TS25MGV-10M 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	2023/09/27	● Initial version

Manufacturer Information

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Contents

1 Precautions

- **General**

① Do not drop, damage, disassemble the camera.
② Do not let children touch the camera without supervision.
③ Do not use the camera for other purposes than those specified herein.
④ If there is any problem with the camera, please contact us in time for technical support.

- **Installation and Maintenance**

① Do not install the camera in an environment with direct sunlight, high humidity or heavy dust.
② Keep the camera away from an environment with strong electromagnetic interference.
③ Keep the camera away from heat sources.
④ Be careful not to let the camera soak in liquid, such as water and drinks.
⑤ Clean dust on the surface of the camera as often as possible to avoid dust entering the camera, otherwise it may cause fault to the camera.
⑥ To clean the dust on the camera surface, do not wash with water, wipe it with lint-free cloth.

- **Power Supply**

① The camera supports external power supply or PoE power supply. The recommended voltage is +12~24V (±10%), and the current must be 1.0A.
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**

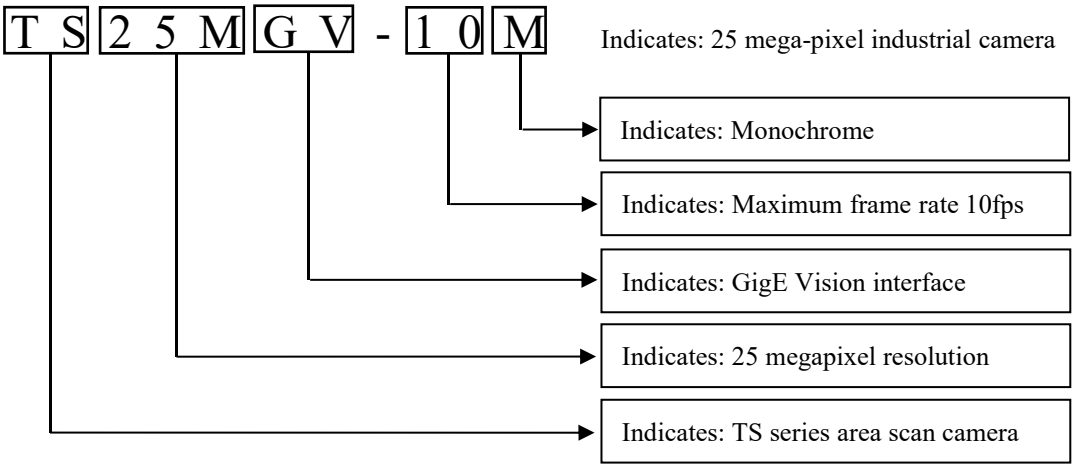
Abbreviation	Image Mode
M	Monochrome
C	Color
F	Full Color
T	Monochrome TDI (Time Delay Integration)
X	Time Division Camera
U	UV (Ultraviolet)
N	NIR (Near Infrared)

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.



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

TS25MGV camera adopts advanced global shutter CMOS image sensor and GigE Vision 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
- High Sensitivity and Low Noise
- ROI
- Binning
- Rich Exposure Control Modes (External Trigger, Free-Run)
- LUT
- Defect Pixel Correction
- Flat Field Correction
- Analog Gain / Digital Gain / Offset Control
- User-Configurable Scanning Direction
- Temperature Monitor
- Gigabit Ethernet Interface for Long Distance Transmission
- Support GigEVision V2.0 and GenICam Standard

4.2 Camera Specifications

Table 1 TS25MGV-10M Product Specifications

Model	TS25MGV-10M
Product Description	25 mega-pixel industrial camera
Resolution	5120 x 5120
Pixel Size	4.5um x 4.5um
Sensor Type	Global shutter CMOS
Image Type	Monochrome
Sensor Size	32.58mm (diagonal)
Dynamic Range	≥ 55dB
SNR	39dB
Data Rate	Non-packed transfer: 124MB/s Packed transfer: 262MB/s
Analog Gain	x1/x1.26/x1.87/x3.17
Analog Offset	0~511
Digital Gain	0.01~8
Digital Offset	-1023~1023
Lens Mount	F Mount/M58

Max Frame Rate	4.72fps (10fps with SAccel™)
Trigger Mode	Free-Run, External Trigger
Exposure Control	Pulse Width Control, Timed
Exposure Time	1us~10s (step: 1us)
Data Format	8/10/10p
Trigger Input	External IO/Software trigger
Operation Temperature	0~55°C
Data Interface	GigE Vision
Power Supply	DC 12~24V (±10%) 1.0A or PoE power supply
Power Consumption	6.7W (DC power supply) or 7.4W (PoE power supply)
Mechanical	F Mount: 62mm x 62mm x 89.3mm M58: 62mm x 62mm x 54.3mm

Note: This table is for 1.3-1.9 version of TS25MGV camera specifications, which may vary slightly from version to version.

4.3 Camera Structure

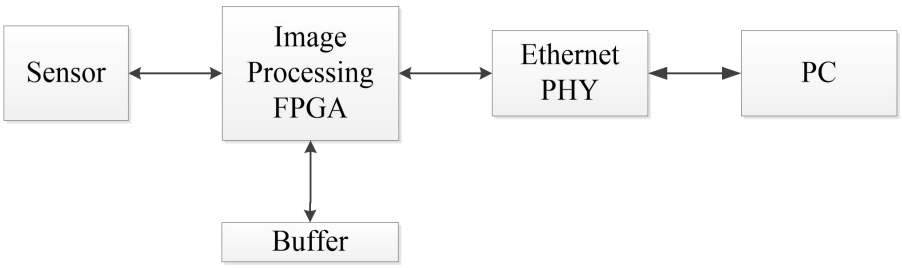


Fig.2 Internal Implementation Structure of Camera

TS25MGV camera uses a unified architecture to realize image sensor control, data transmission and embedded algorithm processing with different resolutions. The internal structure of camera is shown in the figure above. The pixel array is uniformly sampled and maintained by global shutter control system, converted into digital signals by analog front end, and then transmitted to PC network card through GigE Vision interface after relevant algorithm processing by FPGA.

The camera can accept external trigger acquisition, the source is IO signal. At the same time, the camera can also output synchronization signal during exposure, which is convenient for external strobe control.

4.4 Spectral Response

The following is spectral response curve of TS25MGV camera.

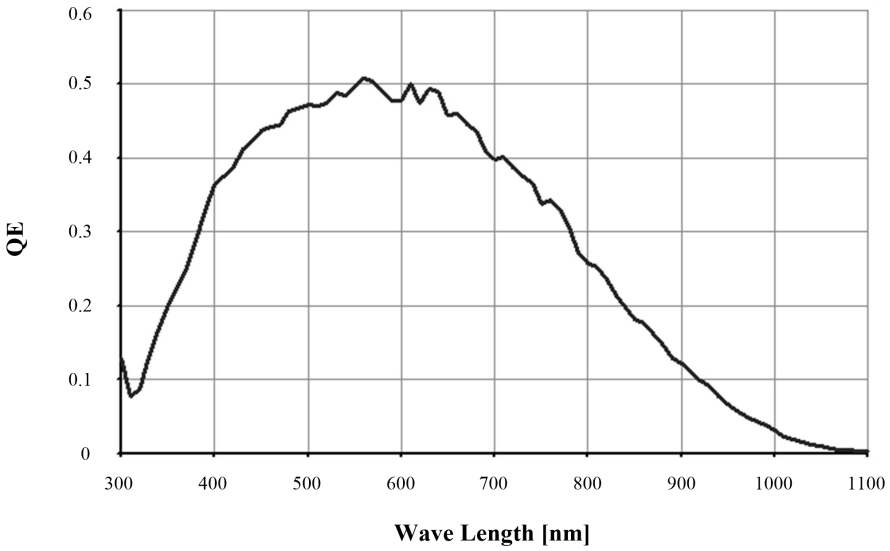


Fig.3 Spectral Response of Camera

4.5 Environmental Requirements

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

(2) The dust-proof sealing for the sensor in camera may effectively prevent dust from entering camera. Dust may enter camera when lens cap is opened, so keep lens cap closed when camera is not in use.

