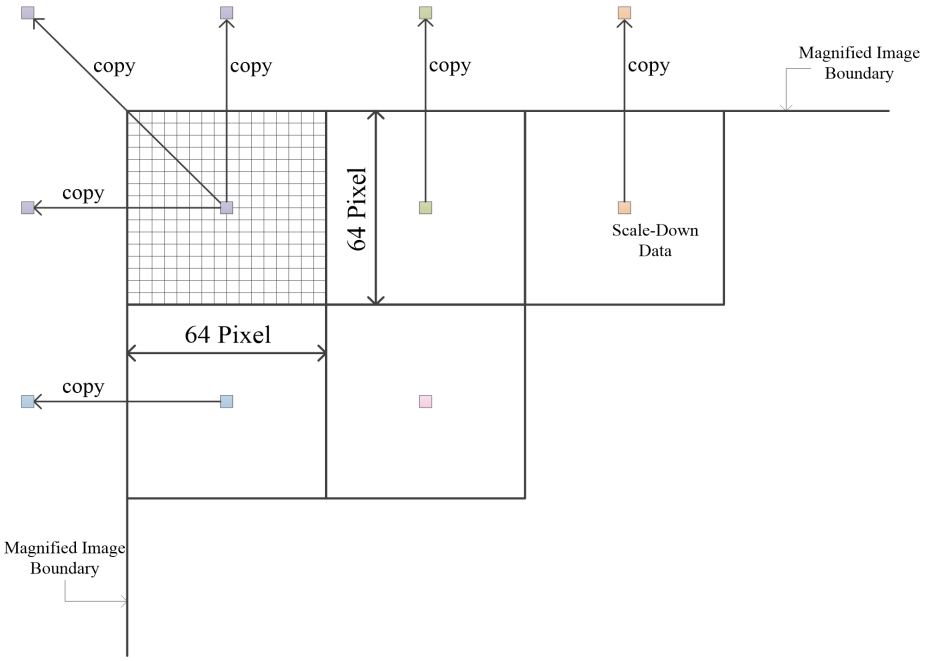


Fig.23 Flat Field Correction Schematic

6.8 Test Image

The camera provides test images. Different from the collected images whose data comes from sensors, test images are fixed images that are pre-edited and stored inside camera, independent of the scene shot by camera, and can be used to test whether data link is smooth.

This camera provides a test image as shown below:

- Test image 1: fixed image with horizontal gray gradient.
- Test image 2: fixed image with vertical gray gradient.
- Test image 3: fixed image with the same gray scale for all pixels.

Fig.24 Test Image 1

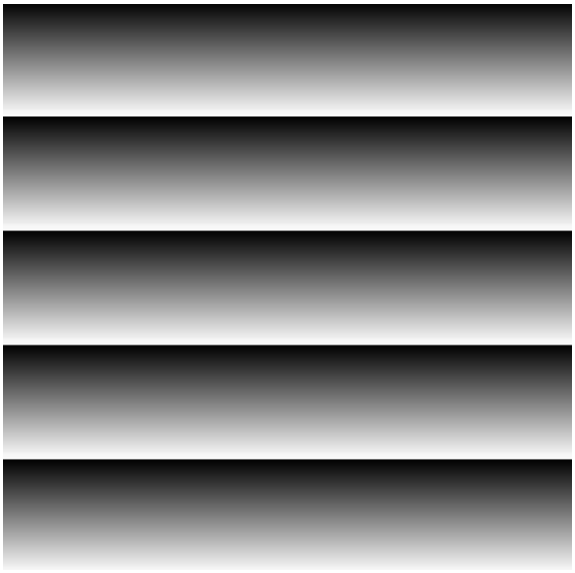


Fig.25 Test Image 2

Fig.26 Test Image 3

6.9 Data Format

TS25MCXP12 camera provides 8bit and 10bit pixel data bit widths. If it is 8bit width, it is equivalent to intercept the upper 8 bits of 10bit data.

