TTS101M(2)CXP-8M/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	2021/12/10	● Initial version
0.2	2022/01/10	● Update the name of company
0.3	2022/04/25	● Update the logo of company
0.4	2023/02/11	● Update company address
0.5	2023/10/20	● Update chapter 7 ● Update camera parameter table

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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 Should there be any problem with the camera, please contact us in time for technical support.

- **Installation and Maintenance**

① Do not install the camera in an environment with direct sunlight, high humidity or heavy dust.
② Keep the camera away from an environment with strong electromagnetic interference.
③ Keep the camera away from heat sources.
④ Be careful not to let the camera soak in liquid, such as water and drinks.
⑤ Clean dust on the surface of the camera as often as possible to avoid dust entering the camera, otherwise it may cause fault to the camera.
⑥ To clean the dust on the camera surface, do not wash with water. Please use a soft object dipped in a small amount of 70% alcohol to wipe it off.

- **Power Supply**

① The recommended voltage is +12V±10%, and the current must be 5.0A.
② Hefei I-TEK Optoelectronics Co., LTD. does not provide 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 free of charge.

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**

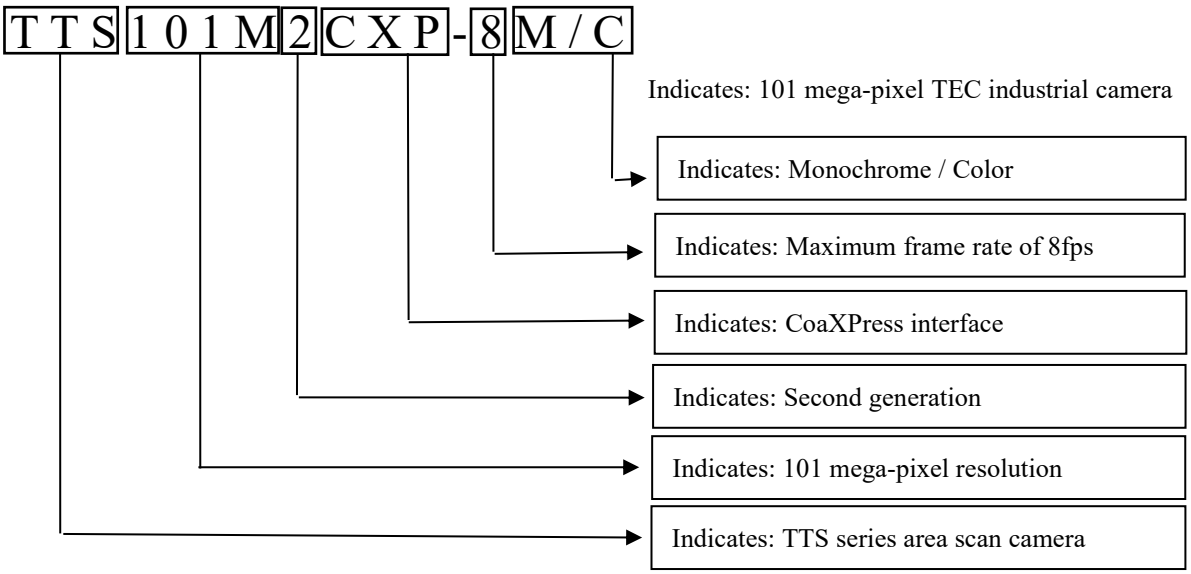
Abbreviation	Image Mode
M	Monochrome
C	Color
F	Full Color
T	Monochrome TDI (Time Delay Integration)
X	Time Division Camera
U	UV (Ultraviolet)
N	NIR (Near Infrared)

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 side of the camera provide threaded holes for mounting camera.

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

4 Product Specifications

TTS101M(2)CXP camera adopts advanced rolling shutter CMOS image sensor and CoaXPress data interface. It is a high-speed area scan camera designed for industrial measurement and inspection. It has high reliability and stability, and is very suitable for occasions with high requirements (high resolution, high speed) for image acquisition, such as surface inspection, electronic placement inspection, etc.

4.1 Main Features

- Rolling Shutter CMOS Sensor
- 101 Mega-Pixel Resolution
- Full Frame Rate up to 8fps
- High Sensitivity and Low Noise
- ROI
- Rich Exposure Control Mode (External Trigger, Free-Run)
- Output Pixel Format: 8/10/12bit
- LUT
- Binning
- Defect Pixel Correction
- Flat Field Correction
- White Balance
- Strobe
- Analog Gain / Digital Gain / Offset Control
- Real Time Temperature Monitor
- Thermal Electric Cooling: about 20 degrees below ambient temperature

4.2 Camera Specifications

Table 1 TTS101M(2)CXP-8M/C Product Specifications

Model	TTS101M(2)CXP-8M/C
Product description	101 mega-pixel TEC industrial camera
Resolution	11648 x 8742
Pixel Size	3.76um x 3.76um
Sensor Type	Rolling shutter CMOS
Image Type	Monochrome / Color
Sensor Size	54.78mm (diagonal)
Dynamic Range	≥78dB
SNR	46dB
Data Rate	1190MB/s
Lens Mount	M72
Max. Frame Rate	8.5fps@8/10bit, 7.83fps@12bit
Analog Gain	0~96
Analog Offset	0~4095

Digital Gain	0.01~30
Digital Offset	-4095~4095
Trigger Mode	Free-Run, External Pulse
Trigger Signal	External IO/ CXP signal
Exposure Control	Timed, Pulse Width Control
Exposure Time	8/10bit: 54us~60s (Step: 27us) 12bit: 29us~60s (Step: 29us)
Data Format	8/10/12bit
Operating Temperature	0~50℃
Data Interface	CoaXPress
Power Supply	DC 12V±10%　5.0A
Power Consumption	50.0W
Mechanical	111mm x 111mm x 103.2mm
Cooling Method	Thermal electric cooling with a external fan
Cooling Performance	About 20℃ below ambient temperature

Note: This table is for 0904-9010 version of TTS101M(2)CXP camera specifications, which may vary slightly from version to version.