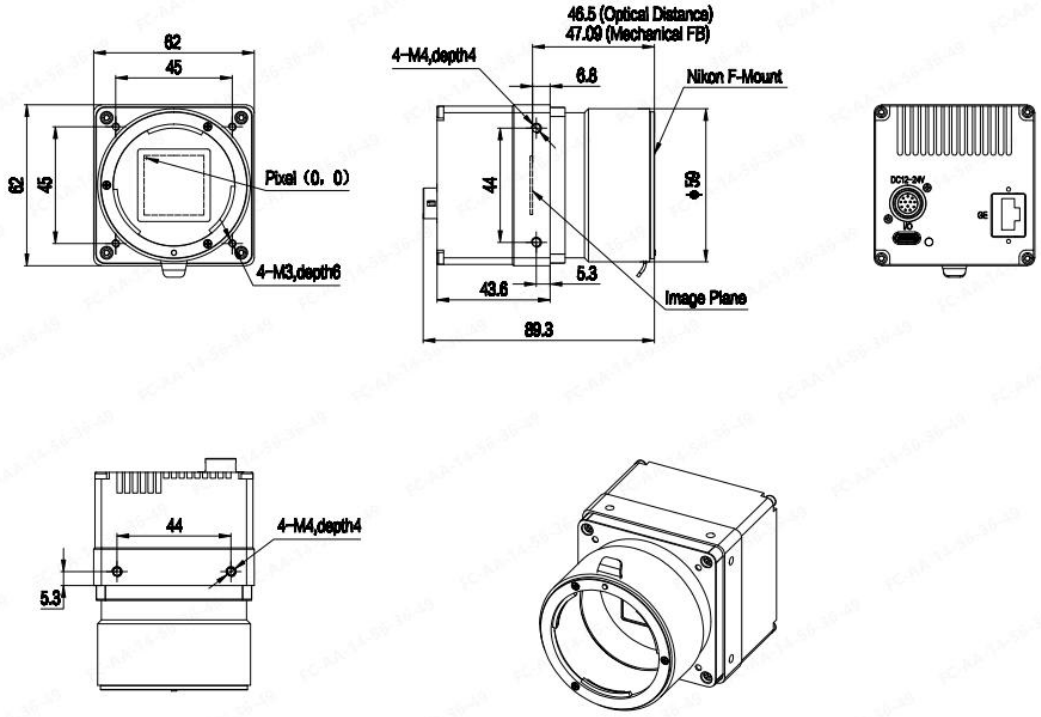
4.6 RoHS Certification

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

5 Mechanical Dimensions and Interfaces

5.1 Mechanical Dimensions

F Mount:



M58 Mount:

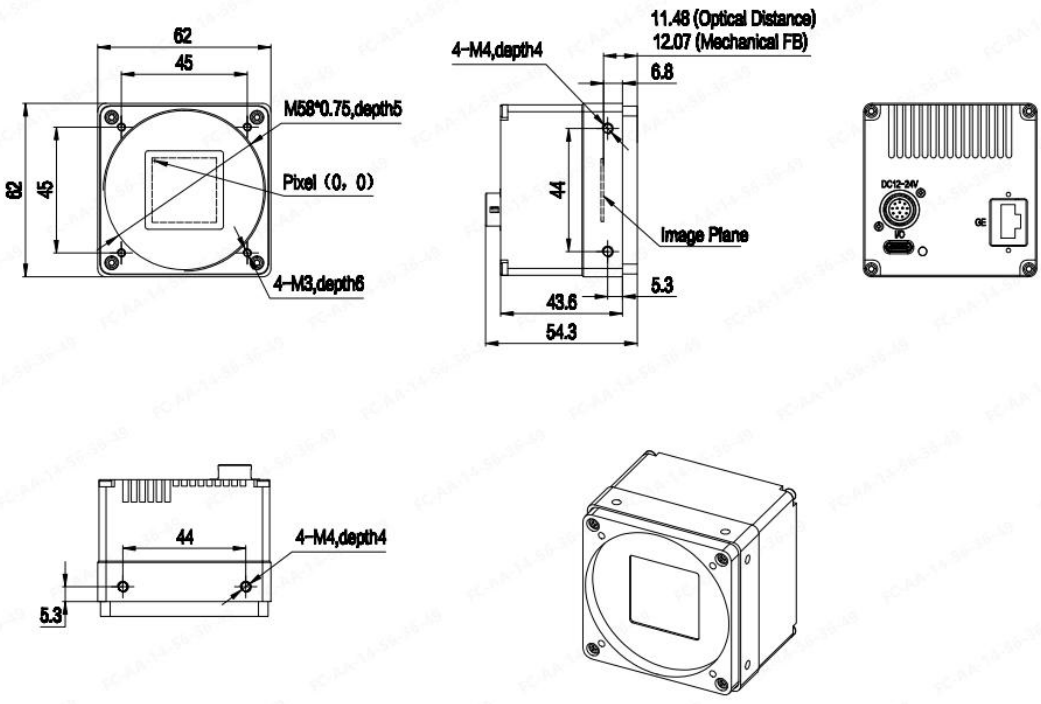


Fig.4 Camera Mechanical Dimensions

5.2 Camera Interface

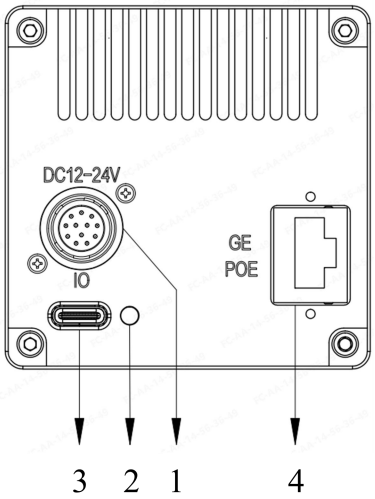


Fig.5 External Interfaces of Camera

(1) Power and Control Interface
(2) Camera Status Indicator
(3) Type-C Interface
(4) Gigabit Ethernet Data and PoE Power Supply Interface

5.2.1 Camera Status Indicator

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

Table 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 and control interface adopts a 12-pin connector with the model:
HR10A-10R-12PB(71) (Male).

Corresponding power connector on the cable model:
HR10A-10P-12S(73) (Female).

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

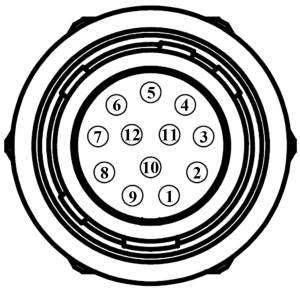


Fig.6 Power and Control Interface

Table 3 Power and Control Interface Pin Definition

Signal	Pin	Signal	Pin
Line 1+	1	Line 2-	7
Power_GND	2	Line 2+	8
Line 1-	3	Reserved	9
Power_VCC	4	Power_GND	10
Line 3	5	Reserved	11
Line 4	6	Reserved	12

Trigger interface circuit diagram is shown as follows:

