TTS46MGV-5M Area Scan Camera User Manual

(V0.7　Oct. 17, 2023)

Hefei I-TEK Optoelectronics Co., LTD.

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

Revision History

Revision	Date	Description
0.1	2020/09/23	● Initial version
0.2	2021/04/26	● Update original position of mechanical dimension
0.3	2022/01/10	● Update the name of company
0.4	2022/04/25	● Update the logo of company
0.5	2022/08/04	● Update camera parameters and trigger interface definition ● Delete description about strobe
0.6	2023/02/11	● Update company address
0.7	2023/10/17	● Update chapter 7 ● Update parameter list of camera

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 4.5A.
② Hefei I-TEK Optoelectronics Co., LTD. does not provide external power supply. Users need to connect power supply by themselves.

- **Document**

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

2 Camera Models

- **Camera Product Model**

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

- **Interface Specification**

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

- **Color Form**

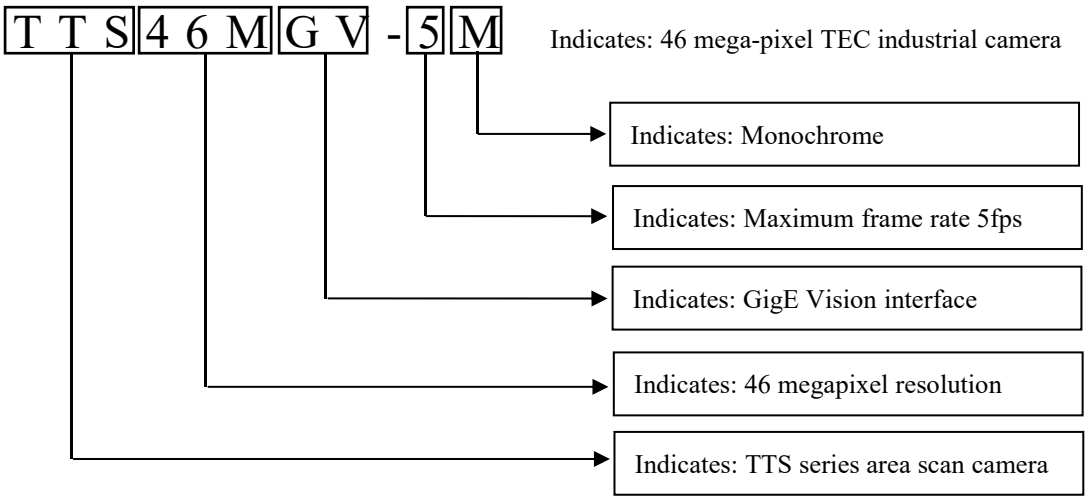
Abbreviation	Image Mode
M	Monochrome
C	Color
F	Full Color
T	Monochrome TDI (Time Delay Integration)
X	Time Division Camera
U	UV (Ultraviolet)
N	NIR (Near Infrared)

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

- **Line Rate or Frame Rate**

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

e.g.



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

TTS46MGV camera adopts advanced rolling 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

- Rolling Shutter CMOS Sensor
- 46 Megapixel Resolution
- Full Frame Rate up to 5fps
- High Sensitivity and Low Noise
- ROI
- Rich Exposure Control Modes (External Trigger, Free-Run)
- Output Pixel Format: 8bit
- LUT
- Defect Pixel Correction
- Flat Field Correction
- Analog Gain / Digital Gain / Offset Control
- User-Configurable Scanning Direction
- Temperature Monitor
- Data Lossless Compression Transmission

4.2 Camera Specifications

Table 1 TTS46MGV-5M Product Specifications

Model	TTS46MGV-5M
Product Description	46 mega-pixel TEC industrial camera
Resolution	8192 x 5556
Pixel Size	2.315um x 2.315um
Sensor Type	Rolling shutter CMOS
Image Type	Monochrome
Sensor Size	22.91mm (diagonal)
Dynamic Range	≥53.5dB
SNR	41.7dB
Lens Mount	F Mount/EF Mount
Data Rate	Packed transfer: 227MB/s Non-packed transfer: 113MB/s
Max Frame Rate	2.5fps (5fps with SAccel™)
Analog Gain	0~64
Analog Offset	0~1023
Digital Gain	0.01~8

Digital Offset	-1023~1023
Trigger Mode	Free-Run, External Trigger
Trigger Input	External IO/Software trigger
Exposure Control	Pulse Width Control, Timed
Exposure Time	1406us~10s
Data Format	8bit
Operation Temperature	0~55°C
Data Interface	GigE Vision
Power Supply	DC12V±10%　4.5A
Power Consumption	TEC turn on: 35.5W TEC turn off: 10.8W
Mechanical	111mm x 111mm x 90.5mm (without adapter)
Cooling Method	Thermal electric cooling with a fan
Cooling Performance	About 20℃ below ambient temperature

Note: This table is for 0104-9103 version of TTS46MGV camera specifications, which may vary slightly from version to version.

4.3 Camera Structure

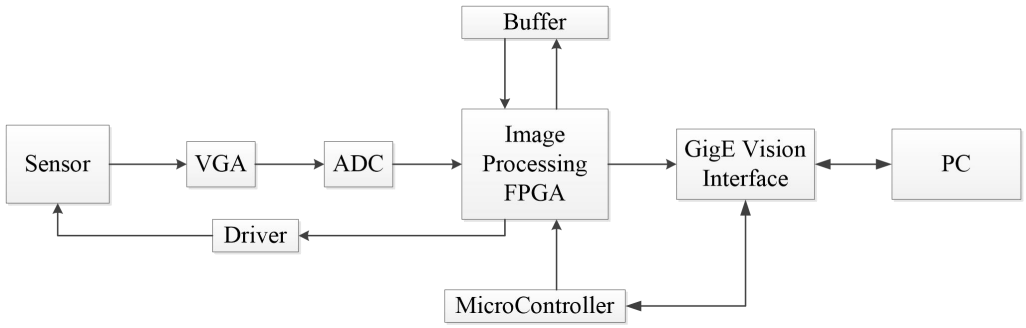


Fig.2 Internal Implementation Structure of Camera

TTS46MGV 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 rolling 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.