4.3 Camera Block Diagram

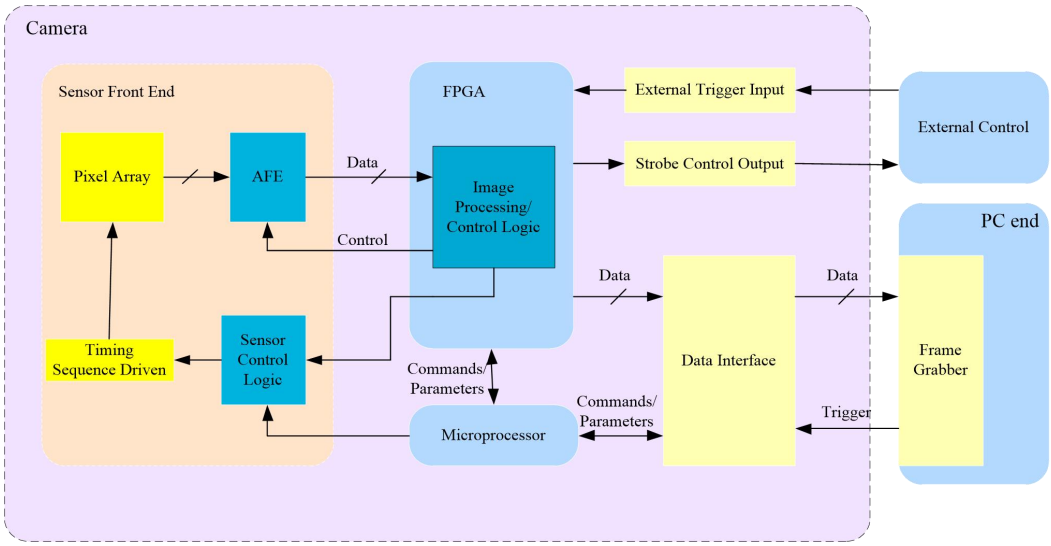


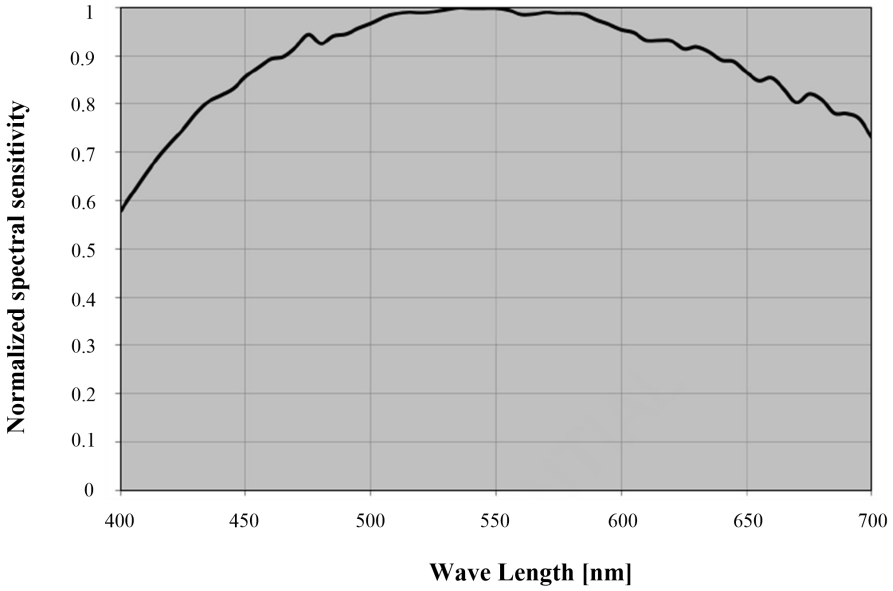
Fig. 2 Internal Implementation Structure of Camera

TTS101M(2)CXP 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 rolling 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.

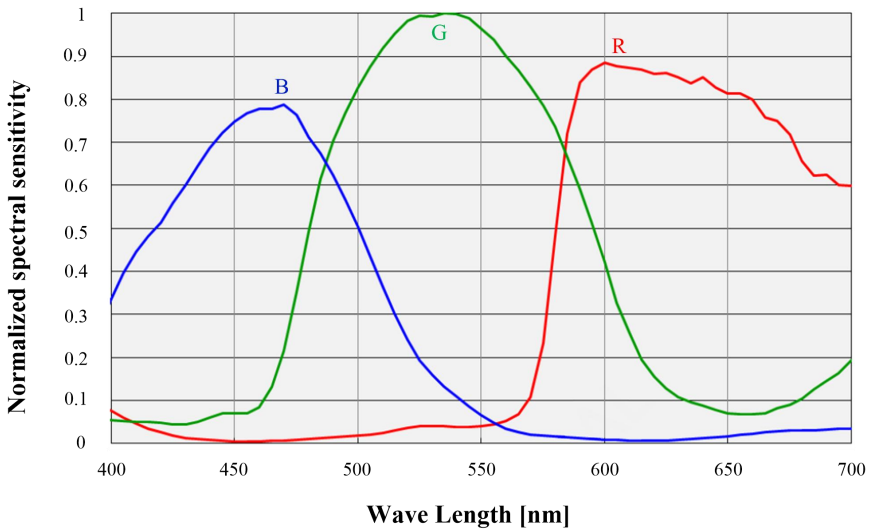
TTS101M(2)CXP camera can receive external signal trigger acquisition, from the IO signal or the CXP signal of CoaXPress interface. At the same time, the camera can also output synchronization signal during exposure, which is convenient for external strobe control.

4.4 Spectral Response

The spectral response of TTS101M(2)CXP camera is shown below.



(a) Monochrome camera



(b) Color camera

Fig. 3 Spectral Response

4.5 Camera Bayer Pattern

TTS101M(2)CXP camera supports color mode, Bayer pattern is shown in figure below (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 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.

4.7 RoHS Certification

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

5 Mechanical Dimensions and Interfaces

5.1 Mechanical Dimensions

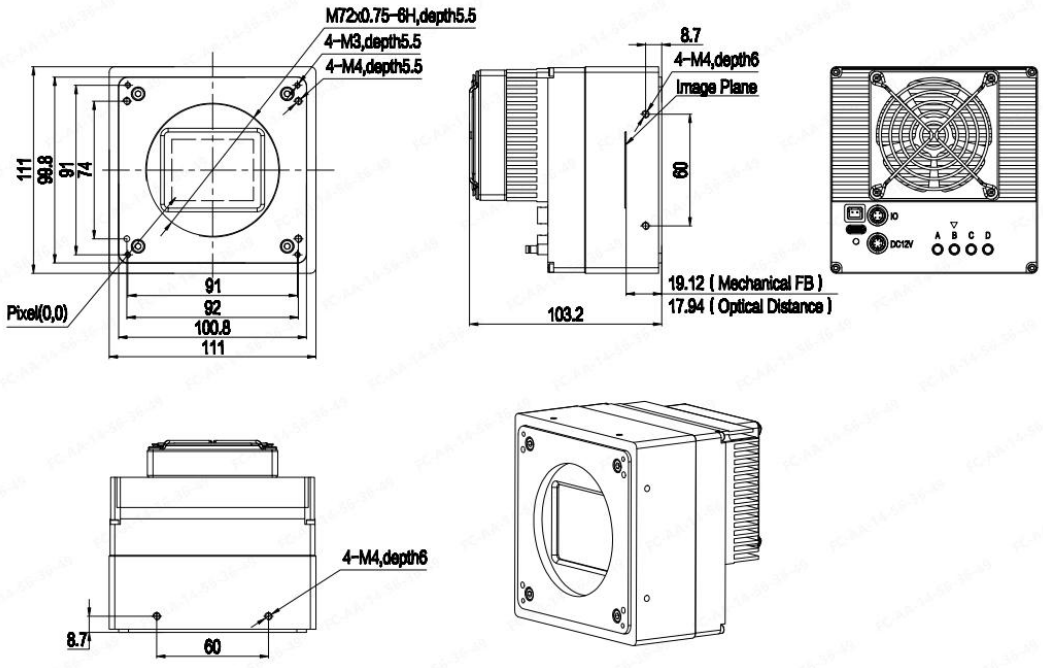


Fig. 5 Camera Mechanical Dimensions

5.2 Camera Interface

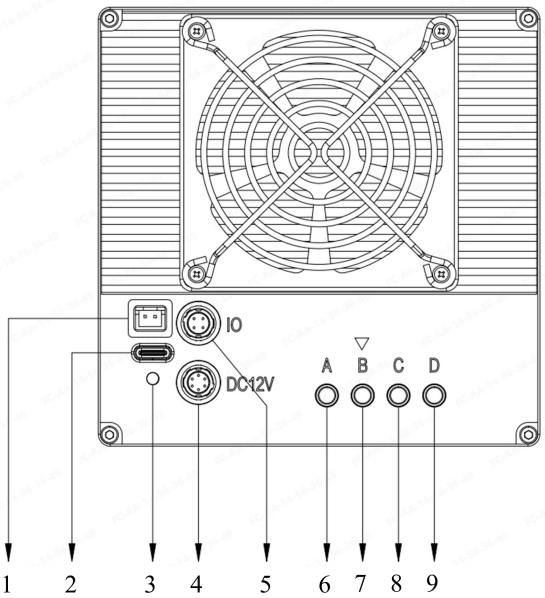


Fig. 6 Interfaces of Camera

① Fan Power Interface
② Type-C Interface
③ Camera Status Indicator
④ 6-pin Power Interface

⑤ 4-pin Control Interface
⑥ CoaXPress Connection A
⑦ CoaXPress Connection B **(Master)**
⑧ CoaXPress Connection C
⑨ CoaXPress Connection D

5.2.1 Camera Status Indicator

Camera status indicator is used to indicate the real-time status of the 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 Interface

Power 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).