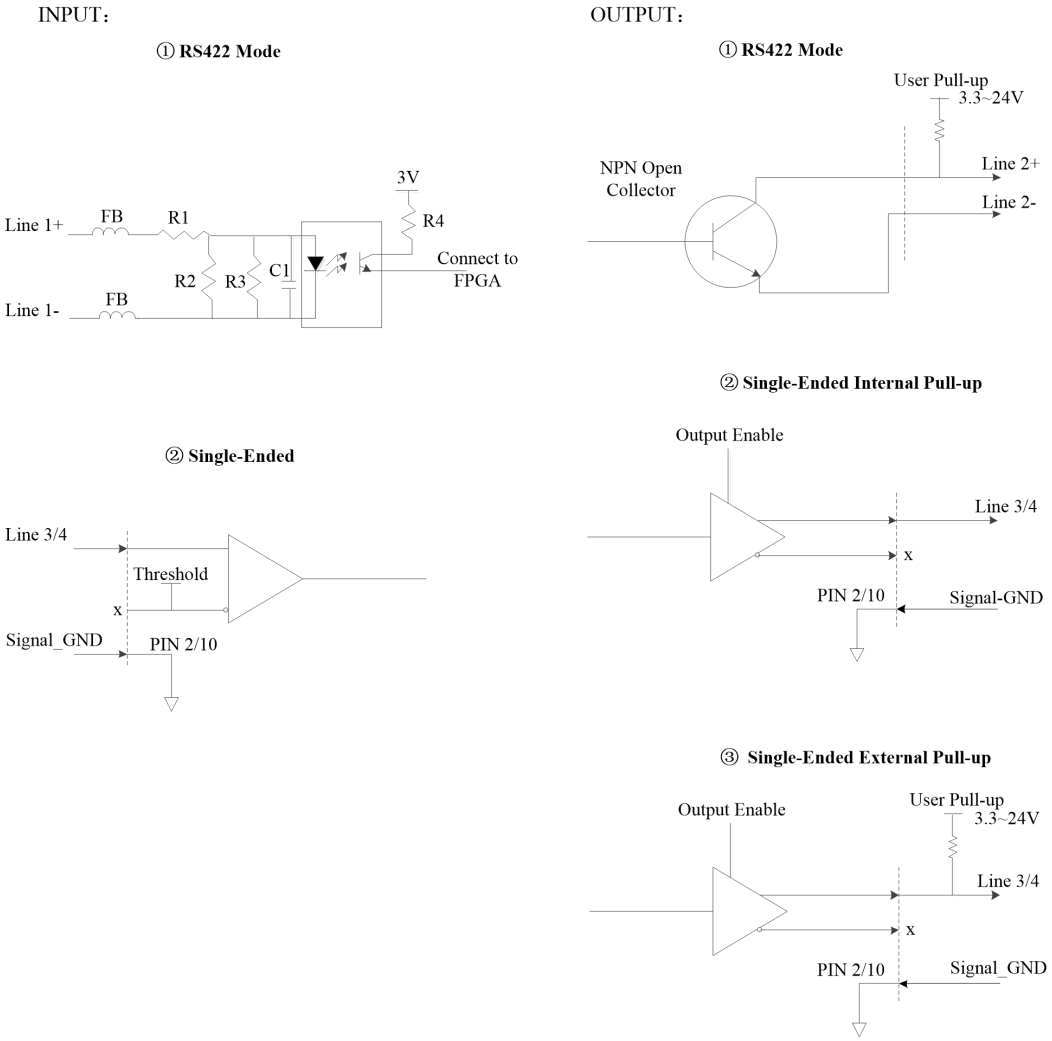


Fig.7 Trigger Interface Circuit Schematic

- Input Level Standard: above 3V
- Strobe Signal Pull-up Level Standard: 3.3~24V

6 Camera Features

This chapter introduces the main features of TS25MGV camera.

6.1 Trigger Mode

TS25MGV 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 relevant control sequence internally according to frame period and exposure time parameters configured by users and outputs images.

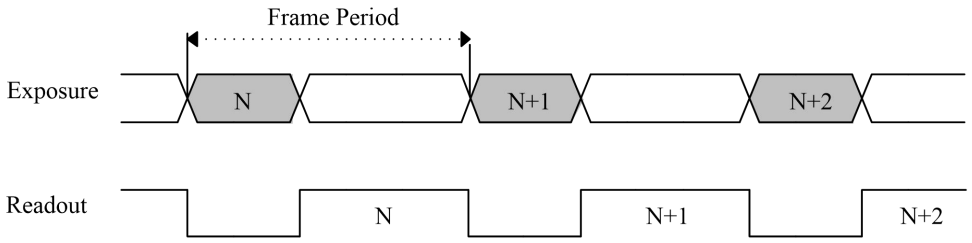


Fig.8 Free-Run Mode

To achieve normal image output, TS25MGV camera limits the range of frame period and exposure time, and the minimum frame period should be longer than both exposure time and readout time of a frame.

6.1.2 External Pulse Mode

In External Pulse mode (Trigger Mode = On, Exposure Mode = Timed), camera starts to expose at rising edge of external trigger signal, and exposure time length is set by users command (consistent with Free-Run mode).

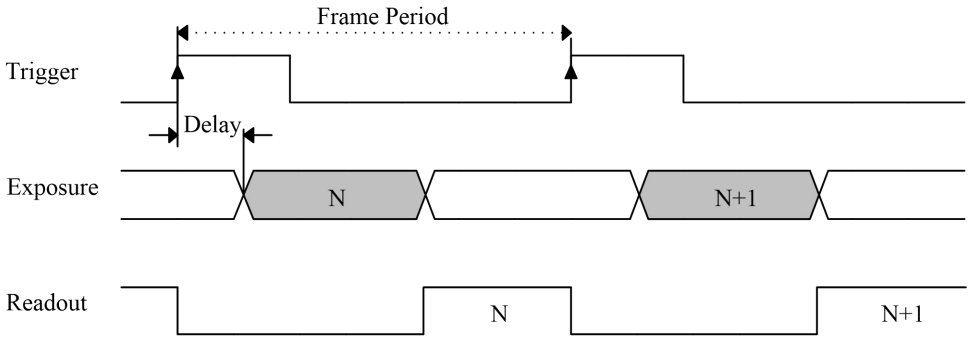


Fig.9 External Pulse Mode

The camera provides trigger delay and anti-shake functions, both of which delay trigger signal. The difference is that anti-shake function will eliminate some of trigger signals with smaller pulse width.

The number of trigger frames is determined by Trigger Frames Count, and its running sequence is shown in the figure below (Trigger Frames Count=2).

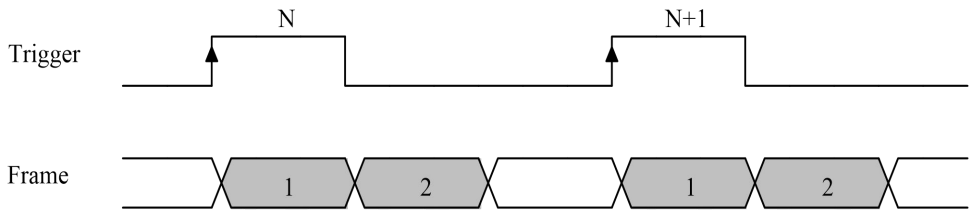


Fig.10 Trigger Frames Count

To get a higher frame rate, a new trigger pulse can be fired at the same time camera reads data after the last frame exposure. In External Pulse mode, frame period parameter is the minimum trigger interval, and external trigger signal smaller than this interval will be automatically ignored by camera, as shown in the figure below.

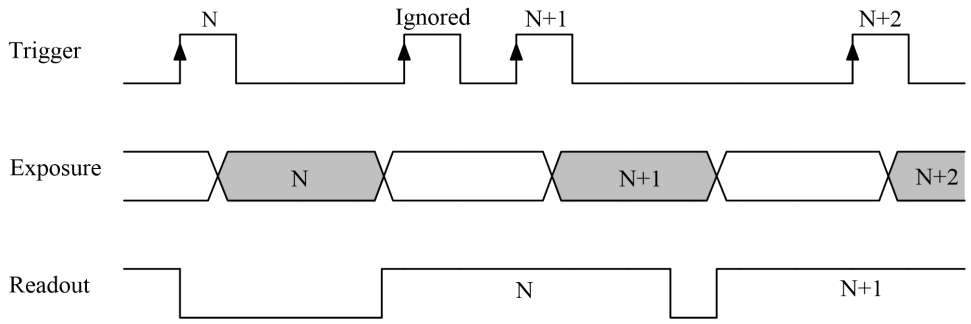


Fig.11 Frame Period of External Trigger is Too Short

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 external trigger signal. That is, actual exposure time is equal to externally triggered high level duration, and frame period is equal to pulse interval.