TTS46MGVcamera can accept external trigger acquisition, and the source is IO signal or software trigger signal.

4.4 Spectral Response

The following is spectral response curve of TTS46MGV camera.

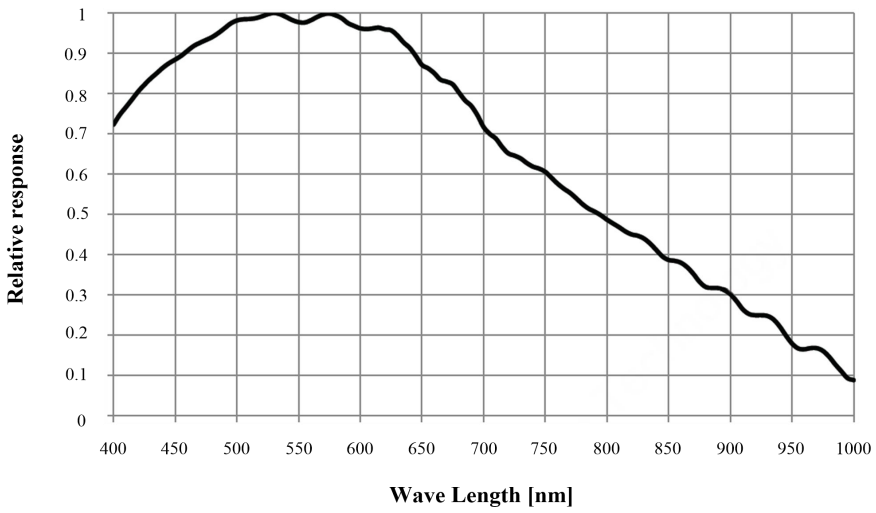


Fig.3 Spectral Response of Camera

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

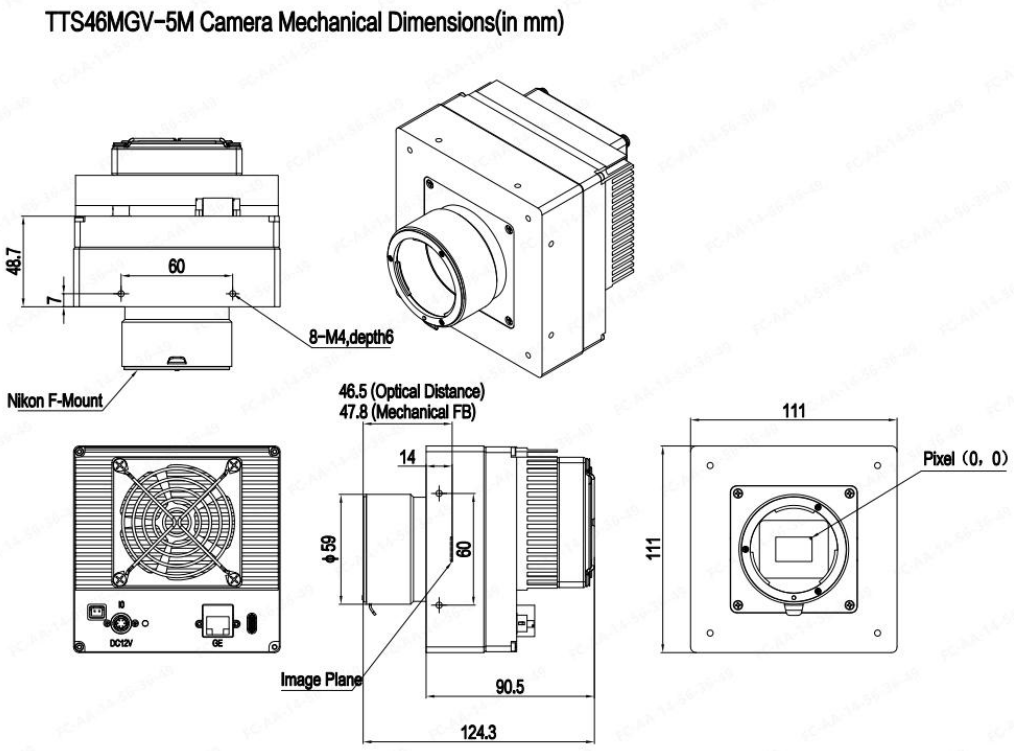


Fig.4 Camera Mechanical Dimensions

5.2 Camera Interface

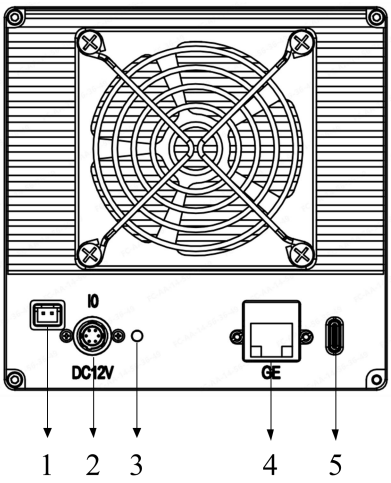


Fig.5 External Interfaces of Camera

① Fan Power Socket
② 6-pin Power and Control Interface
③ Camera Status Indicator
④ Gigabit Ethernet Data Interface

⑤ Type-C Interface

5.2.1 Camera Status Indicator

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

Table 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 is a 6-pin interface with the model:
Hirose HR10A-7R-6PB(Male).