Power interface on the back of the camera is shown as follows:

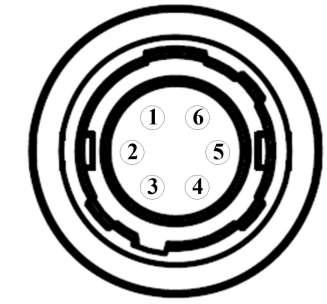


Fig. 7 Pin Assignments for Interface

Table 3 Power Connector Pin Definition

Signal	Pin	Signal	Pin
+12 V	1	GND	4
+12 V	2	GND	5
+12 V	3	GND	6

5.2.3 Control Interface

Control interface is a 4-pin interface with the model:
Hirose HR10A-7R-4PB (Male).

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

Control interface on the back of the camera is shown as follows:

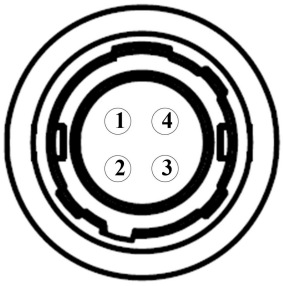


Fig. 8 Control Interface Plugin

Table 4 Control Interface Plugin Pin Definition

Signal	Pin	Signal	Pin
Trigger In +	1	GND	3
Trigger In -	2	Strobe Out	4

The external trigger circuit is shown as follows:

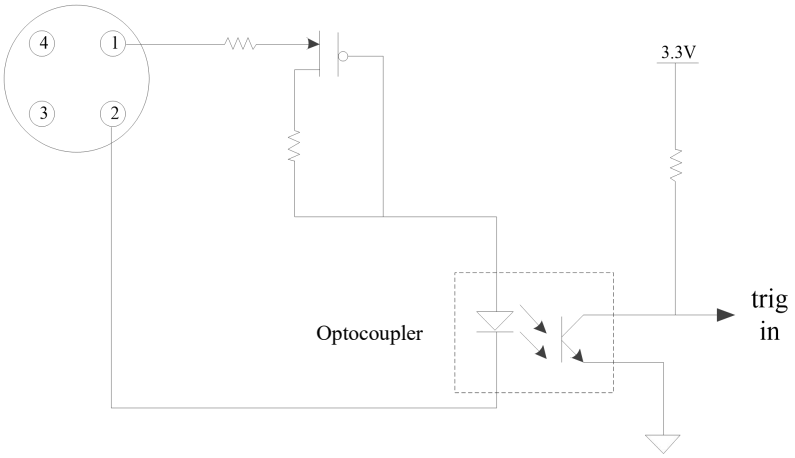


Fig. 9 Diagram of Trig Input Circuit

- Trigger voltage range: 2.5~12V
- Minimum pulse width: 1us

Strobe output circuit is shown below:

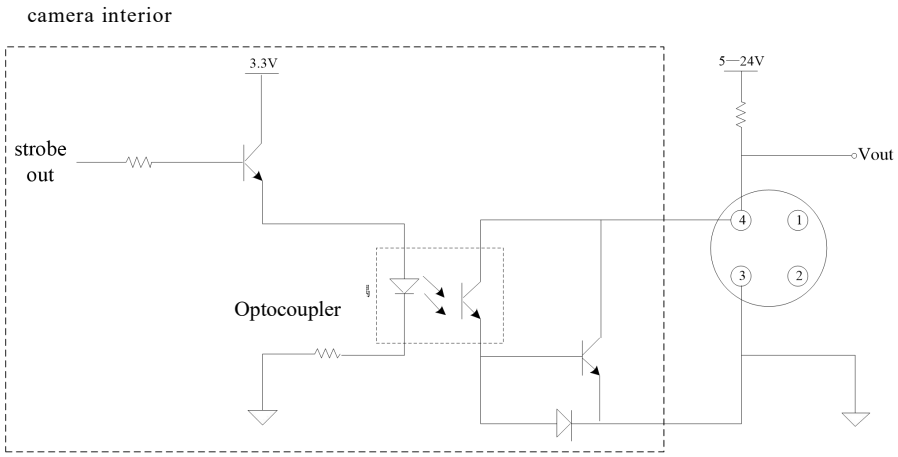


Fig. 10 Diagram of Strobe Output Circuit

- Strobe signal pull-up voltage range: 5~24V

5.2.4 Data Interface

TTS101M(2)CXP camera implements the standard Quad CoaXPress protocol, and the data interface is four DIN 1.0/2.3 sockets on the back of the camera. The data interface on the back of the camera is shown in the red box below:

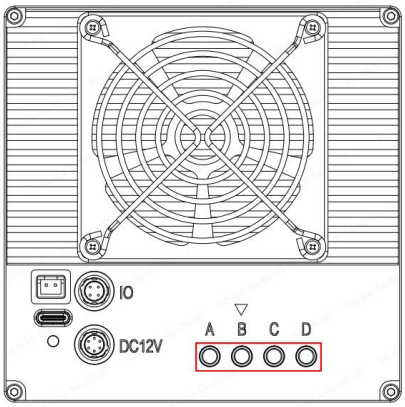


Fig. 11 Data Interface

The mechanical drawing of DIN 1.0/2.3 socket is as follows:

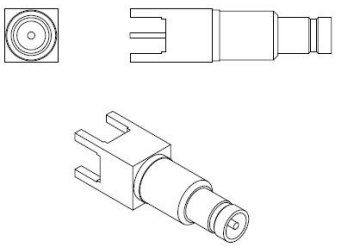


Fig. 12 DIN 1.0/2.3 Socket

6 Camera Features

This chapter details the internal features of TTS101M(2)CXP camera.

6.1 Trigger Mode

TTS101M(2)CXP camera supports three trigger modes: Free-Run mode, External Pulse mode, and External PWM mode.

6.1.1 Free-Run Mode

In the Free-Run mode, camera generates the relevant control sequence internally according to the frame period and exposure time parameters configured by users and outputs the image.

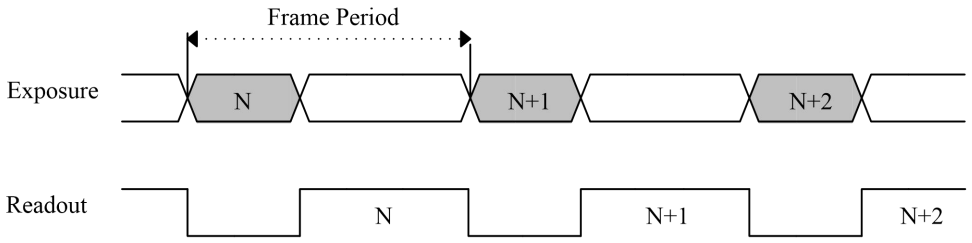


Fig. 13 Free-Run Mode

To achieve normal image output, TTS101M(2)CXP camera limits the range of frame periods and exposure time. The minimum frame period should be longer than both exposure time and readout time of a frame data. The operation sequence of the camera is shown in the figure above.

6.1.2 External Pulse Mode

In the External Pulse mode, camera starts to expose at rising edge of the external trigger signal, while the exposure time is set by users command (consistent with the Free-Run mode). The frame rate of camera is determined by the frame period between the rising edges of the external trigger pulse, as shown in the figure below.