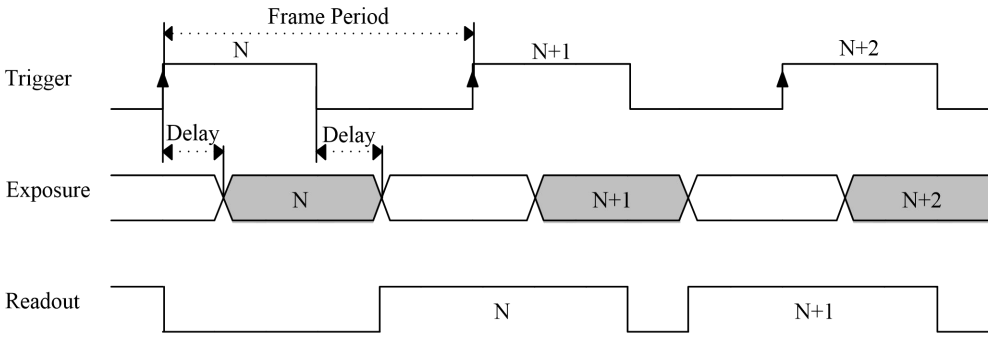


Fig.12 External PWM Mode

It should be noted that the width of external trigger high level in this mode should be greater than minimum exposure time. For pulses less than minimum exposure time, camera may ignore it.

If external trigger interval is too short, it will lead to readout time conflict of two frames before and after camera. At this time, pulse that does not meet requirement will be ignored inside camera, so that camera can maintain normal operation. In External PWM mode, frame period parameter is the minimum trigger interval, and external trigger signal smaller than this interval will be automatically ignored by camera, as shown in the figure below.

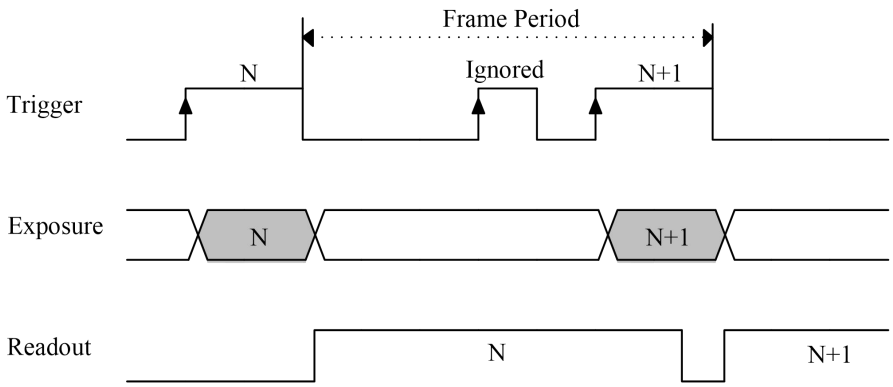


Fig.13 Frame Period of External Trigger is Too Short

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.

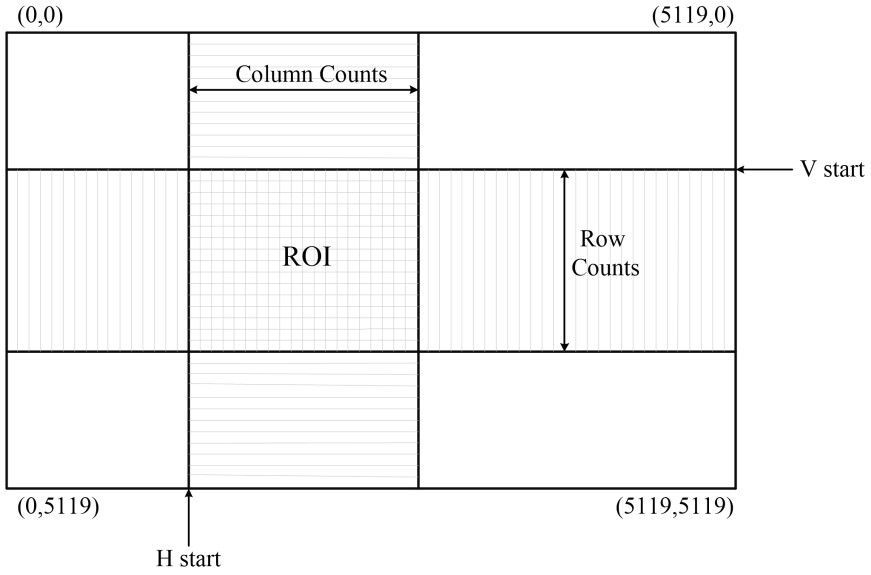


Fig.14 ROI

Table 4 Maximum Frame Rate in Different ROI Parameters

ROI Size H	ROI Size V	8bit	10bit
5120	5120	4.720fps	2.360fps
4992	5120	4.841fps	2.420fps
3968	5120	6.090fps	3.045fps
2944	5120	8.208fps	4.104fps
1984	5120	10.652fps	6.090fps
960	5120	10.652fps	8.191fps
128	5120	10.652fps	9.321fps
5120	5000	4.833fps	2.416fps
5120	4000	6.041fps	3.021fps
5120	3000	8.055fps	4.028fps
5120	2000	12.082fps	6.041fps
5120	1000	24.164fps	12.082fps
5120	128	188.679fps	94.375fps
128	128	347.343fps	310.559fps

6.3 Binning

TS25MGV camera supports 2x2 or 4x4 binning. After normal exposure, camera sums up values of adjacent pixels and outputs them as a single pixel value.