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

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

Fig.6 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

Trigger input circuit diagram is shown as follows:

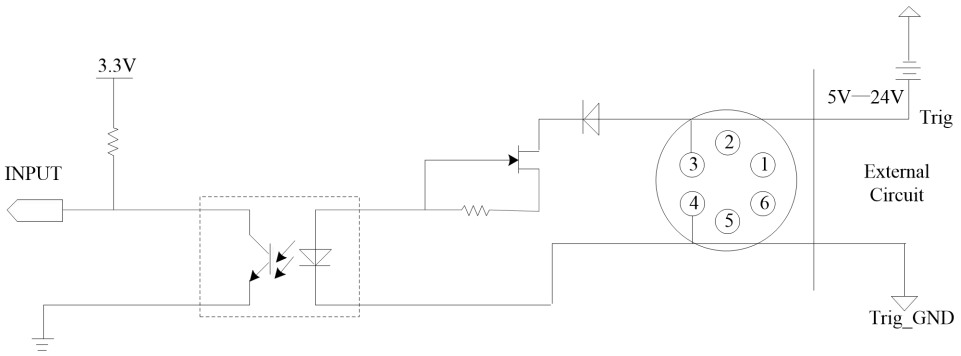


Fig.7 Trig Input Circuit Schematic

- Input Level Standard: 5~24V
- Maximum input current: 7mA
- Rising/Falling edge delay time: ~35us
- Different environment temperature and input voltage will affect delay time, but will not cause circuit abnormality

5.2.3 Data Interface

Single RJ45 Ethernet connector for control and video data to host GigE Vision network card. For industrial environments, Hefei I-TEK Optoelectronics Co., LTD. GigE Vision supports the use of screw to lock Ethernet cables.

TTS46MGV camera is compatible with GigE Vision 1.1 protocol, and data interface is GigE Vision interface on the back of the camera, as shown below:

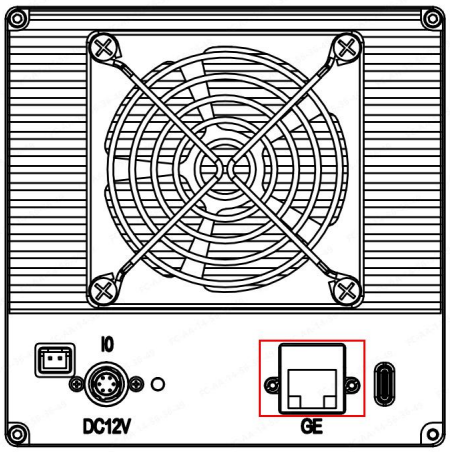


Fig.8 Data Interface

6 Camera Features

This chapter introduces the main features of TTS46MGV camera.

6.1 Trigger Mode

TTS46MGV 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, camera generates control timing according to exposure time and readout time. At this time, the readout of the last frame can be carried out simultaneously with the exposure of the current frame, thus speeding up image acquisition speed.

- When exposure time is less than readout time, frame period is determined by readout time, and its control sequence is shown in the figure below.

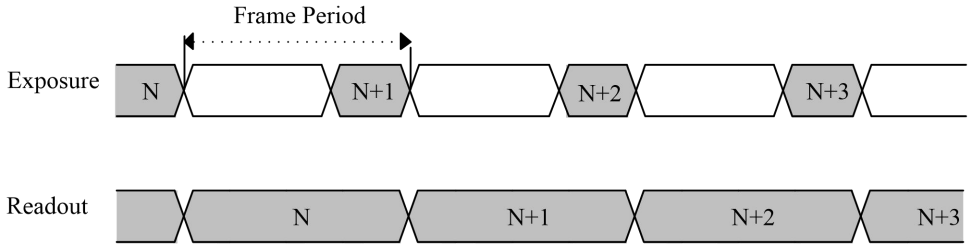


Fig.9 Exposure Time is Less than Readout Time

- When exposure time is longer than readout time, frame period is determined by exposure time, and its control sequence is shown in figure below (fot in figure is the minimum interval between two exposures, which is not allowed to be modified by users).

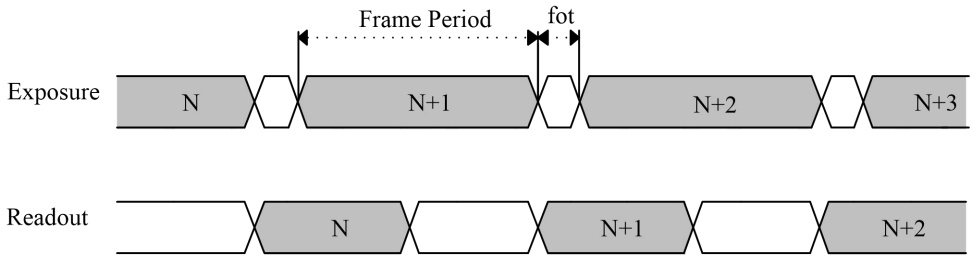


Fig.10 Exposure Time is Longer than Readout Time

Note: If frame loss is serious due to insufficient network bandwidth, users are advised to increase readout time to reduce bandwidth pressure and reduce frame loss.

6.1.2 External Pulse Mode

In External Pulse mode, 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.

External trigger signal can be input from external IO interface or software trigger input. The input source can be selected by users through commands.

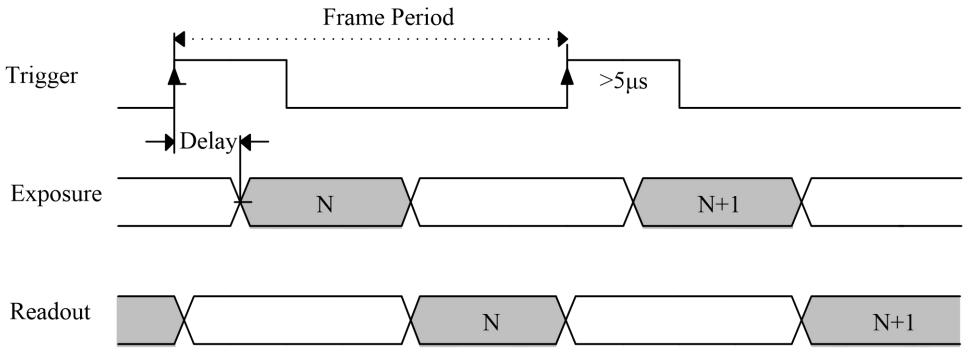


Fig.11 External Pulse Mode

6.1.3 External PWM Mode

In External PWM mode, 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.