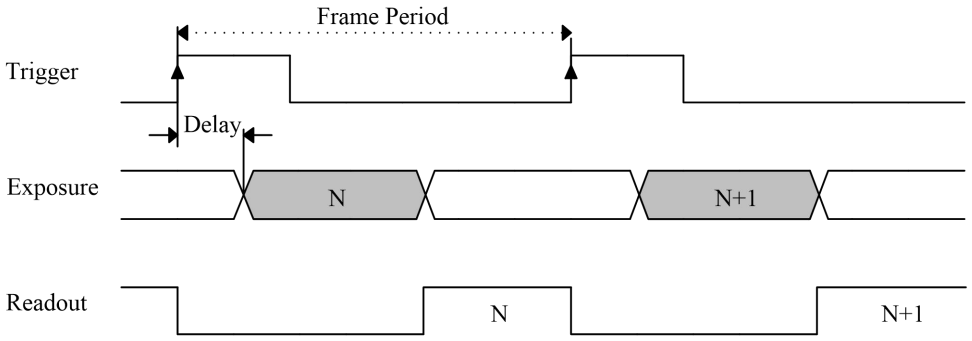


Fig. 14 External Pulse Mode

External trigger signal can be input from CoaXPress interface or 4-pin control interface, and the input source could be selected by users. 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 this fast mode, since it is necessary to ensure that the readout stages of two frames do not conflict, the external trigger with an interval less than 1 frame readout time will be automatically ignored by camera, as shown in the figure below.

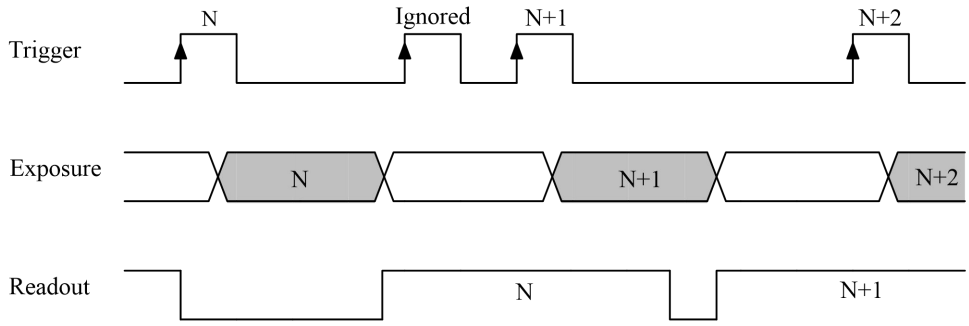


Fig. 15 Frame Period of External Trigger is Too Short

6.1.3 External PWM Mode

In External PWM mode, camera exposure starts at the rising edge and ends at the falling edge of the external trigger signal. That is, actual exposure time is equal to the high level duration of the external trigger, and frame period is equal to the pulse interval.

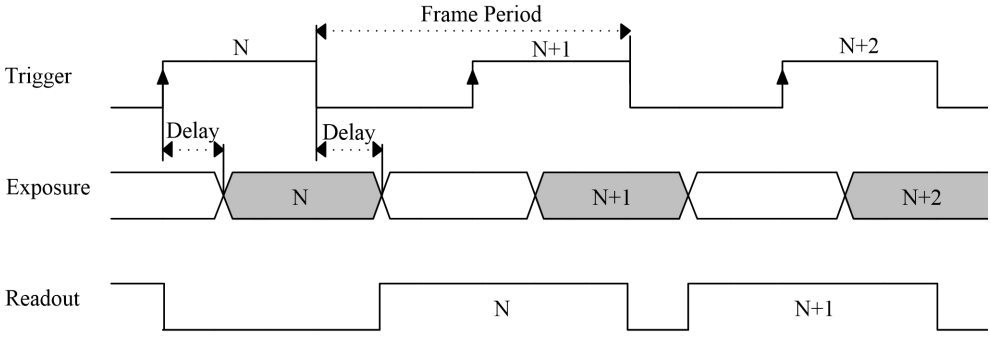


Fig. 16 High Level Trigger Mode

Please note that in this mode, the width of external trigger high level should be greater than minimum exposure time. In fact, for pulses less than minimum exposure time, camera will always process them according to minimum exposure time.

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. Therefore, in this mode, it should be ensured that the frame period between the falling edges of adjacent external triggers is greater than one-frame readout time.

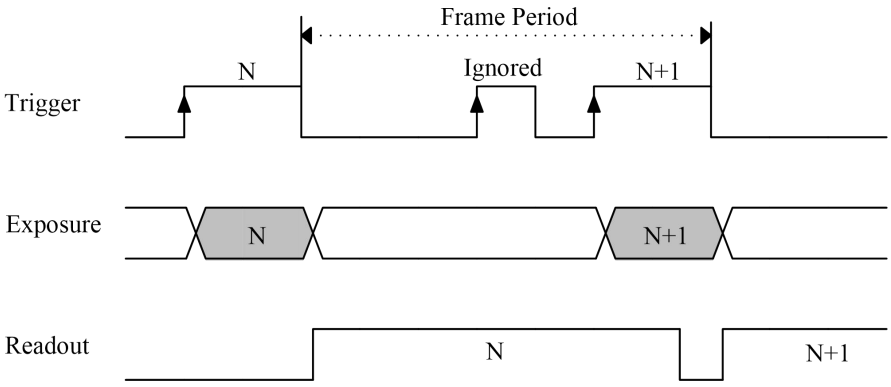


Fig. 17 Frame Period of External Trigger is Too Short

6.2 Region of Interest

Region of interest (ROI) is part of a specified sensor array. Users can obtain frame data from a specified part of the 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, the ROI is determined to be an overlap of the two regions, as shown in the figure below.

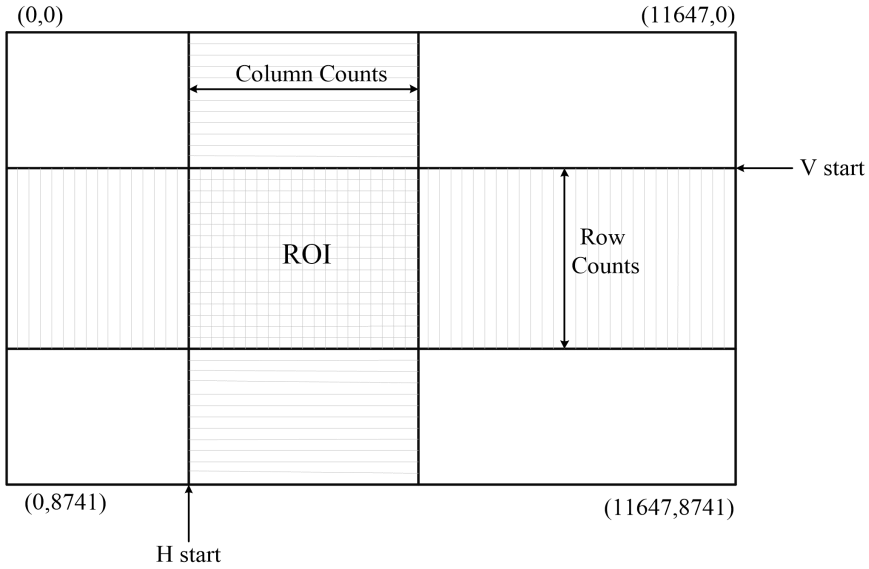


Fig. 18 Region of Interest

Table 5 Maximum Frame Rate Depending on ROI Values(8bit)

ROI Size H	ROI Size V	8bit
11648	8742	8.50fps
10000	8742	8.50fps
8992	8742	8.50fps
8000	8742	8.50fps
6992	8742	8.50fps
6000	8742	8.50fps
4992	8742	8.50fps
4000	8742	8.50fps

2992	8742	8.50fps
2000	8742	8.50fps
1024	8742	8.50fps
11648	8000	9.28fps
11648	7000	10.58fps
11648	6000	12.31fps
11648	5000	14.72fps
11648	4000	18.30fps
11648	3000	24.19fps
11648	2048	34.85fps

Table 6 Maximum Frame Rate Depending on ROI Values(10/12bit)