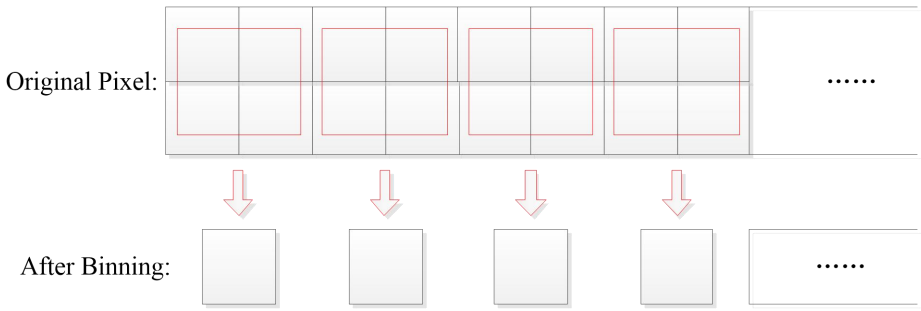


Fig.15 2x2 Binning

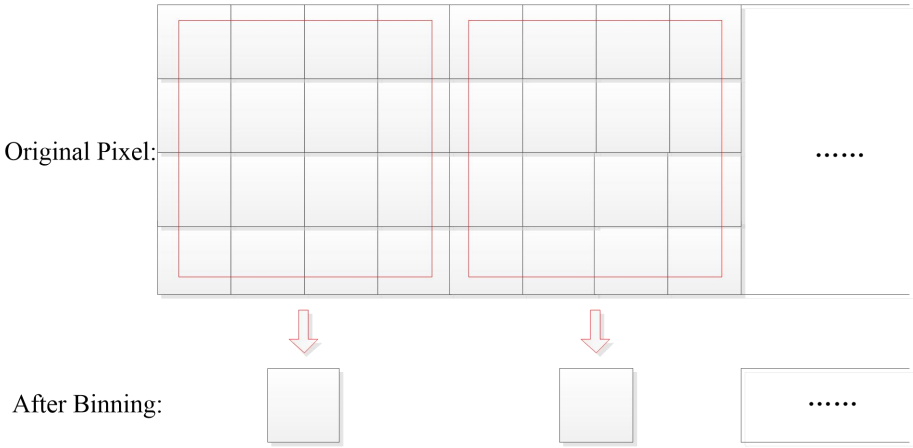
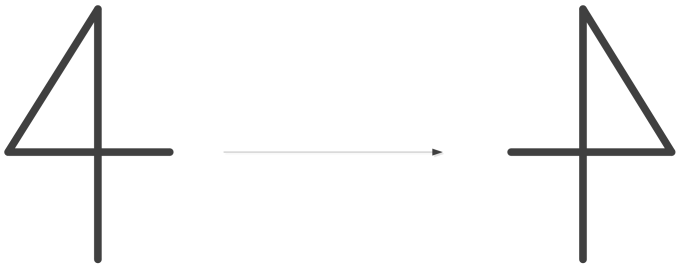


Fig.16 4x4 Binning

6.4 Camera Scanning Direction

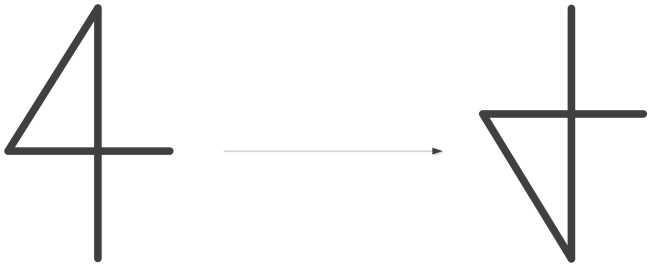
TS25MGV camera can be divided into horizontal scanning direction and vertical scanning direction. Horizontal scanning direction supports left to right and right to left, and vertical scanning direction supports top to bottom and bottom to top.

Horizontal and vertical scanning directions are shown below, and they can also be combined.



From Left to Right From Right to Left

Fig.17 Horizontal Scanning Direction



From Top to Bottom From Bottom to Top

Fig.18 Vertical Scanning Direction

6.5 LUT

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 realize gamma correction.

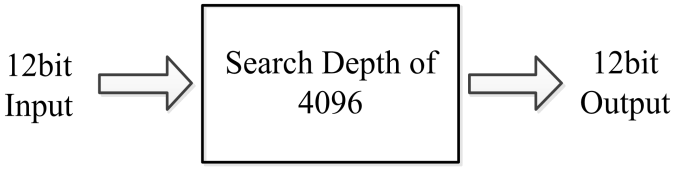


Fig.19 LUT

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

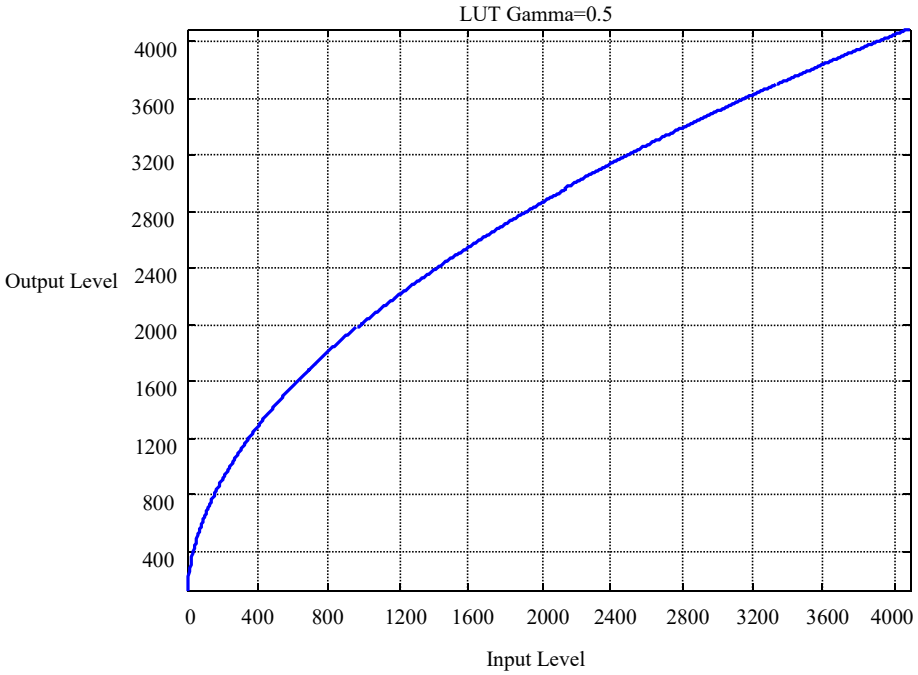


Fig.20 LUT: Gamma = 0.5

6.6 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. TS25MGV 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, TS25MGV camera realizes real-time flat field correction algorithm by using block data and combining with image algorithm. The basic principle is shown in the figure below:

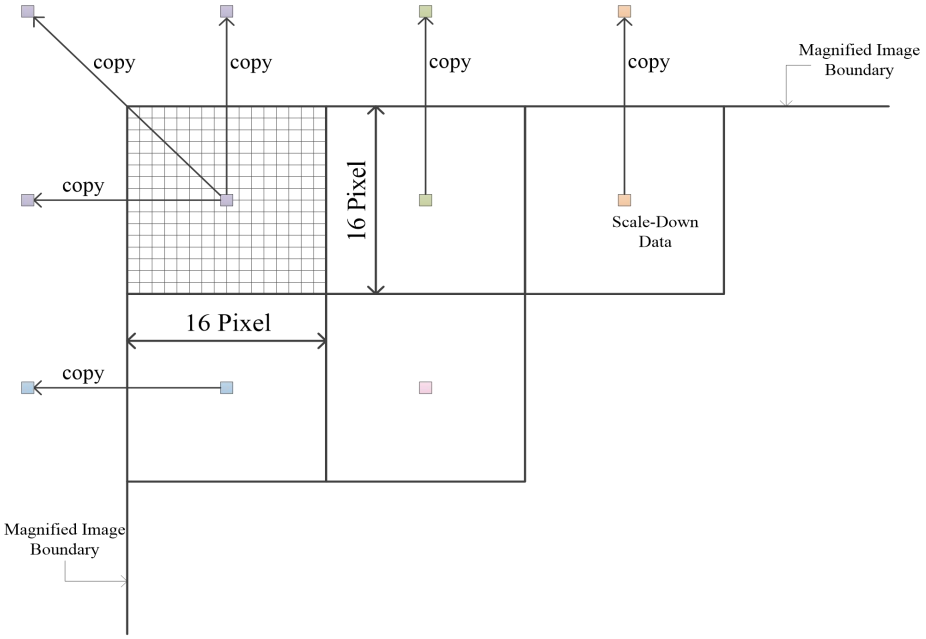


Fig.21 Flat Field Correction Schematic

6.7 Defect Pixel Correction

Due to defects of the material itself and issue with workflow 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. TS25MGV camera provides with defect pixel automatic correction feature. The defect pixel information of the imaging sensor is written into camera before 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.