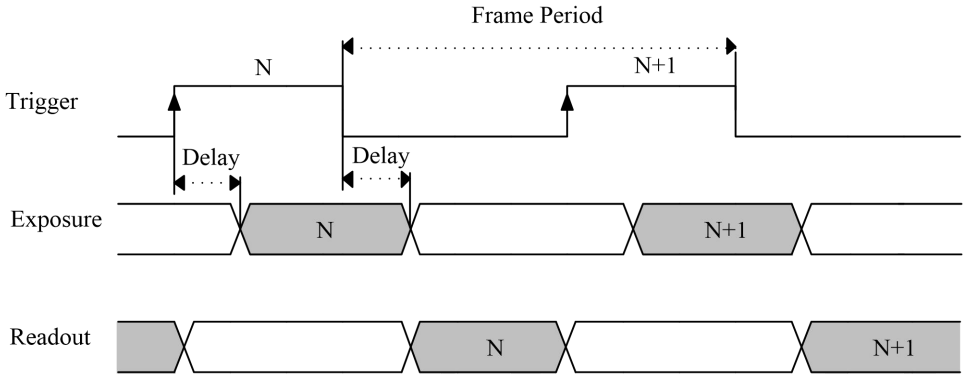


Fig.12 External PWM Mode

It should be noted that the width of external trigger high level should be greater than minimum exposure time. For pulses less than minimum exposure time, camera will treat them with minimum exposure time.

If external trigger interval is too short, it will lead to readout time conflict of two frames. At this time, pulse that does not meet the requirements will be ignored inside camera, so that camera can maintain normal operation. Therefore, in External PWM mode, the falling edge spacing of adjacent external triggers should be greater than one frame readout time.

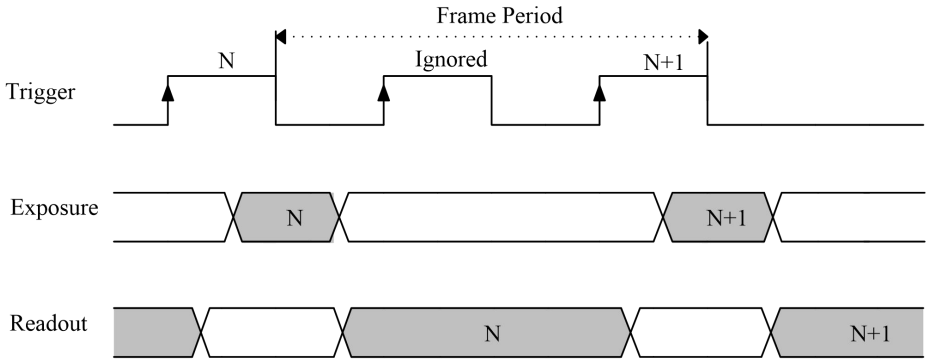


Fig.13 Frame Period of External Trigger is Too Short

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.

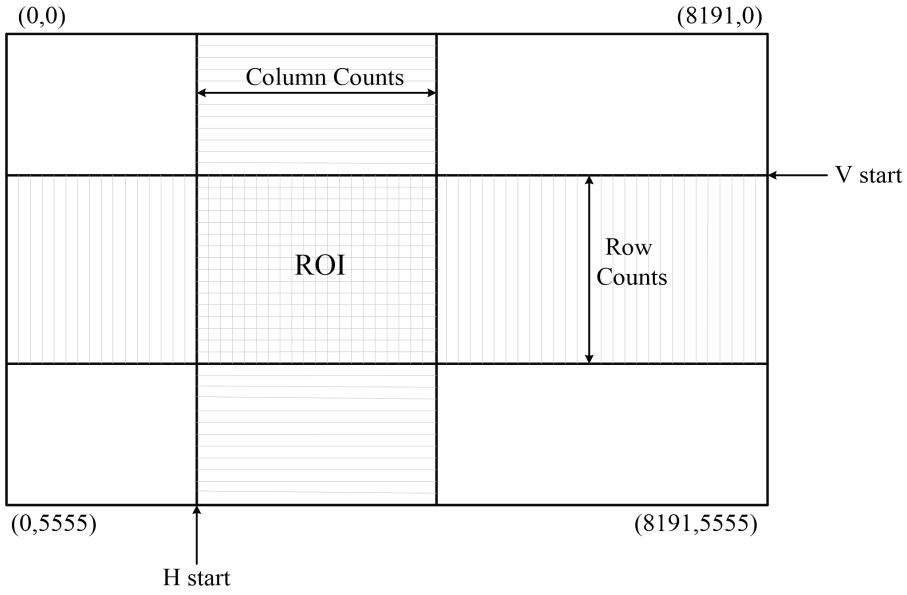


Fig.14 ROI

Table 4 Maximum Frame Rate in Different ROI Parameters

ROI Size H	ROI Size V	8bit
8192	5556	2.52fps
8000	5556	2.58fps
6976	5556	2.96fps
5984	5556	3.45fps
4992	5556	4.14fps
4000	5556	5.16fps
2976	5556	6.94fps

2464	5556	7.78fps
8192	5000	2.80fps
8192	4000	3.50fps
8192	3000	4.67fps
8192	2048	6.84fps
2464	2048	7.78fps

6.3 Image Horizontal Flipping

TTS46MGV camera can flip image along X direction. Users can use this function to change camera scanning direction, as shown below:

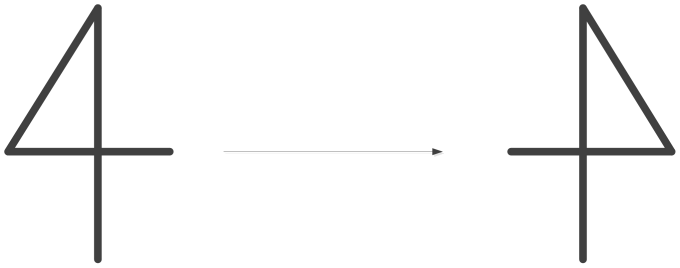


Fig.15 Horizontal Flipping

6.4 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.