ROI Size H	ROI Size V	10bit	12bit
11648	8742	8.50fps	7.83fps
9984	8742	8.50fps	7.83fps
8960	8742	8.50fps	7.83fps
8000	8742	8.50fps	7.83fps
6976	8742	8.50fps	7.83fps
5952	8742	8.50fps	7.83fps
4992	8742	8.50fps	7.83fps
3968	8742	8.50fps	7.83fps
2944	8742	8.50fps	7.83fps
1984	8742	8.50fps	7.83fps
1024	8742	8.50fps	7.83fps
11648	8000	9.28fps	8.54fps
11648	7000	10.58fps	9.75fps
11648	6000	12.31fps	11.34fps
11648	5000	14.72fps	13.56fps
11648	4000	18.30fps	16.85fps
11648	3000	24.19fps	22.27fps
11648	2048	34.85fps	32.09fps

6.3 Binning

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

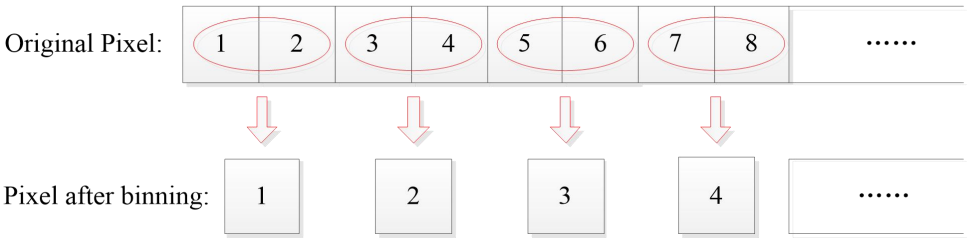


Fig. 19 Horizontal 2x1 Binning

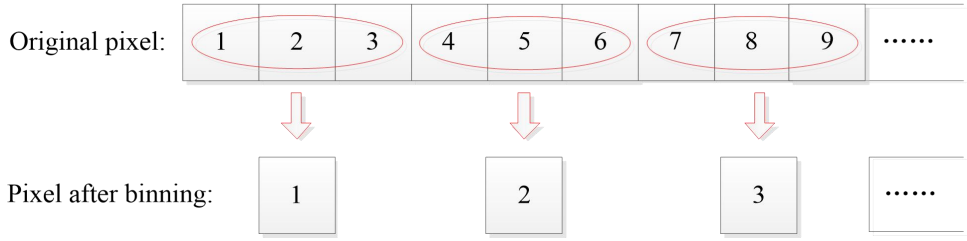


Fig. 20 Horizontal 3x1 Binning

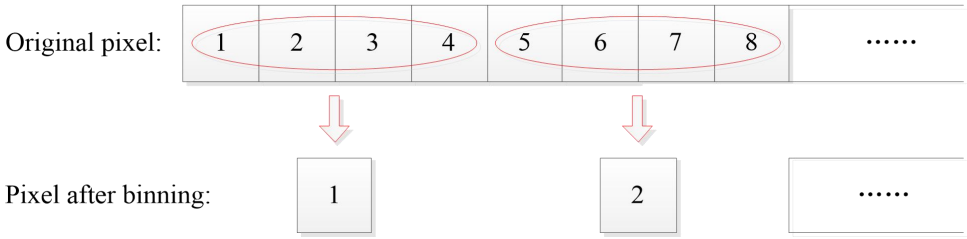


Fig. 21 Horizontal 4x1 Binning

6.4 LUT

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

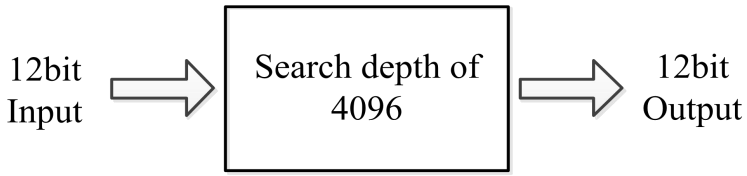


Fig. 22 LUT Structure

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

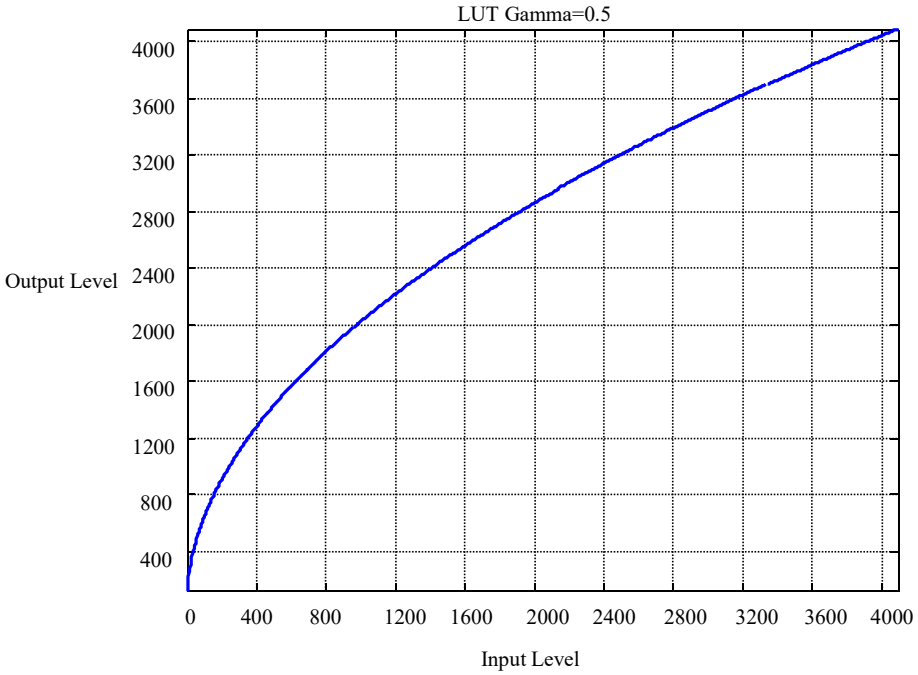


Fig. 23 LUT: Gamma = 0.5

6.5 Defect Pixel Correction

Due to 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. TTS101M(2)CXP camera provides with defect pixel automatic correction feature. The defect pixel information of 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 camera.

Correction method of defect 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 camera, defect pixel values are replaced by adjacent pixel values.
- For color camera, defect pixel values are replaced by separated pixel values.

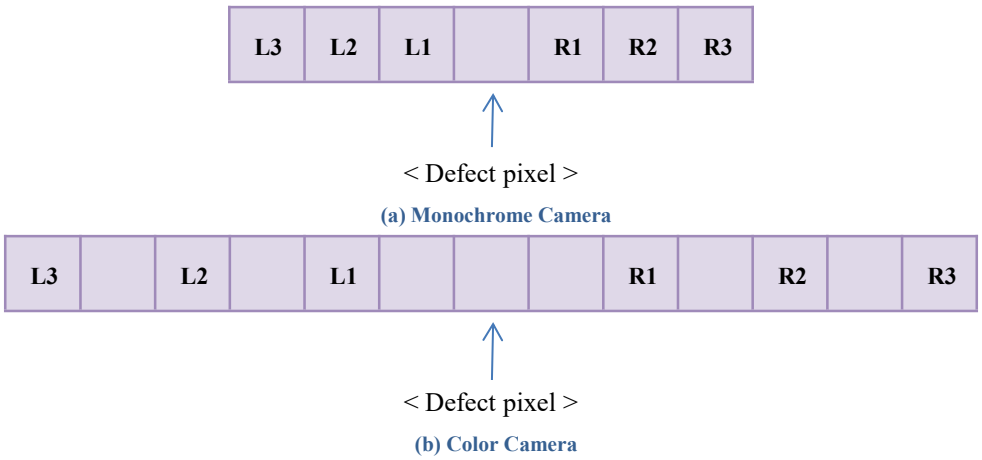


Fig. 24 Defect Pixel Correction Methods for Different Cameras

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 7 Calculation Defect Pixel Correction Value

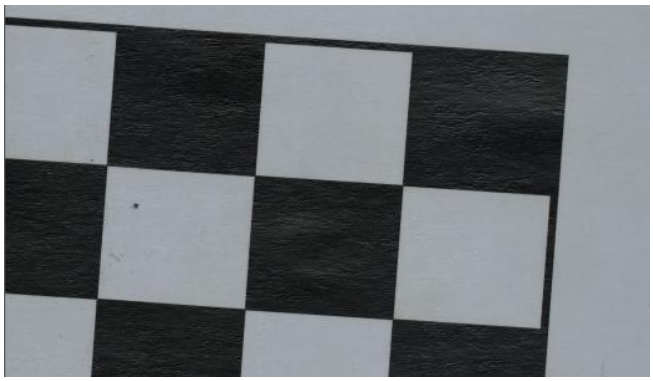
Adjacent Defect Pixel(s)	Correction value of Current Pixel
None	L1
L1	R1
R1	L1
L1,R1	L2
L1,R1,L2	R2
L1,R1,L2,R2	L3
L1,R1,L2,R2,L3	R3

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.