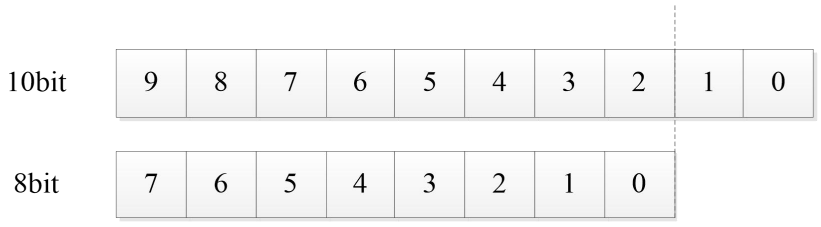


Fig.27 Data Format

6.10 Gain and Offset

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

Analog gain acts on analog signal. By increasing analog gain, a stronger response can be generally obtained under weak illumination, thus realizing a higher signal-to-noise ratio.

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) * 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

Digital offset is set for 10 bit of data. If image data is 8bit, actual digital offset is divided by 4.

6.11 Camera Temperature

TS25MCXP12 camera supports real-time temperature acquisition. Users can read temperature of the camera to monitor working status of the sensor.

The recommended operating temperature range of the camera is 0~50℃. If users detect an abnormal temperature (such as over 65℃), it is recommended to stop the camera immediately and contact our technical support.

6.12 Load/Save Configuration

TS25MCXP12 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.

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 CoaXPress, as shown in the figure.

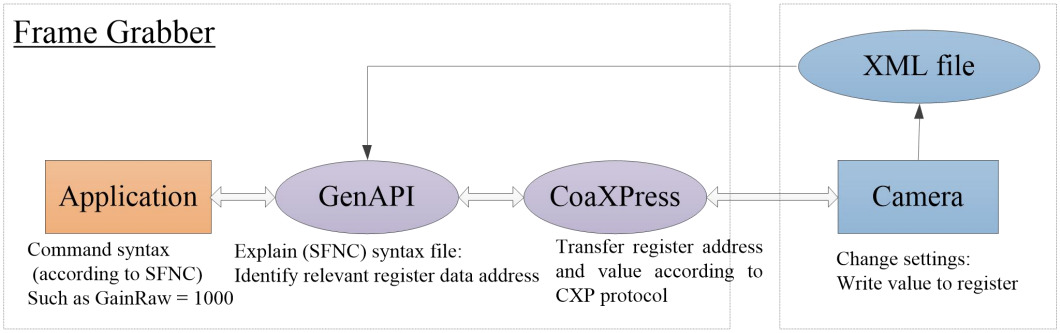


Fig.28 Communication Schematic between Application and Camera

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 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	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) Default parameter value and range

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

7.3 Register Classification

7.3.1 Bootstrap CoaXPress Register

Table 7 Bootstrap CoaXPress Register

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
ConnectionLinkCount	0x61d0	4	E	RW	Beginner
ConnectionConfigDefault	0x4018	4	E	RO	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

- **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:

  - CXP3_X1 (65592)
  - CXP5_X1 (65600)
  - CXP6_X1 (65608)
  - CXP12_X1 (65624)
  - CXP3_X2 (131128)
  - CXP5_X2 (131136)
  - CXP6_X2 (131144)
  - CXP12_X2 (131160)
  - CXP3_X4 (262200)
  - CXP5_X4 (262208)
  - CXP6_X4 (262216)
  - CXP10_X4 (262224)
  - CXP12_X4 (262232)

- **ConnectionLinkCount**

  Set the number of link channel. The enumeration names and values are as follows:

- Two (0)
- Four (1)

- **ConnectionConfigDefault**

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

- CXP3_X1 (65592)
- CXP5_X1 (65600)
- CXP6_X1 (65608)
- CXP12_X1 (65624)
- CXP3_X2 (131128)
- CXP5_X2 (131136)
- CXP6_X2 (131144)
- CXP12_X2 (131160)
- CXP3_X4 (262200)
- CXP5_X4 (262208)
- CXP6_X4 (262216)
- CXP10_X4 (262224)
- CXP12_X4 (262232)

- **TestMode**

Enable transmission of test packets 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**

Number of test data frames.