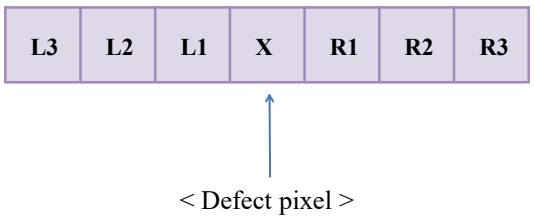


Fig.22 Defect Pixel Position

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

- If X is the beginning of line and R1 is not a defect pixel, X is replaced by R1.
- If X is the beginning of line and R1 is a defect pixel, X is replaced by R2.
- If X is the end of line and L1 is not a defect pixel, X is replaced by L1.
- If X is the end of line and L1 is a defect pixel, X is replaced by L2.
- If X is a middle pixel and L1 is not a defect pixel, X is replaced by L1.
- If X is a middle pixel, L1 is a defect pixel, and R1 is not a defect pixel, X is replaced by R1.
- If X is a middle pixel, L1 and R1 are defect pixels but L2 is not defect pixel, X is replaced by L2.
- If X is a middle pixel and L1, L2 and R1 are defect pixels, X is replaced by R2.

Note: More than 4 consecutive defect pixels will cause defect pixels to be replaced with defect pixels.

6.8 Strobe

The strobe signal is used to synchronize the external light source with the camera. The timing of the strobe signal is exactly the same as that of the camera exposure. When the camera exposure begins, the strobe signal will pull down/up the level. It will return to its initial level when camera exposure is over.

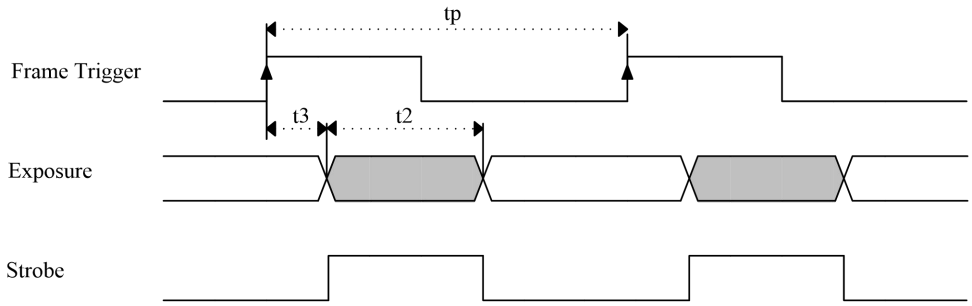


Fig.23 Strobe Signal

6.9 Test Image

TS25MGV camera supports three image types to better adapt to different scenarios:

- Original image
- Image after correction algorithm
- Test image

The test image is generally used to test whether data link is smooth, which is convenient for users to carry out various debugging. Figure shown below is oblique stripe mode. The output horizontal data of image keeps increasing. After reaching maximum value, it starts to count again from 0, and the cycle repeats.

Fig.24 Monochrome Test Image

6.10 Gain and Offset

Camera gain is divided into analog gain and digital gain.

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

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

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

Data value (Output) = Data value (digital gain=1 & digital offset=0) * 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 8 bit, actual digital offset is divided by 4.

6.11 Data Format

TS25MGV camera processes data in 10bit data format, but provides 8bit, 10bit output data formats. When camera outputs 8bit data, the lowest 2bit data will be deleted.

Fig.25 Data Format

6.12 Camera Temperature

TS25MGV camera supports real-time temperature acquisition of camera. Users can read temperature of the camera to monitor working status of the sensor.

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

6.13 Load/Save Configuration

TS25MGV camera supports three working parameter sets, including one factory default parameter set and two user parameter sets. Factory default parameter set can be used in most occasions. Users can also configure parameters based on actual requirements and save in user parameter set for self-loading after power on. The camera will automatically load the last saved parameter set each time.

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

6.14 Camera IP Address

TS25MGV camera communicates with the host computer through Gigabit Ethernet, so users must set a proper IP address before using PN2KGV camera. When camera and the host are in the same local area network, they can normal communication.

TS25MGV cameras support three IP configuration modes, namely static IP, DHCP, and LLA, with descending priorities. Static IP and DHCP are enabled for users. If DHCP fails, LLA is used to allocate IP addresses.

7 Camera Control

7.1 GenICam Standard

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

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

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

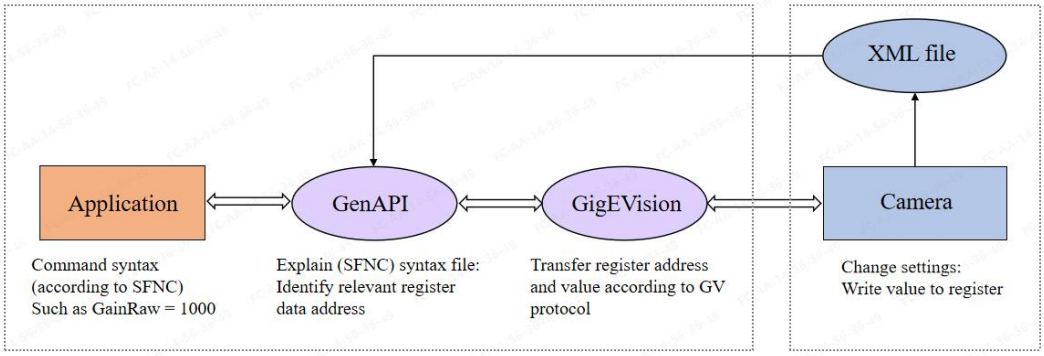


Fig.26 Communication Schematic between Application and Camera

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

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

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

7.2 GenAPI Parameter Attribute

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

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

(1) Register name

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

(2) Register address

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

(3) Register size

This parameter represents register value size (in bytes).

(4) Register interface

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

Table 5 Overview of Parameter Interface

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

(5) Parameter access

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

(6) 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 Device Control Register

Table 6 Device Control Register

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

DeviceSerialNumber	0x00d8	16	S	RO	Expert
DeviceUserID	0x00e8	16	S	RW	Beginner
SensorTemperature	0xa004	4	F	RO	Beginner
DeviceLinkSpeed	0x0670	4	I	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.

- **SensorTemperature**
  Sensor temperature.

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

7.3.2 Image Format Control Register

Table 7 Image Format Control Register

Name	Address	Size	Interface	Access	Visibility
Width	0xa800	4	I	RW	Beginner
Height	0xa804	4	I	RW	Beginner
OffsetX	0xa80c	4	I	RW	Beginner
OffsetY	0xa844	4	I	RW	Beginner
Binning	0xa810	4	E	RW	Beginner
PixelFormat	0xa84c	4	E	RW	Beginner
VideoMode	0xa834	4	E	RW	Beginner
HorizontalScanDirection	0xa838	4	E	RW	Beginner
VerticalScanDirection	0xa848	4	E	RW	Beginner

- **Width**

  Actual width of output image. The parameter range is as follows:

  - Minimum: 128

- **Height**

  Actual height of output image. The parameter range is as follows:

  - Minimum: 128
  - Increment: 2

- **OffsetX**

  Horizontal offset.

- **OffsetY**

  Vertical offset. The parameter range is as follows:

  - Minimum: 0
  - Increment: 2

- **Binning**

  Binning. The enumeration names and values are as follows:

  - Binning_1X1 (1)
  - Binning_2X2 (2)
  - Binning_4X4 (4)

- **PixelFormat**

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

  - Mono8 (0x7): Monochrome 8bit
  - Mono10 (0x8): Monochrome 10bit
  - Mono10Packed (0x9): Monochrome packed 10bit

- **VideoMode**

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

  - Original (0): Original image
  - Corrected (1): Corrected image
  - MonochromePattern (2): Monochrome test pattern

- **HorizontalScanDirection**

  Horizontal scanning direction. The enumeration names and values are as follows:

  - LeftToRight (0): From left to right
  - RightToLeft (1): From right to left

- **VerticalScanDirection**

  Vertical scanning direction. The enumeration names and values are as follows:

  - TopToBottom (0): From top to bottom
  - BottomToTop (1): From bottom to top

7.3.3 Acquisition Control Register

Table 8 Acquisition Control Register

Name	Address	Size	Interface	Access	Visibility
AcquisitionStart	0xb000	4	C	RW	Beginner
AcquisitionStop	0xb000	4	C	RW	Beginner
AcquisitionFrameRate	/	/	F	/	Beginner
AcquisitionFramePeriod	0xb028	4	I	RW	Beginner
AcquisitionMaxFrameRate	0xb02c	4	C	WO	Beginner
ExposureTime	0xb040	4	I	RW	Beginner
ExposureTimeStep	0xb044	4	I	RO	Beginner
CompressionTransfer	0xb048	4	B	RW	Expert

- **AcquisitionStart**
  Start acquisition.