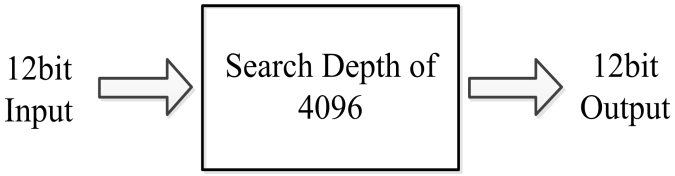


Fig.16 LUT

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

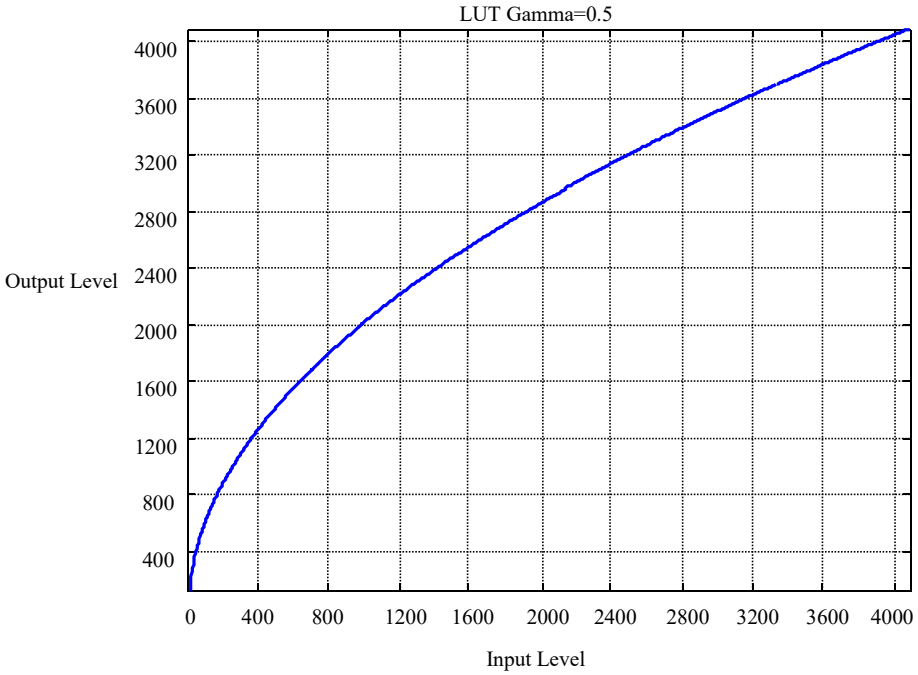


Fig.17 LUT: Gamma = 0.5

6.5 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. TTS46MGV 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.

The correction method of defect pixels is based on the calculation of adjacent effective pixel values in the same line and output:

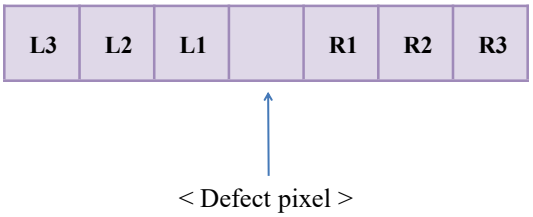


Fig.18 Defect Pixel Position

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

Table 5 Defect Pixel Calculation Table

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 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. TTS46MGV 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:

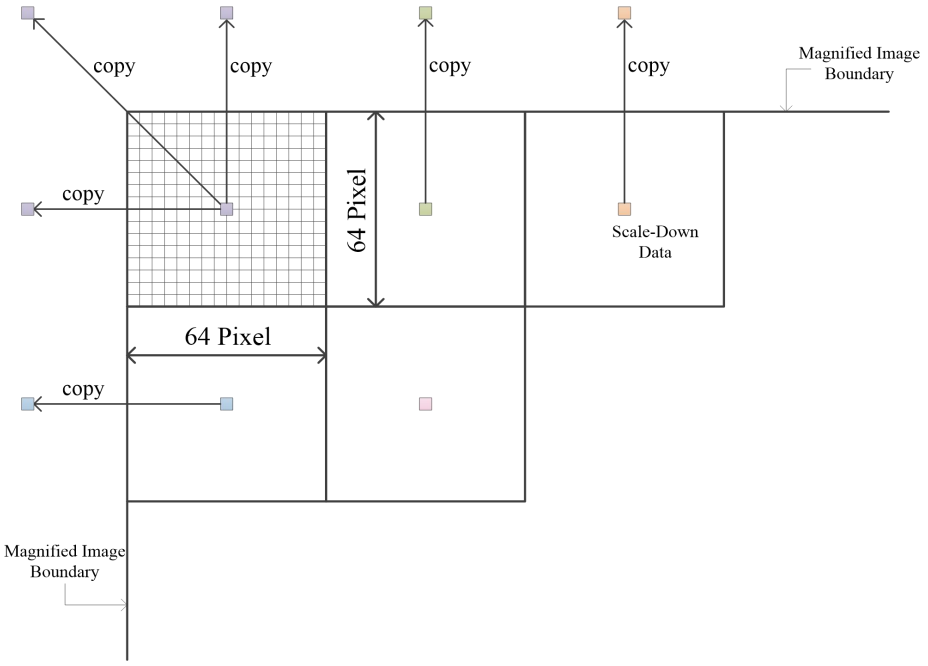


Fig.19 Flat Field Correction Schematic

6.7 Test Image

TTS46MGV 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 all pixels of the same gray scale.