- **ElectricalCompliancyTest**

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

- NormalOperatingMode (0)

- CXP3_X1 (65592)
- CXP5_X1 (65600)
- CXP6_X1 (65608)
- CXP3_X2 (131128)
- CXP5_X2 (131136)
- CXP6_X2 (131144)
- CXP3_X4 (262200)
- CXP5_X4 (262208)
- CXP6_X4 (262216)

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

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

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

- **AcquisitionStartAddress**
  The address of camera acquisition 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.

7.3.2 Device Control Register

Table 8 Device Control Register

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	RO	Beginner
MCUTemperature	0x6118	4	F	RO	Expert
SensorTemperature	0x6038	4	F	RO	Expert
BoardTemperature	0x6114	4	F	RO	Expert

- **DeviceVendorName**
  Device vendor name.

- **DeviceModelName**
  Device model name.

- **DeviceManufacturerInfo**
  Device manufacturer information.

- **DeviceVersion**
  Device version.

- **DeviceSerialNumber**
  Device serial number.

- **DeviceUserID**
  User-defined ID.

- **MCUTemperature**
  MCU temperature.

- **SensorTemperature**
  Sensor temperature.

- **BoardTemperature**
  Board temperature.

7.3.3 Image Format Control Register

Table 9 Image Format Control Register

Name	Address	Size	Interface	Access	Visibility
Width	0x6000	4	I	RW	Beginner
Height	0x6004	4	I	RW	Beginner
OffsetX	0x6010	4	I	RW	Beginner
OffsetY	0x6014	4	I	RW	Beginner
PixelFormat	0x6020	4	E	RW	Beginner

VideoMode	0x602c	4	E	RW	Beginner
ReverseX	0x613c	4	B	RW	Beginner
ReverseY	0x6140	4	B	RW	Beginner
DeviceTapGeometry	0x6030	4	E	RO	Expert
Image1StreamID	0x6034	4	I	RO	Guru

- **Width**

  Actual camera output width. The parameter range is as follows:
  - Minimum: 128
  - Increment: 64

- **Height**

  Actual camera output height. The parameter range is as follows:
  - Minimum: 128

- **OffsetX**

  Horizontal offset. The parameter range is as follows:
  - Minimum: 0
  - Increment: 32

- **OffsetY**

  Vertical offset. The parameter range is as follows:
  - Minimum: 0
  - Increment: 2

- **PixelFormat**

  Pixel format. The enumeration names and values are as follows:
  - Mono8 (17301505): Monochrome 8bit
  - Mono10 (17825795): Monochrome 10bit
  - BayerBG8 (17301515): Bayer BGGR 8bit
  - BayerBG10 (17825807): Bayer BGGR 10bit
  - BayerGB8 (17301514): Bayer GBRG 8bit
  - BayerGB10 (17825806): Bayer GBRG 10bit
  - BayerGR8 (17301512): Bayer GRBG 8bit
  - BayerGR10 (17825804): Bayer GRBG 10bit
  - BayerRG8 (17301513): Bayer RGGB 8bit
  - BayerRG10 (17825805): Bayer RGGB 10bit

- **VideoMode**

  Output image format. 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

- Uniform (4): Uniform test image

- **ReverseX**
  Horizontal flipping.

- **ReverseY**
  Vertical flipping.

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

- **Image1StreamID**
  Data stream1 index.

7.3.4 Acquisition Control Register

Table 10 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
AcquisitionFrameRateEnable	0x61f4	4	B	RW	Expert
AcquisitionFrameRate	0x6164	4	F	RW	Beginner
TriggerMode	0x61f8	4	E	RW	Beginner
TriggerSource	0x6050	4	E	RW	Beginner
TriggerActivation	0x6054	4	E	RW	Beginner
TriggerDelayTime	0x6058	4	I	RW	Beginner
ExposureMode	0x605c	4	E	RW	Beginner
ExposureTime	0x6060	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.