TTS101M(2)CXP 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 the coefficient to make the 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. 25 White Balance

6.7 Test Image

Camera provides 2 test images. Different from the collected images whose data comes from sensors, the test images are fixed patterns that are pre-edited and stored inside the camera, independent of the scene shot by the camera, and can be used to test whether the data link works normal.

The camera provides test images as shown in the figure below.

- Test image 1: fixed image with horizontal gray gradient.
- Test image 2: scroll image with vertical gray gradient.

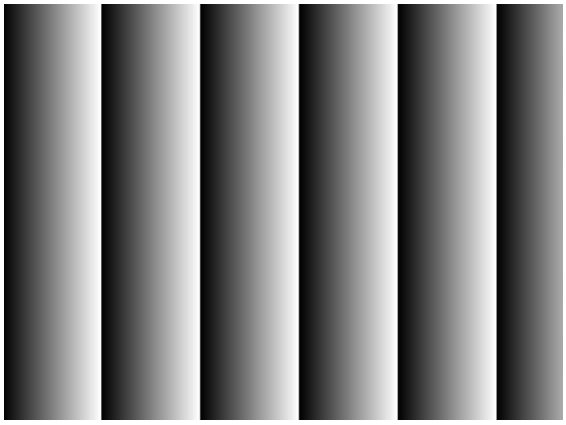


Fig. 26 Test Image 1

Fig. 27 Test Image 2

6.8 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 the image output by the camera and the actual signal, that is, the output data of the camera is different for the signal with the same brightness. TTS101M(2)CXP camera provides a flat field correction function to correct this problem. Actually, users can achieve flat field effect by by flat field correction.

Taking into account the pixel array scale and vignetting effect of area scan cameras, this camera uses 64 x 64 pixel block data, combined with image algorithms to achieve real-time flat field correction algorithms. The fundamental is shown in the figure below:

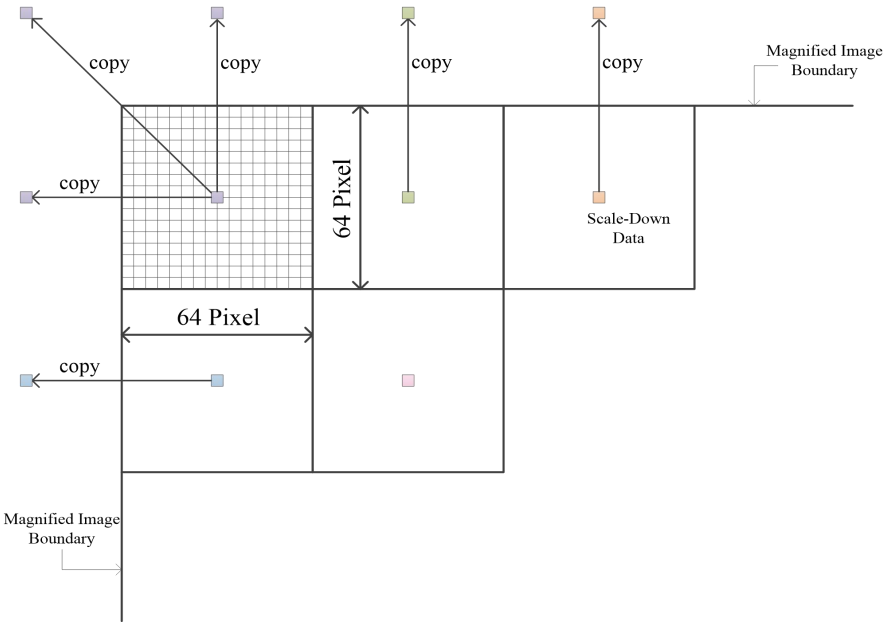


Fig. 28 Flat Field Correction Schematic

6.9 Strobe

Strobe signal is used to synchronize the external light source with the camera. As a Rolling Shutter type camera, TTS101M(2)CXP camera requires the camera or the target to stand still during exposure, otherwise smearing may happen. The strobe signal can be used as a basis to judge whether the exposure is over.

6.9.1 Strobe Signal Type

TTS101M(2)CXP camera provides two modes of strobe signal: Wide Strobe and Narrow Strobe.

- Wide Strobe: Strobe signal goes high when the exposure time for the top line of pixels begins and goes low when the exposure time for the bottom line of pixels ends.
- Narrow Strobe: Strobe signal goes high when the exposure time for the bottom line of pixels begins and goes low when the exposure time for the top line of pixels ends.

Narrow Strobe mode is only valid when the exposure time is greater than the readout time. The following figure shows strobe output timing sequence for Wide Strobe mode / Narrow Strobe mode.

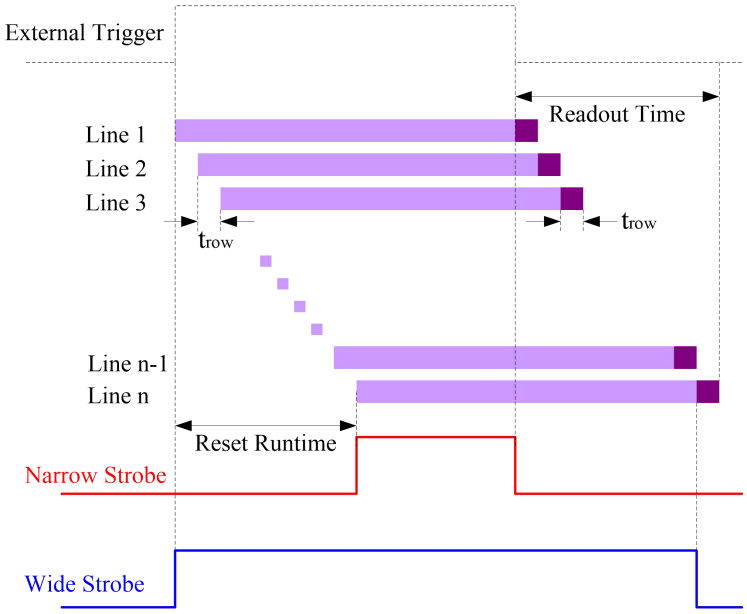


Fig. 29 Strobe Signal (Polarity：High)

6.9.2 Strobe Signal Polarity

TTS101M(2)CXP camera supports setting of the polarity of strobe output signal. Refer to the command list below for the setting command. Strobe polarity settings comprise high or low.

- High: High level effective, strobe signal defaults to low level, transitions to high level at the beginning of exposure.
- Low: Low level effective, strobe signal defaults to high level, transitions to low level at the beginning of exposure.

6.10 Data Format

TTS101M(2)CXP camera processes data in 12bit data format, but provides 8bit, 10bit and 12bit output. When the camera outputs 8bit data, the lowest 4bit data will be deleted. When the camera outputs 10bit of data, the lowest 2bit will be deleted.