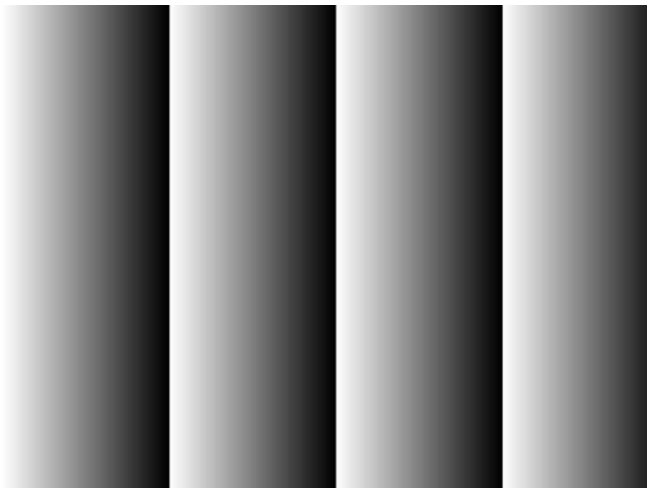


Fig.20 Test Image 1

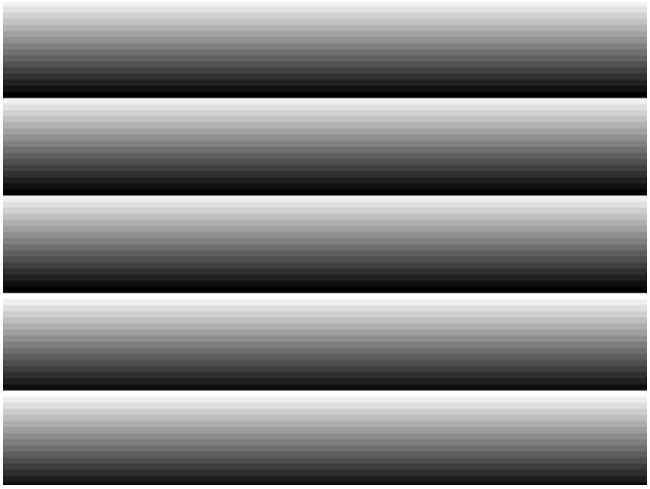


Fig.21 Test Image 2

Fig.22 Test Image 3

6.8 Data Format

Currently, the camera only supports 8 bit of data output.

6.9 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

6.10 Camera Temperature

TTS46MGV 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.

6.11 Load/Save Configuration

TTS46MGV 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.

6.12 Camera IP Address

TTS46MGV 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.

TTS46MGV 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.

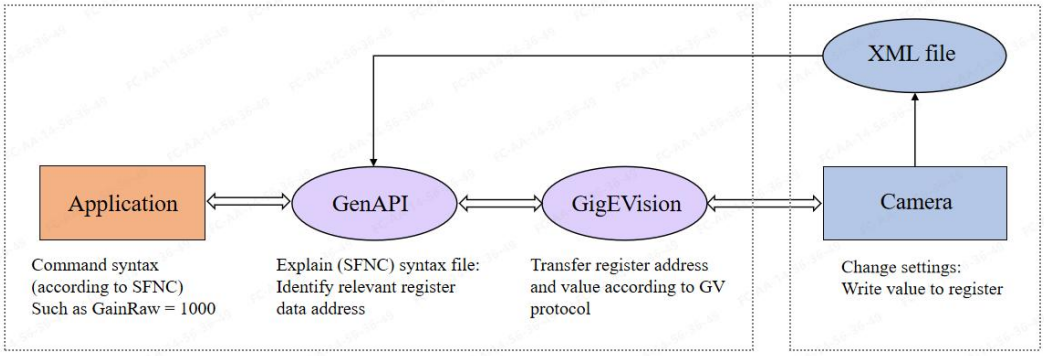


Fig.23 Communication Schematic between Application and Camera

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 Device Control Register

Table 7 Device Control Register

Name	Address	Size	Interface	Access	Visibility
DeviceVersion	0x0088	32	S	RO	Beginner
DeviceSerialNumber	0x00d8	32	S	RO	Beginner
DeviceManufacturerInfo	0x00a8	48	S	RO	Beginner
DeviceInfo	0xa11c	4	I	RW	Beginner

DeviceScanType	/	/	E	/	Beginner
DeviceFPGATemperature	0xa018	4	F	RO	Expert
DeviceMCUTemperature	0xa010	4	F	RO	Expert
DeviceSensorTemperature	0xa014	4	F	RO	Expert

- **DeviceVersion**
  Device version.

- **DeviceSerialNumber**
  Device serial number.

- **DeviceManufacturerInfo**
  Device manufacturer information.

- **DeviceInfo**
  Device information.

- **DeviceScanType**
  Device scan type.

- **DeviceFPGATemperature**
  Device FPGA temperature.

- **DeviceMCUTemperature**
  Device MCU temperature.

- **DeviceSensorTemperature**
  Device sensor temperature.

7.3.2 Image Format Control Register

Table 8 Image Format Control Register

Name	Address	Size	Interface	Access	Visibility
Width	0xa004	4	I	RW	Beginner
Height	0xa008	4	I	RW	Beginner
OffsetX	0xa020	4	I	RW	Beginner
OffsetY	0xa024	4	I	RW	Beginner
ReverseX	0xa034	4	B	RW	Beginner
PixelFormat	0xa030	4	E	RW	Beginner
VideoMode	0xa03c	4	E	RW	Beginner

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

- Minimum: 512
- Increment: 16

- **Height**

  Actual height of output image. The parameter range is as follows:
  - Minimum: 2048
  - Increment: 2

- **OffsetX**

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

- **OffsetY**

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

- **ReverseX**

  Horizontal image flipping.