- **AcquisitionFrameRateEnable**

Enable acquisition frame rate setting. Users can set acquisition frame rate by checking this item, otherwise frame rate is set to the maximum value currently allowed by default.

- **AcquisitionFrameRate**

  Acquisition frame rate, unit is Hz. The parameter range is as follows:
  - Maximum: 10000
  - Minimum: 0

- **TriggerMode**

  Trigger mode. The enumeration names and values are as follows:
  - Off (0): Turn off trigger mode
  - On (1): Turn on trigger mode

- **TriggerSource**

  Trigger source selector. The enumeration names and values are as follows:
  - IO (1): IO interface signal
  - CXP (0): CXP signal

- **TriggerActivation**

  Trigger polarity. The enumeration names and values are as follows:
  - FallingEdge (1): Trigger acquisition at falling edge
  - RisingEdge (0): Trigger acquisition at rising edge

- **TriggerDelayTime**

  Trigger delay time. The parameter range is as follows:
  - Maximum: 1000000
  - Minimum: 0
  - Increment: 1

- **ExposureMode**

  Exposure mode. The enumeration names and values are as follows:
  - Timed (0): Timed
  - TriggerWidth (2): Trigger width control

- **ExposureTime**

  Exposure time, unit is us.

7.3.5 Digital Control Register

Table 11 Digital Control Register

Name	Address	Size	Interface	Access	Visibility
DigitalGain	0x6068	4	F	RW	Beginner
DigitalOffset	0x606c	4	I	RW	Beginner
WhiteBalanceRedGain	0x6070	4	I	RW	Expert

WhiteBalanceGreenGain	0x6074	4	I	RW	Expert
WhiteBalanceBlueGain	0x607c	4	I	RW	Expert
WhiteBalanceEnable	0x608c	4	B	RW	Expert
WhiteBalanceInitialize	0x6080	4	C	WO	Expert
WhiteBalanceCalibrate	0x6080	4	C	WO	Expert
BlackLevelOdd	0x6168	4	I	RW	Guru
BlackLevelEven	0x61d0	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: 4095
  - Minimum: -4095
  - Increment: 1

- **WhiteBalanceRedGain**

  White balance R channel gain, only color camera can set this parameter. The parameter range is as follows:
  - Maximum: 16384
  - Minimum: 1024
  - Increment: 1

- **WhiteBalanceGreenGain**

  White balance G channel gain, only color camera can set this parameter. The parameter range is as follows:
  - Maximum: 16384
  - Minimum: 1024
  - Increment: 1

- **WhiteBalanceBlueGain**

  White balance B channel gain, only color camera can set this parameter. The parameter range is as follows:
  - Maximum: 16384
  - Minimum: 1024
  - 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.

- **BlackLevelOdd**

  Black level odd column, 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: 8191
  - Minimum: -8191
  - Increment: 1

- **BlackLevelEven**

  Black level even column, 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: 8191
  - Minimum: -8191
  - Increment: 1

7.3.6 Analog Control Register

Table 12 Analog Control Register

Name	Address	Size	Interface	Access	Visibility
AnalogGain	0x6088	4	E	RW	Beginner
AnalogOffset	0x6130	4	I	RW	Beginner

- **AnalogGain**

  Analog gain. The enumeration names and values are as follows:

  - X1 (0)
  - X1_5 (1)
  - X2 (2)
  - X2_5 (3)

- **AnalogOffset**

  Analog offset. The parameter range is as follows:

  - Maximum: 4095
  - Minimum: 0
  - Increment: 1

7.3.7 Defect Pixel Register

Table 13 Defect Pixel Register

Name	Address	Size	Interface	Access	Visibility
DefectPixelCorrectionEnable	0x60d0	4	B	RW	Guru
DefectPixelTotal	0x60d8	4	I	RO	Expert
DefectPixelSelect	0x60dc	4	I	RW	Expert
DefectPixelReadX	0x60e0	4	I	RO	Expert
DefectPixelReadY	0x60e4	4	I	RO	Expert
DefectPixelWriteX	0x60e8	4	I	RW	Expert
DefectPixelWriteY	0x60ec	4	I	RW	Expert
DefectPixelAdd	0x60f0	4	C	WO	Expert
DefectPixelRemove	0x60f4	4	C	WO	Expert
DefectPixelClearAll	0x60f8	4	C	WO	Expert
DefectPixelSave	0x60fc	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.