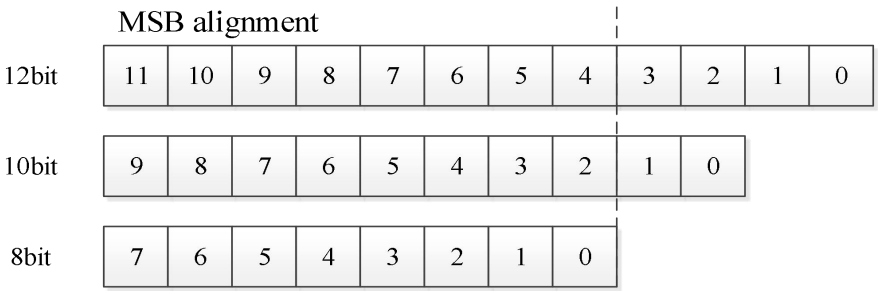


Fig. 30 Data Format

6.11 Gain and Offset

The camera gain is divided into the analog gain and digital gain.

Analog gain acts on analog signals, and usually increasing the analog gain can achieve stronger response under weak lighting, thereby achieving higher signal-to-noise ratio. Users can configure the analog gain of this camera. Similarly, analog offset is generally used to adjust the black level position of front-end sensors.

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

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

Data value (Output) = Data value (digital gain=1 & digital offset=0) * 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 12bit data. If the image data is 10bit or 8bit, the actual digital offset will be divided by 4 or 16.

6.12 Camera Temperature

TTS101M(2)CXP supports real-time acquisition of temperature. Users can read the camera temperature value to monitor the current temperature value of the sensor or make some responses according to the temperature value.

The recommended operating environment temperature of the camera is 0~50°C. If users detect an abnormal internal temperature (such as over 60°C), it is recommended to stop the camera immediately to avoid component damage. Power off and contact our technical support in time.

6.13 Load / Save Configuration

TTS101M(2)CXP camera provides three working parameter sets to meet the use demand in most scenarios. Among them, the factory parameter set has already been optimized and cannot be modified by users. The camera is provided with two user operating parameter sets, among which the internal parameters can be modified and saved by users. The saved operating parameter set will be automatically loaded upon power-on next time.

If the camera is found abnormal after modification of the parameters, users can restore the camera to the factory parameter set.

7 Camera Control

7.1 GenICam Standard

GenICam standard, promulgated by European Machine Vision Association (EMVA), provides a unified programming interface for all types of industrial cameras. The programming interface (API) is the same regardless of which transmission protocol the camera uses or which functions it implements. It mainly contains the following three modules:

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

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

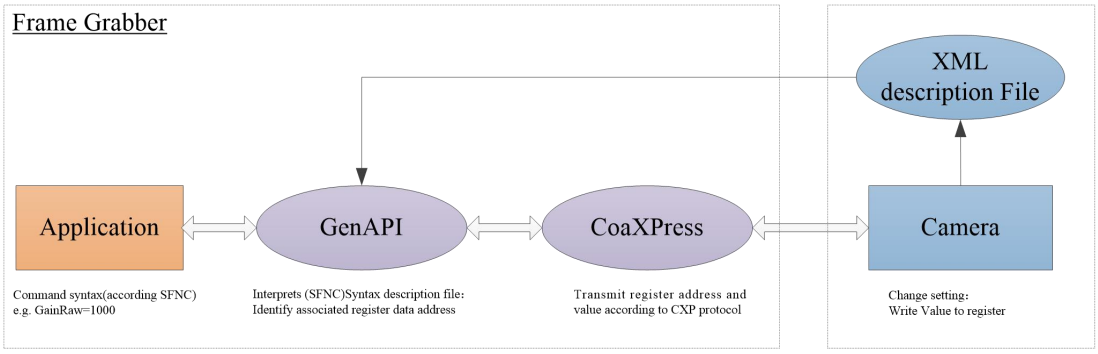


Fig. 31 Communication Principle Diagram Between Application and Camera

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

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

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

7.2 GenAPI Parameter Attributes

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

(1) Register name

Each parameter is identified by a unique name. Most 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 the 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 the frame grabber to assign a display type to parameter.

Table 8 Overview of Parameter Interface

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

(5) Parameter access

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

(6) Parameter range

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

7.3 Register Classification

7.3.1 Bootstrap Customized Registers

Table 9 Bootstrap Customized Registers

Name	Address	Size	Interface	Access	Visibility
Standard	0x0	4	I	RO	Beginner
Revision	0x4	4	I	RO	Beginner
XmlManifestSize	0x8	4	I	RO	Guru
XmlManifestSelector	0xc	4	I	RW	Guru
XmlVersion	0x10	4	I	RO	Guru
XmlSchemeVersion	0x14	4	I	RO	Guru
XmlUrlAddress	0x18	4	I	RO	Guru

Iidc2Address	0x1c	4	I	RO	Guru
ConnectionReset	0x4000	4	I	RW	Guru
DeviceConnectionID	0x4004	4	I	RO	Guru
MasterHostConnectionID	0x4008	4	I	RW	Guru
ControlPacketSizeMax	0x400c	4	I	RO	Guru
StreamPacketSizeMax	0x4010	4	I	RW	Guru
ConnectionConfig	0x4014	4	E	RW	Beginner
ConnectionConfigDefault	0x4018	4	E	RO	Beginner
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)
  - CXP6_X1 (65608)
  - CXP3_X2 (131128)
  - CXP6_X2 (131144)
  - CXP3_X4 (262200)
  - CXP6_X4 (262216)

- **ConnectionConfigDefault**

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

  - CXP3_X1 (65592)
  - CXP6_X1 (65608)
  - CXP3_X2 (131128)
  - CXP6_X2 (131144)
  - CXP3_X4 (262200)
  - CXP6_X4 (262216)

- **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)
  - CXP6_X1 (65608)
  - CXP3_X2 (131128)
  - CXP6_X2 (131144)
  - CXP3_X4 (262200)
  - 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**
  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 Registers

Table 10 Device Control Registers

Name	Address	Size	Interface	Access	Visibility
DeviceVendorName	0x2000	32	S	RO	Beginner
DeviceModelName	0x2020	32	S	RO	Beginner
DeviceManufacturerInfo	0x2040	48	S	RO	Beginner
DeviceVersion	0x2070	32	S	RO	Beginner
DeviceSerialNumber	0x20b0	16	S	RO	Expert
DeviceUserID	0x20c0	16	S	RO	Beginner
SensorTemperature	0x6014	4	F	RO	Expert
FPGATemperature	0x6018	4	F	RO	Expert
MCUTemperature	0x6010	4	F	RO	Expert
Humidity	0x6164	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.

- **SensorTemperature**
  Sensor temperature.

- **FPGA Temperature**
  FPGA temperature.

- **MCUTemperature**
  MCU temperature.

- **Humidity**
  Humidity.

7.3.3 Image Format Control Registers

Table 11 Image Format Control Registers

Name	Address	Size	Interface	Access	Visibility
Width	0x6000	4	I	RW	Beginner
Height	0x6004	4	I	RW	Beginner
OffsetX	0x6008	4	I	RW	Beginner
OffsetY	0x6024	4	I	RW	Beginner
Binning	0x6118	4	E	RW	Beginner
PixelFormat	0x6020	4	E	RW	Beginner
VideoMode	0x6038	4	E	RW	Guru
DeviceTapGeometry	0x6030	4	E	RO	Expert
Image1StreamID	0x6034	4	I	RO	Guru

- **Width**
  Actual camera output width.

- **Height**
  Actual camera output height. The parameter range is as follows:
  - Maximum: 2048
  - Minimum: 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

- **Binning**

  Binning. The enumeration names and values are as follows:

  - Binning_1x1 (0)
  - Binning_2x1 (1)
  - Binning_3x1 (2)
  - Binning_4x1 (3)

- **PixelFormat**

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

  - Mono8 (17301505): Monochrome 8bit
  - Mono10 (17825795): Monochrome 10bit
  - Mono12 (17825797): Monochrome 12bit
  - BayerRG8 (17301513): Bayer RGGB 8bit
  - BayerRG10 (17825805): Bayer RGGB 10bit
  - BayerRG12 (17825809): Bayer RGGB 12bit

- **VideoMode**

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

  - Original (0): Original image
  - Corrected (1): Corrected image
  - TestPattern1 (2): Test image1
  - TestPattern2 (3): Test image2

- **DeviceTapGeometry**

  Tap arrangement. The enumeration names and values are as follows:

  - Geometry_1X_1Y (0)

- **Image1StreamID**

  Data stream1 index.