- **PixelFormat**

  Pixel format. The enumeration names and values are as follows:
  - Mono8 (17301505): Monochrome 8bit

- **VideoMode**

  Output image mode. The enumeration names and values are as follows:
  - Original (0): Original image
  - Corrected (1): Corrected image
  - TestPattern1 (2): Test pattern 1
  - TestPattern2 (3): Test pattern 2
  - TestPattern3 (4): Test pattern 3

7.3.3 Acquisition Control Register

Table 9 Acquisition Control Register

Name	Address	Size	Interface	Access	Visibility
AcquisitionMode	/	/	E	/	Beginner
AcquisitionStart	0xa000	4	C	WO	Beginner
AcquisitionStop	0xa000	4	C	WO	Beginner
AcquisitionFrameRate	0xa040	4	F	RO	Beginner
ExposureMode	0xa044	4	E	RW	Beginner
ExposureTime	0xa048	4	I	RW	Beginner

ReadoutTime	0xa118	4	I	RW	Expert
CompressionTransfer	0xa04c	4	B	RW	Expert

- **AcquisitionMode**

  Acquisition mode. The enumeration names and values are as follows:
  - Continuous (0): Continuous acquisition

- **AcquisitionStart**

  Start acquisition.

- **AcquisitionStop**

  Stop acquisition.

- **AcquisitionFrameRate**

  Acquisition frame rate, unit is Hz. The parameter range is as follows:
  - Maximum: 20
  - Minimum: 0

- **ExposureMode**

  Exposure mode. The enumeration names and values are as follows:
  - Timed (0): Free-Run
  - TriggerPulse (1): External pulse
  - TriggerWidth (2): External PWM

- **ExposureTime**

  Exposure time, unit is us.

- **ReadoutTime**

  Readout time, unit is us. The parameter range is as follows:
  - Maximum: 2000000
  - Minimum: 125000
  - Increment: 1

- **CompressionTransfer**

  Enable compression transfer function.

7.3.4 IO Control Register

Table 10 IO Control Register

Name	Address	Size	Interface	Access	Visibility
TriggerSoftware	0xa050	4	C	WO	Expert
TriggerSource	0xa054	4	E	RW	Beginner
TriggerDelayTime	0xa05c	4	I	RW	Beginner

TriggerActivation	0xa058	4	E	RW	Beginner
FlashStrobeMode	0xa060	4	E	RW	Beginner
FlashStrobeActivation	0xa064	4	E	RW	Beginner

- **TriggerSoftware**

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

- **TriggerSource**

  Trigger source selector. The enumeration names and values are as follows:
  - Software (0): Software trigger signal
  - IO_Connector (1): External IO signal

- **TriggerDelayTime**

  Trigger time delay. The parameter range is as follows:
  - Maximum: 100000
  - Minimum: 0
  - Increment: 1

- **TriggerActivation**

  Trigger polarity. 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

- **FlashStrobeMode**

  Strobe signal mode. The enumeration names and values are as follows:
  - Wide (0): Wide mode
  - Narrow (1): Narrow mode

- **FlashStrobeActivation**

  Strobe signal polarity. 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

7.3.5 Analog Control Register

Table 11 Analog Control Register

Name	Address	Size	Interface	Access	Visibility
AnalogueGain	0xa068	4	I	RW	Beginner
AnalogueOffset	0xa06c	4	I	RW	Beginner

- **AnalogueGain**

  Analog gain. The parameter range is as follows:
  - Maximum: 64
  - Minimum: 0

- Increment: 1

- **AnalogueOffset**

  Analog offset. The parameter range is as follows:

  - Maximum: 1023
  - Minimum: 0
  - Increment: 1

7.3.6 Digital Control Register

Table 12 Digital Control Register

Name	Address	Size	Interface	Access	Visibility
DigitalGain	0xa070	4	F	RW	Beginner
DigitalOffset	0xa074	4	I	RW	Beginner
WhiteBalanceRedGain	0xa078	4	I	RW	Expert
WhiteBalanceGreenGain	0xa07c	4	I	RW	Expert
WhiteBalanceBlueGain	0xa084	4	I	RW	Expert
WhiteBalanceEnable	0xa088	4	B	RW	Expert
WhiteBalanceInitialize	0xa08c	4	C	WO	Expert
WhiteBalanceCalibrate	0xa08c	4	C	WO	Expert
BlackLevel	0xa144	4	I	RW	Guru

- **DigitalGain**

  Digital gain. The parameter range is as follows:

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

- **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: 2048
  - Minimum: 512
  - Increment: 1

- **WhiteBalanceGreenGain**

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

- Maximum: 2048
- Minimum: 512
- Increment: 1

- **WhiteBalanceBlueGain**

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

- Maximum: 2048
- Minimum: 512
- Increment: 1

- **WhiteBalanceEnable**

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

- **WhiteBalanceInitialize**

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

- **WhiteBalanceCalibrate**

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

- **BlackLevel**

Black level, used to adjust the bottom value of camera output in dark field condition. The smaller black level is, the smaller gray value of image in dark field condition is. The parameter range is as follows:

- Maximum: 255
- Minimum: 0
- Increment: 1

7.3.7 Flat Field Correction Register

Table 13 Flat Field Correction Register

Name	Address	Size	Interface	Access	Visibility
FF_Enable	0xa090	4	B	RW	Expert
FF_Calibrate	0xa094	4	C	WO	Expert
FF_RestoreFactory	0xa094	4	C	WO	Expert

- **FF_Enable**

Enable flat field correction.

- **FF_Calibrate**

Execute flat field correction.