- **AcquisitionStop**
  Stop acquisition.

- **AcquisitionFrameRate**
  Acquisition frame rate, unit is Hz. The parameter range is as follows:
  - Minimum: 0.1

- **AcquisitionFramePeriod**
  Acquisition frame period, unit is us. The parameter range is as follows:
  - Maximum: 12000000

- **AcquisitionMaxFrameRate**
  Maximum acquisition frame rate, click this parameter to set frame rate to the maximum under this occasion.

- **ExposureTime**
  Exposure time, unit is us. The parameter range is as follows:
  - Maximum: 10000000
  - Minimum: 1

- **ExposureTimeStep**
  Exposure time step, unit is us. The parameter range is as follows:
  - Maximum: 1000000
  - Minimum: 1

- **CompressionTransfer**
  Enable compression transfer function.

7.3.4 IO Control Register

Table 9 IO Control Register

Name	Address	Size	Interface	Access	Visibility
TriggerMode	0xb008	4	E	RW	Beginner
TriggerSource	0xb014	4	E	RW	Beginner
TriggerDelay	0xb020	4	I	RW	Beginner
TriggerActivation	0xb030	4	E	RW	Beginner
TriggerSoftware	0xb004	4	C	WO	Expert
TriggerFrameCount	0xf800	4	I	RW	Beginner
ExposureMode	0xb03c	4	E	RW	Beginner
TriggerDebouncingPeriod	0xf830	4	I	RW	Beginner
TriggerFrequency	0xf83c	4	I	RO	Beginner
TriggerThreshold	0xf850	4	E	RW	Beginner
Line2StrobeActivation	0xf84c	4	E	RW	Beginner
Line3StrobeActivation	0xf854	4	E	RW	Beginner
Line4StrobeActivation	0xf858	4	E	RW	Beginner
Line3Selection	0xf860	4	E	RW	Beginner
Line4Selection	0xf864	4	E	RW	Beginner

- **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:
  - Line1 (0): Line 1
  - Line3 (1): Line 3
  - Line4 (2): Line 4
  - Software (3): Software trigger

- **TriggerDelay**

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

- **TriggerActivation**

  Trigger polarity. The enumeration names and values are as follows:
  - RisingEdge (0): Rising edge
  - FallingEdge (1): Falling edge

- **TriggerSoftware**

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

- **TriggerFrameCount**

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

  - Maximum: 65536
  - Minimum: 1

- **ExposureMode**

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

  - Timed (2): Timed
  - TriggerWidth (3): Trigger width control

- **TriggerDebouncingPeriod**

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

  - Maximum: 2600
  - Minimum: 0

- **TriggerFrequency**

  Trigger signal frequency, unit is Hz.

- **TriggerThreshold**

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

  - Threshold_3V (1): Voltage should be greater than 3V
  - Threshold_5V (0): Voltage should be greater than 5V

- **Line2StrobeActivation**

  Strobe signal polarity of Line 2. The enumeration names and values are as follows:

  - FallingEdge (1): Generate strobe signal at falling edge of exposure
  - RisingEdge (0): Generate strobe signal at rising edge of exposure

- **Line3StrobeActivation**

  Strobe signal polarity of Line 3. The enumeration names and values are as follows:

  - FallingEdge (1): Generate strobe signal at falling edge of exposure
  - RisingEdge (0): Generate strobe signal at rising edge of exposure

- **Line4StrobeActivation**

  Strobe signal polarity of Line 4. The enumeration names and values are as follows:

  - FallingEdge (1): Generate strobe signal at falling edge of exposure
  - RisingEdge (0): Generate strobe signal at rising edge of exposure

- **Line3Selection**

  Mode selector of Line 3. The enumeration names and values are as follows:

  - Input (0): Input signal
  - OutputInternalPullUp (2): Output strobe signal and select internal pull-up voltage
  - OutputExternalPullUp (3): Output strobe signal and select external pull-up voltage

- **Line4Selection**

  Mode selector of Line 4. The enumeration names and values are as follows:

  - Input (0): Input signal
  - OutputInternalPullUp (2): Output strobe signal and select internal pull-up voltage
  - OutputExternalPullUp (3): Output strobe signal and select external pull-up voltage

7.3.5 Analog Control Register

Table 10 Analog Control Register

Name	Address	Size	Interface	Access	Visibility
AnalogGain	0xb808	4	E	RW	Beginner
AnalogOffset	0xb810	4	I	RW	Beginner

- **AnalogGain**

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

  - Gain_x1 (0)
  - Gain_x1p26 (1)
  - Gain_x1p87 (2)
  - Gain_x3p17 (3)

- **AnalogOffset**

  Analog offset. The parameter range is as follows:

  - Maximum: 511
  - Minimum: 0
  - Increment: 1

7.3.6 Digital Control Register

Table 11 Digital Control Register

Name	Address	Size	Interface	Access	Visibility
DigitalGain	/	/	F	/	Beginner
GainRaw	0xc028	4	I	RW	Beginner
DigitalOffset	0xc004	4	I	RW	Beginner
WhiteBalanceRedGain	0xc008	4	I	RW	Expert
WhiteBalanceG1Gain	0xc00c	4	I	RW	Expert
WhiteBalanceG2Gain	0xc010	4	I	RW	Expert
WhiteBalanceBlueGain	0xc014	4	I	RW	Expert

WhiteBalanceEnable	0xc018	4	B	RW	Expert
WhiteBalanceInitialize	0xc01c	4	C	WO	Expert
WhiteBalanceCalibrate	0xc020	4	C	WO	Expert
Saturation	0xc078	4	F	RW	Beginner
Denoise	0xc07c	4	F	RW	Expert
ColorTemperature	0xc080	4	I	RW	Expert
Sharpen	0xc088	4	I	RW	Expert

- **DigitalGain**

  Digital gain. The parameter range is as follows:

  - Maximum: 8
  - Minimum: 0.01
  - Increment: 0.01

- **GainRaw**

  Digital gain raw data. The meaning and function of this parameter is the same as DigitalGain, and only be different in name. The parameter range is as follows:

  - Maximum: 32767
  - Minimum: 0
  - Increment: 1

- **DigitalOffset**

  Digital offset. The parameter range is as follows:

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

- **WhiteBalanceRedGain**

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

  - Maximum: 28671
  - Minimum: 0
  - Increment: 1

- **WhiteBalanceG1Gain**

  White balance G1 channel gain, only color camera can set this parameter. The parameter range is as follows:

  - Maximum: 28671
  - Minimum: 0
  - Increment: 1

- **WhiteBalanceG2Gain**

  White balance G2 channel gain, only color camera can set this parameter. The parameter range is as follows:

- Maximum: 28671
- Minimum: 0
- Increment: 1

- **WhiteBalanceBlueGain**

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

- Maximum: 28671
- Minimum: 0
- 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.