7.3.4 Acquisition Control Registers

Table 12 Acquisition Control Registers

Name	Address	Size	Interface	Access	Visibility
AcquisitionMode	0x603c	4	E	RW	Beginner
AcquisitionStart	0x6040	4	C	RW	Beginner
AcquisitionStop	0x6044	4	C	RW	Beginner
AcquisitionFrameRate	0x6174	4	F	RW	Beginner
ExposureMode	0x6178	4	E	RW	Beginner
ExposureTime	0x6048	4	I	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.

- **AcquisitionFrameRate**

  Acquisition frame rate in Hz. The parameter range is as follows:

  - Maximum:100
  - Minimum:0

- **ExposureMode**

  Exposure mode. Please refer to Section 6.1 for specific descriptions. The enumeration names and values are as follows:

  - Timed (0): Free-run mode
  - TriggerPulse (1): External pulse mode
  - TriggerWidth (2): External PWM mode

- **ExposureTime**

  Exposure time, unit is us.

7.3.5 IO Control Registers

Table 13 IO Control Registers

Name	Address	Size	Interface	Access	Visibility
TriggerSource	0x6054	4	E	RW	Beginner
TriggerDelayTime	0x605c	4	I	RW	Beginner
TriggerActivation	0x6058	4	E	RW	Beginner
FlashStrobeMode	0x6060	4	E	RW	Beginner
FlashStrobeActivation	0x6064	4	E	RW	Beginner

- **TriggerSource**

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

  - CXP(0): CXP signal
  - IO_Connector(1): 4 pin interface signal

- **TriggerDelayTime**

  Trigger delay time, in units of us. The parameter range is as follows:

- Maximum value: 100000
- Minimum value: 0
- Incerment: 1

- **TriggerActivation**

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

- **FlashStrobeMode**

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

- **FlashStrobeActivation**

  Strobe signal polarity. The enumeration names and values are as follows:
  - FallingEdge (1): Default high level, generate strobe signal at falling edge of exposure
  - RisingEdge (0): Default low level, generate strobe signal at rising edge of exposure

7.3.6 Analog Control Registers

Table 14 Analog Control Registers

Name	Address	Size	Interface	Access	Visibility
AnalogueGain	0x6088	4	I	RW	Beginner
AnalogueOffset	0x606c	4	I	RW	Beginner

- **AnalogueGain**

  Analog gain. The parameter range is as follows:
  - Maximum: 96
  - Minimum: 0
  - Incerment: 1

- **AnalogueOffset**

  Analog offset. The parameter range is as follows:
  - Maximum: 4095
  - Minimum: 0
  - Incerment: 1

7.3.7 Digital Control Registers

Table 15 Digital Control Registers

Name	Address	Size	Interface	Access	Visibility
DigitalGain	0x6070	4	F	RW	Beginner

DigitalOffset	0x6074	4	I	RW	Beginner
WhiteBalanceRedGain	0x6078	4	I	RW	Expert
WhiteBalanceGreenGain	0x607c	4	I	RW	Expert
WhiteBalanceBlueGain	0x6084	4	I	RW	Expert
WhiteBalanceEnable	0x6088	4	B	RW	Expert
WhiteBalanceInitialize	0x608c	4	C	WO	Expert
WhiteBalanceCalibrate	0x608c	4	C	WO	Expert
BlackLevel	0x6144	4	I	RW	Guru

- **DigitalGain**

  Digital gain. The parameter range is as follows:
  - Maximum: 30
  - Minimum: 0.01
  - Incerment: 0.01

- **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: 16383
  - Minimum: 1024
  - Increment: 1

- **WhiteBalanceGreenGain**

  White balance G channel gain, only color camera can set this parameter. The parameter range is as follows:
  - Maximum: 16383
  - Minimum: 1024
  - Increment: 1

- **WhiteBalanceBlueGain**

  White balance B channel gain, only color camera can set this parameter. The parameter range is as follows:
  - Maximum: 16383
  - 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.

- **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: 16383
  - Minimum: 0
  - Increment: 1

7.3.8 Flat Field Correction Registers

Table 16 Flat Field Correction Registers

Name	Address	Size	Interface	Access	Visibility
FF_Enable	0x6090	4	B	RW	Expert
FF_Calibrate	0x6094	4	C	WO	Expert
FF_RestoreFactory	0x6094	4	C	WO	Expert

- **FF_Enable**

Enable flat field correction.

- **FF_Calibrate**

Perform flat field correction.

- **FF_RestoreFactory**

Restore factory settings for flat field correction.

7.3.9 Defect Pixel Registers

Table 17 Defect Pixel Registers

Name	Address	Size	Interface	Access	Visibility
DefectPixelCorrectionEnable	0x6098	4	B	RW	Guru
DefectPixelTotal	0x609c	4	I	RO	Expert
DefectPixelSelect	0x60a0	4	I	RW	Expert
DefectPixelReadX	0x60a4	4	I	RO	Expert
DefectPixelReadY	0x60a8	4	I	RO	Expert

DefectPixelWriteX	0x60ac	4	I	RW	Expert
DefectPixelWriteY	0x60b0	4	I	RW	Expert
DefectPixelAdd	0x60b4	4	C	WO	Expert
DefectPixelRemove	0x60b8	4	C	WO	Expert
DefectPixelClearAll	0x60bc	4	C	WO	Expert
DefectPixelSave	0x60c0	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: 14191
  - Minimum: -63
  - Increment: 1

- **DefectPixelWriteY**

  Write the Y coordinate of defect pixel. The parameter range is as follows:
  - Maximum: 10639
  - Minimum: -63

- Increment: 1

- **DefectPixelAdd**
  Add defect pixel.

- **DefectPixelRemove**
  Remove current defect pixels.

- **DefectPixelClearAll**
  Remove all defect pixels.

- **DefectPixelSave**
  Save defect pixels.

7.3.10 Cooler Control Registers

Table 18 Cooler Control Registers

Name	Address	Size	Interface	Access	Visibility
FanSpeed	0x61c8	4	I	RW	Expert
TECCoolerEnable	0x60c4	4	B	RW	Expert
TECTemperature	0x60c8	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: 55
  - Minimum: -10
  - Increment: 1

7.3.11 LUT Control Registers

Table 19 LUT Control Registers

Name	Address	Size	Interface	Access	Visibility
LUTEnable	0x60cc	4	B	RW	Expert
LUTSelector	0x60d0	4	I	RW	Expert

LUTIndex	0x60d4	4	I	RW	Expert
LUTValue	0x60d8	4	I	RW	Expert
Gamma	0x60dc	4	F	RW	Beginner

- **LUTEnable**

  Enable LUT function.

- **LUTSelector**

  Select LUT. 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 coefficient. The parameter range is as follows:

  - Maximum: 127
  - Minimum: 0.01

7.3.12 User Set Control Registers

Table 20 User Set Control Registers

Name	Address	Size	Interface	Access	Visibility
UserSetSelector	0x60e0	4	E	RW	Beginner
UserSetLoad	0x60e4	4	C	WO	Beginner
UserSetSave	0x60e8	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.

8 FAQ

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

① Ensure that the CoaXPress interface cable is OK.

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

- **If the 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 acquire images, ensure that the Frame Grabber and supporting software are operating properly, which can be checked by restarting the computer.

③ Ensure that the CoaXPress interface cable is OK.

- **If the camera has no image output in External Pulse 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).

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

- **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 is 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 whether the CoaXPress interface is normal 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 Pulse 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.