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

7.3.8 Defect Pixel Register

Table 14 Defect Pixel Register

Name	Address	Size	Interface	Access	Visibility
DefectPixelCorrectionEnable	0xa098	4	B	RW	Guru
DefectPixelTotal	0xa09c	4	I	RO	Expert
DefectPixelSelect	0xa0a0	4	I	RW	Expert
DefectPixelReadX	0xa0a4	4	I	RO	Expert
DefectPixelReadY	0xa0a8	4	I	RO	Expert
DefectPixelWriteX	0xa0ac	4	I	RW	Expert
DefectPixelWriteY	0xa0b0	4	I	RW	Expert
DefectPixelAdd	0xa0b4	4	C	WO	Expert
DefectPixelRemove	0xa0b8	4	C	WO	Expert
DefectPixelClearAll	0xa0bc	4	C	WO	Expert
DefectPixelSave	0xa0c0	4	C	WO	Expert

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

- **DefectPixelTotal**
  Total number of defect pixel. The parameter range is as follows:
  - Maximum: 16380
  - Minimum: 0
  - Increment: 1

- **DefectPixelSelect**
  Select index of defect pixel.The parameter range is as follows:
  - Maximum: 16379
  - Minimum: 0
  - Increment: 1

- **DefectPixelReadX**
  Read the X coordinate of current defect pixel. The parameter range is as follows:
  - Maximum: 65535
  - Minimum: 0
  - Increment: 1

- **DefectPixelReadY**

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

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

- **DefectPixelWriteX**

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

  - Maximum: 8192
  - Minimum: 0
  - Increment: 1

- **DefectPixelWriteY**

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

  - Maximum: 5556
  - Minimum: 0
  - Increment: 1

- **DefectPixelAdd**

  Add defect pixel.

- **DefectPixelRemove**

  Remove current defect pixel.

- **DefectPixelClearAll**

  Remove all defect pixels.

- **DefectPixelSave**

  Save defect pixels.

7.3.9 Cooling Control Register

Table 15 Cooling Control Register

Name	Address	Size	Interface	Access	Visibility
FanSpeed	0xa1c8	4	I	RW	Expert
TECCoolerEnable	0xa0c4	4	B	RW	Expert
TECTemperature	0xa0c8	4	I	RW	Guru

- **FanSpeed**

  Fan speed. The parameter range is as follows:

  - Maximum: 127
  - Minimum: 0
  - Increment: 1

- **TECCoolerEnable**

Enable TEC cooling function.

- **TECTemperature**

  Set TEC cooling target temperature. The parameter range is as follows:

  - Maximum: 40
  - Minimum: -10
  - Increment: 1

7.3.10 LUT Control Register

Table 16 LUT Control Register

Name	Address	Size	Interface	Access	Visibility
LUTEnable	0xa0cc	4	B	RW	Expert
LUTSelector	0xa0d0	4	I	RW	Expert
LUTIndex	0xa0d4	4	I	RW	Expert
LUTValue	0xa0d8	4	I	RW	Expert
Gamma	0xa0dc	4	F	RW	Beginner

- **LUTEnable**

  Enable LUT function.

- **LUTSelector**

  LUT selector. The parameter range is as follows:

  - Maximum: 1
  - 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: 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

- **Gamma**

  Gamma correction value. The parameter range is as follows:

  - Maximum: 127

- Minimum: 0.01

7.3.11 User Set Control Register

Table 17 User Set Control Register

Name	Address	Size	Interface	Access	Visibility
UserSetSelector	0xa0e0	4	E	RW	Beginner
UserSetLoad	0xa0e4	4	C	WO	Beginner
UserSetSave	0xa0e8	4	C	WO	Beginner

- **UserSetSelector**

  User configuration selector. The enumeration names and values are as follows:
  - Factory (0): Factory configuration
  - User1 (1): User configuration 1
  - User2 (2): User configuration 2

- **UserSetLoad**

  Load selected camera configuration.

- **UserSetSave**

  Save selected camera configuration.

7.3.12 Transport Layer Control Register

Table 18 Transport Layer Control Register

Name	Address	Size	Interface	Access	Visibility
PayloadSize	0xa100	4	I	RO	Expert
GevVersionMajor	/	/	I	/	Expert
GevVersionMinor	/	/	I	/	Expert
GevDeviceModeIsBigEndian	/	/	B	/	Guru
GevDeviceModeCharacterSet	/	/	E	/	Guru
GevInterfaceSelector	/	/	I	/	Beginner
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
GevNumberOfInterfaces	0x0600	4	I	RW	Expert
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
GevTimestampControlReset	/	/	C	/	Expert
GevTimestampValue	/	/	I	/	Expert
GevCCP	/	/	E	/	Guru
GevMCPHostPort	/	/	I	/	Guru
GevMCDA	0x0b10	4	I	RW	Guru
GevMCTT	0x0b14	4	I	RW	Guru
GevMCRC	0x0b18	4	I	RW	Guru
GevMCSP	0x0d1c	4	I	RW	Guru
GevStreamChannelSelector	/	/	I	/	Expert
GevSCPInterfaceIndex	/	/	I	/	Guru
GevSCPHostPort	/	/	I	/	Guru
GevSCPSFireTestPacket	/	/	B	/	Guru
GevSCPSDoNotFragment	/	/	B	/	Guru
GevSCPSBigEndian	/	/	B	/	Guru
GevSCPSPacketSize	/	/	I	/	Expert
GevSCPD	0x0d08	4	I	RW	Expert
GevSCDA	0x0d18	4	I	RW	Guru
GevPendingAckEnable	0xa81c	4	B	RW	Expert
GevPacketDelay	0xa104	4	I	RW	Guru

- **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.

- **GevInterfaceSelector**
  Device interface selector.

- **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.

- **GevNumberOfInterfaces**
  Number of device interface.

- **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.

- **GevMCPHostPort**
  Communication host control port.

- **GevMCDA**
  IP address of communication host.

- **GevMCTT**
  Control parameter retry timeout, unit is ms.

- **GevMCRC**
  Control the number of parameter retries.

- **GevMCSP**
  Device data port.

- **GevStreamChannelSelector**

Device data channel selection.

- **GevSCPInterfaceIndex**
  Index of device network interface.

- **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.

- **GevPacketDelay**
  Packet delay (clock).

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.