- **Saturation**

Saturation. The parameter range is as follows:

- Maximum: 1.9921875
- Minimum: 0
- Increment: 0.0078125

- **Denoise**

Denoise. The parameter range is as follows:

- Maximum: 1
- Minimum: 0
- Increment: 0.001

- **ColorTemperature**

Color temperature. The parameter range is as follows:

- Maximum: 15000
- Minimum: 3000
- Increment: 100

- **Sharpen**

Sharpen. The parameter range is as follows:

- Maximum: 255
- Minimum: 0

- Increment: 1

7.3.7 LUT Control Register

Table 12 LUT Control Register

Name	Address	Size	Interface	Access	Visibility
LUTEnable	0xd004	4	B	RW	Expert
LUTIndex	0xd008	4	I	RW	Expert
LUTValue	0xd00c	4	I	RW	Expert
GammaCorrectionEnable	0xd010	4	B	RW	Expert
GammaCorrectionValue	0xd014	4	F	RW	Expert

- **LUTEnable**

  Enable LUT function.

- **LUTIndex**

  Lookup table data index, that is, the gray value of image before mapping lookup table. The parameter range is as follows:

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

- **GammaCorrectionEnable**

  Enable Gamma correction.

- **GammaCorrectionValue**

  Gamma correction value. The parameter range is as follows:

  - Maximum: 4
  - Minimum: 0.1

7.3.8 Flat Field Correction Register

Table 13 Flat Field Correction Register

Name	Address	Size	Interface	Access	Visibility
PRNUEnable	0xd800	4	B	RW	Expert
PRNUStart	0xd814	4	C	WO	Expert

PRNUReset	0xd818	4	C	WO	Expert

- **PRNUEnable**
  Enable flat field correction.

- **PRNUStart**
  Execute flat field correction.

- **PRNUReset**
  Reset flat field correction to default setting.

7.3.9 Defect Pixel Register

Table 14 Defect Pixel Register

Name	Address	Size	Interface	Access	Visibility
DefectPixelCorrectionEnable	0xe000	4	B	RW	Expert
DefectPixelTestMode	0xe008	4	E	RW	Expert
DefectPixelTotal	0xe010	4	I	RO	Expert
DefectPixelSelect	0xe014	4	I	RW	Expert
DefectPixelReadX	0xe018	4	I	RO	Expert
DefectPixelReadY	0xe01c	4	I	RO	Expert
DefectPixelWriteX	0xe020	4	I	RW	Expert
DefectPixelWriteY	0xe024	4	I	RW	Expert
DefectPixelAdd	0xe028	4	C	WO	Expert
DefectPixelRemove	0xe02c	4	C	WO	Expert
DefectPixelClearAll	0xe030	4	C	WO	Expert
DefectPixelSave	0xe034	4	C	WO	Expert

- **DefectPixelCorrectionEnable**
  Enable defect pixel correction function.

- **DefectPixelTestMode**
  Defect pixel test mode selection. The enumeration names and values are as follows:
  - Replace (0): Replace mode
  - MarkDefectsWhiteOnVideo (1): Mark defect pixel

- **DefectPixelTotal**
  Total number of defect pixel.

- **DefectPixelSelect**
  Select index of defect pixel.

- **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.

- **DefectPixelWriteY**
  Write the Y coordinate of defect pixel.

- **DefectPixelAdd**
  Add defect pixel.

- **DefectPixelRemove**
  Remove current defect pixel.

- **DefectPixelClearAll**
  Remove all defect pixels.

- **DefectPixelSave**
  Save defect pixels.

7.3.10 User Set Control Register

Table 15 User Set Control Register

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.

7.3.11 Transport Layer Control Register

Table 16 Transport Layer Control Register

Name	Address	Size	Interface	Access	Visibility
PayloadSize	0xa018	4	I	RO	Expert
GevVersionMajor	/	/	I	/	Expert
GevVersionMinor	/	/	I	/	Expert
GevDeviceModeIsBigEndian	/	/	B	/	Guru
GevDeviceModeCharacterSet	/	/	E	/	Guru
GevMACAddress	/	/	I	/	Beginner
GevSupportedOptionSelector	/	/	E	/	Expert
GevSupportedOption	/	/	B	/	Expert
GevCurrentIPConfigurationLLA	/	/	B	/	Beginner
GevCurrentIPConfigurationDHCP	/	/	B	/	Beginner
GevCurrentIPConfigurationPersistentIP	/	/	B	/	Beginner
GevCurrentIPAddress	0x0024	4	I	RO	Beginner
GevCurrentSubnetMask	0x0034	4	I	RO	Beginner
GevCurrentDefaultGateway	0x0044	4	I	RO	Beginner
GevFirstURL	/	/	S	/	Guru
GevSecondURL	/	/	S	/	Guru
GevPersistentIPAddress	0x064c	4	I	RW	Beginner
GevPersistentSubnetMask	0x065c	4	I	RW	Beginner
GevPersistentDefaultGateway	0x066c	4	I	RW	Beginner
GevMessageChannelCount	0x0900	4	I	RO	Expert
GevStreamChannelCount	0x0904	4	I	RO	Expert
GevHeartbeatTimeout	0x0938	4	I	RW	Guru
GevTimestampTickFrequency	/	/	I	/	Expert
GevTimestampControlLatch	0x0944	4	C	RW	Expert
GevTimestampValue	/	/	I	/	Expert
GevCCP	/	/	E	/	Guru
GevSCPHostPort	/	/	I	/	Guru
GevSCPSFireTestPacket	/	/	C	/	Guru
GevSCPSDoNotFragment	/	/	B	/	Guru
GevSCPSBigEndian	/	/	B	/	Guru
GevSCPSPacketSize	/	/	I	/	Expert
GevSCPD	0x0d08	4	I	RW	Expert
GevSCDA	0x0d18	4	I	RW	Guru
GevGVCPPendingAck	/	/	B	/	Expert

- **PayloadSize**
  Payload size transferred.

- **GevVersionMajor**

GigE Vision major version.

- **GevVersionMinor**
  GigE Vision minor version.

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

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

- **GevMACAddress**
  Device MAC address.

- **GevSupportedOptionSelector**
  GigE Vision function list.

- **GevSupportedOption**
  Whether function is supported.

- **GevCurrentIPConfigurationLLA**
  Enable LLA configuring IP.

- **GevCurrentIPConfigurationDHCP**
  Enable DHCP configuring IP.

- **GevCurrentIPConfigurationPersistentIP**
  Enable static configuring IP.

- **GevCurrentIPAddress**
  Current IP address.

- **GevCurrentSubnetMask**
  Current subnet mask.

- **GevCurrentDefaultGateway**
  Current default gateway.

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

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

- **GevPersistentIPAddress**
  Static IP address.

- **GevPersistentSubnetMask**
  Static subnet mask.

- **GevPersistentDefaultGateway**
  Static default gateway.

- **GevMessageChannelCount**
  Control channel count.

- **GevStreamChannelCount**
  Data channel count.

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

- **GevTimestampTickFrequency**
  Time stamp frequency.

- **GevTimestampControlLatch**
  Time stamp latch.

- **GevTimestampValue**
  Time stamp value.

- **GevCCP**
  Device Access rights.

- **GevSCPHostPort**
  Communication host data port.

- **GevSCPSFireTestPacket**
  Send test packet.

- **GevSCPSDoNotFragment**
  Prohibit IP subcontracting.

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

- **GevSCPSPacketSize**
  Packet size.

- **GevSCPD**
  Packet delay.

- **GevSCDA**
  Image data destination address.

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

8 FAQ

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

① Ensure that the network interface cable is OK.

② Ensure that the camera IP address and computer IP address are on the same subnet.

③ Ensure that the network card is working in Gigabit Ethernet mode.

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

① Ensure that the external input pulse is normal.

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

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

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

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

- **If images are dark,**

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

② Ensure that the exposure time and gain are set properly.

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

① Ensure that the sensor glass is clean.

② Ensure that the camera status indicator is normal.

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

① Check that the Gigabit Ethernet interface is normal, it can be confirmed by the test image.

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

③ Check whether the external pulse input is normal in the external trigger mode by the camera indicator.

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