- **DefectPixelReadY**

  Read the Y coordinate of current defect pixel.

- **DefectPixelWriteX**

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

  - Maximum: 9344
  - Minimum: 0
  - Increment: 1

- **DefectPixelWriteY**

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

  - Maximum: 7000
  - Minimum: 0

- Increment: 1

- **DefectPixelAdd**
  Add defect pixel.

- **DefectPixelRemove**
  Remove current defect pixel.

- **DefectPixelClearAll**
  Remove all defect pixels.

- **DefectPixelSave**
  Save defect pixels.

7.3.8 LUT Control Register

Table 14 LUT Control Register

Name	Address	Size	Interface	Access	Visibility
LUTEnable	0x60c0	4	B	RW	Beginner
LUTSelector	0x6134	4	I	RW	Expert
LUTIndex	0x60c4	4	I	RW	Expert
LUTValue	0x60c8	4	I	RW	Expert
Gamma	0x6138	4	F	RW	Beginner

- **LUTEnable**
  Enable LUT function.

- **LUTSelector**
  Select LUT, that is, input the index of LUT. The parameter range is as follows:
  - Maximum: 3
  - Minimum: 0
  - Increment: 1

- **LUTIndex**
  Lookup table data index, that is, the gray value of image before mapping lookup table. The parameter range is as follows:
  - Maximum: 1023
  - Minimum: 0
  - Increment: 1

- **LUTValue**
  Lookup table data value, that is, the gray value of image after mapping lookup table. The parameter range is as follows:
  - Maximum: 1023

- Minimum: 0
- Increment: 1

- **Gamma**

  Gamma correction coefficient. The parameter range is as follows:
  - Maximum: 127
  - Minimum: 0.01

7.3.9 Dark Field Correction Register

Table 15 Dark Field Correction Register

Name	Address	Size	Interface	Access	Visibility
DF_TargetValue	0x61c0	4	I	RW	Expert
DF_Calibrate	0x61c4	4	C	WO	Expert
DF_RestoreFactory	0x61c4	4	C	WO	Expert

- **DF_TargetValue**

  Dark correction target value. The parameter range is as follows:
  - Maximum: 1023
  - Minimum: 0
  - Increment: 1

- **DF_Calibrate**

  Start dark field correction.

- **DF_RestoreFactory**

  Reset dark field correction to default setting.

7.3.10 Flat Field Correction Register

Table 16 Flat Field Correction Register

Name	Address	Size	Interface	Access	Visibility
FF_Enable	0x6100	4	B	RW	Beginner
FF_Calibrate	0x6104	4	C	WO	Beginner
FF_RestoreFactory	0x6104	4	C	WO	Beginner

- **FF_Enable**

  Enable flat field correction.

- **FF_Calibrate**

  Start flat field correction.

- **FF_RestoreFactory**

Reset flat field correction to default setting.

7.3.11 Cooler Register

Table 17 Cooler Register

Name	Address	Size	Interface	Access	Visibility
FanSpeed	0x61c8	4	I	RW	Expert
TECCoolerEnable	0x6124	4	B	RW	Expert
TECTemperature	0x6128	4	I	RW	Guru

- **FanSpeed**

  Fan speed. The parameter range is as follows:
  - Maximum: 127
  - Minimum: 0
  - Increment: 1

- **TECCoolerEnable**

  Enable TEC refrigeration function.

- **TECTemperature**

  Set TEC refrigeration target temperature. The parameter range is as follows:
  - Maximum: 40
  - Minimum: -10
  - Increment: 1

7.3.12 User Set Control Register

Table 18 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
  - 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 the 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 is 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.